The Severn Estuary / Môr Hafren European Marine Site

comprising :

The Severn Estuary / Môr Hafren Special Area of Conservation (SAC)

The Severn Estuary Special Protection Area (SPA)

The Severn Estuary / Môr Hafren Ramsar Site

Natural England & the Countryside Council for Wales' advice given under Regulation 33(2)(a) of the Conservation (Natural Habitats, &c.) Regulations 1994, as amended.

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NATURAL ENGLAND

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

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Welsh Assembly Government
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SUMMARY

This document contains Natural England and the Countryside Council for Wales' (CCW's) advice issued under Regulation 33 of the Conservation (Natural Habitats, &c.) Regulations 1994, for the *Severn Estuary European Marine Site (EMS,) which comprises the Special Area of Conservation (SAC), Special Protection Area (SPA), and Ramsar site*, namely conservation objectives and advice on operations. It also includes an explanation of the purpose and format of Natural England and CCW's "Regulation 33 advice".

Section 1 provides the legal basis and practical requirements for setting conservation objectives for Natura 2000 sites, as understood by Natural England and CCW. It also briefly explains the legal and practical basis of the operations advice.

Section 2 details the qualifying features for the Severn Estuary SAC, SPA and Ramsar site under the EU Habitats and Birds directives and the Convention on Wetlands of International Importance.

Section 3 provides a description of the features of the Severn Estuary EMS

Section 4 contains Natural England and CCW's advice as to the conservation objectives (Regulation 33(2)(a)) for SAC, SPA and Ramsar site. This section also includes the favourable condition tables for the SAC, SPA and Ramsar site.

Section 5 contains Natural England and CCW's advice on operations which may cause deterioration or disturbance of the habitats and species for which the SAC, SPA and Ramsar 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 these sites and the requirements of the Habitats Regulations and government policy.

Section 6 contains the references.

Section 7 contains a glossary of terms.

Appendices 1-9 provide maps of the extent of the SAC, SPA and Ramsar designations; the indicative extent of the habitat features, and sub features where information is available; and the low-tide distribution of birds.

Appendices 10-11 provide additional background information useful to the understanding of this advice.

Notes :

CCW and Natural England's predecessor English Nature, issued advice under Regulation 33(2)(a) and 33(2)(b) in relation to the SPA in February 2005 which is now superseded by this document.

This advice does not cover the terrestrial areas of the Severn Estuary SPA (ie ground which lies behind flood defences and which are not subject to the tidal influence of the estuary and are not therefore within the European Marine Site.

CCW and Natural England also issued advice under Regulation 33(2)(a) in relation to the cSAC in June 2008 which is also superseded by this document.

1. Introduction

This document provides advice under Regulation 33 (2) for the Severn Estuary European Marine Site (EMS), which comprises the following sites :

- Severn Estuary Special Area of Conservation (SAC)*
- Severn Estuary Special Protection Area (SPA)
- Severn Estuary Ramsar Site

(*At the time of issue of this document the Severn Estuary has been accepted by the European Commission as a Site of Community Importance (SCI) but formal notices have not yet been issued (expected to take place in 2009). Given the imminent notification of the SAC the Severn Estuary SCI is referred to as SAC throughout this document).

The indicative extent and relationship of these designated sites is shown in Appendix 1

This document:

- is designed to help relevant and competent authorities responsible for complying with the requirements of the Habitats Directive to understand the international importance of the site and the underlying physical and ecological processes supporting the habitats and species for which each of the above designated sites has been selected.
- is intended to assist the relevant authorities to develop, if considered appropriate, a management scheme under Regulation 34 of the Habitats Regulations, under which they shall exercise their functions in accordance with the requirements of the Directive;
- contains Natural England and CCW's advice to competent authorities as to the conservation objectives of each of the above designated sites, for the purpose of considering plans and projects in accordance with Article 6 of the Habitats Directive and Parts IV and IVa of the Habitats Regulations. Natural England and CCW will provide more detailed advice to competent authorities to assess the implications of particular plans or projects, where appropriate, at the time those plans or projects are being considered.

Anyone proposing to undertake plans or projects with a potential impact on site features are encouraged to consult Natural England or CCW early in the planning stages to identify possible issues of concern.

The advice in this document is subject to review by Natural England and CCW, for example to:

- add further advice on monitoring requirements in order to assess the degree to which the conservation objectives are being achieved in future;
- add further advice on operations likely to damage the features for which the SPA, SAC and Ramsar Site are selected (under Habitats Regulation 33(2)(b));
- take account of new information about the SPA, SAC and Ramsar site or its features, or any future changes to the designations.

Notes :

CCW and Natural England's predecessor English Nature, issued advice under Regulation 33(2)(a) and 33(2)(b) in relation to the SPA in February 2005 which is now superseded by this document.

This advice does not cover the terrestrial areas of the Severn Estuary SPA (ie ground which lies behind flood defences are which are not subject to the tidal influence of the estuary and are not therefore within the European Marine Site.

CCW and Natural England also issued advice under Regulation 33(2)(a) in relation to the cSAC in June 2008 which is also superseded by this document.

1.1 Natura 2000

The European Union Habitats[1] and Birds[2] Directives are international obligations which set out a number of actions to be taken for nature conservation. They represent 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[3].The Habitats Directive aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements, and sets out measures to maintain or restore, natural habitats and species of European Union interest at favourable conservation status[4].

European sites include Special Areas of Conservation (SACs) designated under the 1992 Habitats Directive, which support natural habitats and species of European importance, and Special Protection Areas (SPAs) classified under the 1979 Birds Directive, which support internationally important wild bird populations. UK and Welsh Assembly Government policy also requires that Ramsar sites should receive the same level of protection as European sites[5].

The Habitats Directive is given effect in the UK largely through the Conservation (Natural Habitats, &c.) Regulations 1994 ("the Habitats Regulations")[6]. 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 will form a network of conservation areas to be known as 'Natura 2000'. Where SAC or SPA consist of marine areas they are referred to as European Marine Sites.[7]

There are various sources of guidance on the legal framework for European sites and European Marine Sites.[8]

A note on Ramsar :
The Convention on Wetlands of International Importance especially as Waterfowl Habitats (Ramsar Convention) was signed in Ramsar, Iran in 1971. The broad objectives of the Convention are to stem the loss and progressive encroachment on wetlands now and in the future, including through the designation of Ramsar sites.

A habitat can qualify as a Ramsar site for its representation of a wetland, or for the plant or animal species, including waterbirds, that it supports.

In accordance with Office of the Deputy Prime Minister (2005) *Planning Policy Statement 9: Biological and Geological Conservation*, Welsh Office Planning Guidance *Technical Advice Note No. 5* (TAN5), the DETR and NAW statements *Ramsar Sites in England* (November 2000) and *Ramsar Sites in Wales* (February

[1] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.
[2] Council Directive 79/409/EEC on the conservation of wild birds.
[3] 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/)
[4] A habitat or species is defined as being at favourable conservation status 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.
[5] Office of the Deputy Prime Minister (2005) *Planning Policy Statement 9: Biological and Geological Conservation,* Welsh Assembly Government (2006) *Draft Revised Technical Advice Note 5 Nature Conservation and Planning,* DETR (2000) *Ramsar sites in England*, National Assembly for Wales (20010, *Ramsar sites in Wales*.
[6] SI 1994/2716, HMSO, London. http://www.legislation.hmso.gov.uk/si/si1994/uksi_19942716_en_1.htm)
[7] "Marine areas" are defined in the Habitats Regulations as areas "continuously or intermittently covered by tidal waters or any part of the sea in or adjacent to Great Britain up to the limit of territorial waters."
[8] *European Marine Sites in England & Wales: A guide to the Conservation (Natural Habitats &c.) Regulations 1994 and to the Preparation and Application of Management Schemes* (DETR & The Welsh Office, 1998), Office of the Deputy Prime Minister (2005) *Planning Policy Statement 9: Biological and Geological Conservation,* Welsh Assembly Government (2006*) Draft Revised Technical Advice Note 5 Nature Conservation and planning,* CCW (undated) *Natura 2000: European wildlife sites.*

2001); Ramsar sites classified under the Convention on Wetlands of International Importance should be given the same consideration as European sites when considering plans and projects that may affect them.

1.2 The role of Natural England and the Countryside Council for Wales

Regulation 33 of the Habitats Regulations requires Natural England and the Countryside Council for Wales (CCW) to advise the relevant authorities[9] for each European Marine Site in, or partly in, England and 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 Natural England and CCW's advice under Regulation 33 in relation to the designated sites which comprise the Severn Estuary EMS.

The Conservation (Natural Habitats &c.) Regulations 1994, as amended transpose the Habitats Directive into law in Great Britain. They give Natural England and CCW a statutory responsibility to advise relevant authorities as to the conservation objectives for European Marine Sites and Ramsar Sites in England and Wales and to any operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species for which the sites have been designated. This information will be a key component of any management scheme that may be developed for this site. It will also aid competent authorities in defining the scope and nature of 'appropriate assessment' which the Habitats Directive requires to be undertaken for 'plans and projects' having a significant effect on the European site (Habitats Regulations 20, 48, 50, 60-62 and 85B). Note that Natural England and CCW will also advise competent authorities on individual plans and projects as they arise. Natural England and CCW are also competent and relevant authorities under the Habitats Regulations.

1.3 The precautionary principle

The advice on operations contained within this package has been made based on the precautionary principle and any actions which may need to be taken in response to concerns identified as a result of monitoring undertaken by Natural England and the Countryside Council for Wales will also be made on this basis. All forms of environmental risk should be tested against the precautionary principle which means that where there are real risks to the site, lack of full scientific certainty should not be used as a reason for postponing measures that are likely to be cost effective in preventing such damage. It does not however imply that the suggested cause of such damage must be eradicated unless proved to be harmless and it cannot be used as a licence to invent hypothetical consequences. Moreover, it is important, when considering whether the information available is sufficient, to take account of the associated balance of likely costs, including environmental costs, and benefits (DETR & the Welsh Office, 1998).

1.4 The role of other competent and relevant authorities

The Conservation (Natural Habitats &c.) Regulations 1994 require competent authorities to exercise their functions so as to secure compliance with the requirements of the Habitats and Birds Directives. The term "competent authority" includes all public bodies and statutory undertakers. The Regulations identify a number of competent authorities as "relevant authorities", with particular functions in relation to European Marine Sites. In addition to their duties as competent authorities, under Regulation 34 the relevant authorities may establish a management scheme for a European Marine Site under which they shall exercise their relevant functions. Such a management scheme should be guided by the information contained in this document. Relevant authorities must, within their areas of jurisdiction, have regard to both direct and indirect effects on an interest feature of the site. This may include consideration of issues outside the boundary of the European Marine Site.

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

Relevant authorities should ensure that all plans for the area integrate with the management scheme for the European Marine Site. Such plans may include Shoreline Management Plans, the Environment Agency's Flood Risk Management Strategy and Catchment Flood Management Plans, Local Development Plans/ Frameworks, Sites of Special Scientific Interest management plans, local Biodiversity Action Plans and sustainable development strategies for estuaries. This must occur to ensure that there is only a single management scheme through which all relevant authorities exercise their duties under the Conservation (Natural Habitats &c.) Regulations 1994.

Relevant authorities also need to have regard to changing circumstances of the European Marine Site and may therefore need to modify the management scheme and/or the way in which they exercise their functions so as to maintain the favourable condition of interest features concerned in the long term. There is no requirement for relevant authorities to take any actions outside their statutory functions. For the purposes of this document the term 'interest feature' refers to any of the habitat types or species for which the European Marine Sites have been designated.

Under certain circumstances, where another relevant authority is unable to act for legal reasons, or where there is no other relevant authority, Natural England and CCW are empowered to use their bylaw-making powers under Regulation 36 of the Habitats Regulations 1994.

None of the information contained in this document legally binds any organisation (including Natural England and 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 on 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"[10], if such a scheme is established.

1.5 Responsibilities under other conservation designations

In addition to its SAC, SPA and Ramsar Site status, parts of the Severn Estuary are also notified as Sites of Special Scientific Interest (SSSIs) under the 1981 Wildlife and Countryside Act and Bridgwater Bay is also a National Nature Reserve. The obligations of relevant authorities and other organisations under such designations are not directly affected by the advice contained in this document.

Relevant authorities and others may have obligations towards the conservation of habitats and species that are not features for which the Severn Estuary European Marine Site has been designated, and such obligations are not affected by this document.

1.6 Role of advice 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 4 (conservation objectives and favourable condition tables) and 5 (operations advice) should be read in conjunction with these explanatory notes.

The information contained in this document is based on best available knowledge at time of writing and is subject to review at Natural England and CCW's discretion.

As referred to under section 1.1. above, there are various sources of guidance on the legal framework for European sites and European Marine Sites.[11]

[10] Regulation 34 of the Habitats Regulations.

[11] European Marine Sites in England & Wales: A guide to the Conservation (Natural Habitats &c.) Regulations 1994 and to the Preparation and Application of Management Schemes (DETR & The Welsh Office, 1998), Office of the Deputy Prime Minister (2005) Planning Policy Statement 9: Biological and Geological Conservation, Welsh Assembly Government (2006) Draft Revised Technical Advice Note 5 Nature Conservation and planning, CCW (undated) Natura 2000: European wildlife sites.

1.6.1 Outline of legal context and purpose of conservation objectives

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 as follows;

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 of a species 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

In addition, the Birds Directive requires that, in relation to certain species of birds listed in Annex 1 of the Directive and regularly occurring migratory species, special measures are taken in order to ensure their survival and reproduction in their area of distribution. The species listed in Annex 1 of the Birds Directive are the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution. Species listed on Annex 1 are in danger of extinction, rare or vulnerable. Annex 1 species that regularly occur at levels over 1% of the national population meet the SPA qualifying criteria.

Therefore, the conservation objectives for the Severn Estuary SAC, SPA and Ramsar site represents Natural England and the Countryside Council for Wales' current judgement of the appropriate contribution of the site to the achievement of the favourable conservation status of the habitats and species of the European Marine Site. The conservation objectives in this document are intended to guide relevant and competent authorities in the exercise of their functions to comply with the requirements of the Directives outlined above.

1.7 Condition

Natural England and CCW use the term "favourable condition" for the condition represented by the achievement of the conservation objectives, in other words the desired condition for a designated habitat or a species on an individual site.

On many terrestrial European sites, we know sufficient about the required condition of qualifying habitats to be able to define favourable condition with confidence. In contrast understanding the functioning of large, varied, dynamic marine and estuarine sites, which experience a variety of pressures resulting from historic and current activities, is much more difficult. Consequently it is much harder to precisely define favourable condition in sites like the Severn Estuary. In general the conservation objectives provided are based on a working assumption that the current condition of the features is favourable for most attributes. Nevertheless there are certain instances where the assumption does not apply. In particular some of the intertidal habitats of the Severn are subject to coastal squeeze. Where existing problems *have* been identified, the relevant objectives reflect this.

If it becomes evident that the condition of other features is significantly degraded, and is therefore unfavourable, then restorative management actions will need to be undertaken to return the interest feature to favourable condition. In future revisions of our advice under Regulation 33, Natural England and CCW will keep our assumption under review in light of ongoing and future monitoring and our developing understanding of the features and the factors affecting them.

1.8 Favourable Condition Tables

The detailed information regarding the measures and targets that may be used during site monitoring to determine whether favourable condition is being achieved in practice is presented within the Favourable Condition Tables in section 4.

The favourable condition table specifies the following (in columns from left to right):

- **Features**: interest features for which the SAC, SPA or Ramsar site is selected.
- **Subfeatures**: ecologically important sub-divisions of an interest feature. In the case of a habitat interest feature, subfeatures would be component habitats or communities (eg. defined by type and/or by geographic location within the site). In the case of species interest features, subfeatures include the population itself, or any ecologically relevant subdivisions of the population, and any habitats or communities on which it/they depend.
- **Attributes**: particular characteristics of the features or sub-features which provide an indication of the condition of the feature (eg. total population size, extent of a habitat type).
- **Measures**: what exactly about the attributes will be measured, in terms of the units of measurement to be used, arithmetic nature and an indication of the frequency at which the measurement is taken. An indication of the method that is likely to be used to obtain the observed values of attributes. The method is closely linked to the way in which the measure is expressed. It is important to note that in many cases the precise monitoring method to be used may not be known at this stage.
- **Targets**: These define the attribute values that equate to favourable condition. If changes are observed that are 'significantly' different from the target, this will act as a trigger for further investigation as to the cause of the change, or remedial management action. In general the targets in the favourable condition table are subject to natural processes as set out in the conservation objectives; i.e. where natural processes alone dictate that targets are not met this will not result in the condition of the feature being classed as unfavourable. The term 'subject to natural processes' is explained further in Section 4.1.
- **Comments**: notes on the rationale for the use of each attribute and measure.

The favourable condition table is intended to supplement the conservation objectives, including with respect to the management of established and ongoing activities, future requirements of monitoring and reporting on the condition of the features of the site and, together with the conservation objectives, informs the scope and

nature of any appropriate assessment that may be needed. The table **does not by itself** provide a comprehensive basis on which to assess plans and projects as required under the Habitats Regulations. It should be noted that appropriate assessments are a separate activity to condition monitoring, requiring consideration of issues specific to individual plans or projects. Natural England and CCW will provide more detailed advice to competent and relevant authorities to assess the implications of any given plan or project under the Regulations, where appropriate, at the time a plan or project is being considered.

The favourable condition table specifies the main types of information that Natural England and CCW may use to assess the condition of interest features. On many terrestrial European sites, we know sufficient about the preferred or target condition of qualifying species and habitats to be able to define measures and associated targets for all attributes. In European Marine Sites favourable condition is generally harder to define precisely since our knowledge of features is still developing. Accordingly, in the absence of such information, condition of interest features in European Marine Sites will, in the first instance, be assessed against targets based on their condition at the time the sites were selected, which may need to be established through baseline surveys in many cases.

The information contained within the favourable condition table is not necessarily what will be monitored but provides a basis for discussions with management and advisory groups. The attributes and associated measures and targets may be modified over time. The selection of attributes is based on the current understanding of the habitats and species and the available measuring techniques.

The appropriateness of individual attributes as indicators of condition will be reviewed as more knowledge of the condition of interest features is obtained and/or survey and monitoring techniques develop. Monitoring of the attributes may be of fairly coarse methodology, underpinned by more rigorous methods on specific areas within the site.

The favourable condition table will be an important, but not the only, driver of the site monitoring programme. Other data, such as results from compliance monitoring and appropriate assessments, will also have an important role in assessing condition of interest features. The monitoring programme will be developed as part of the management scheme process through discussion with the relevant authorities and other interested parties. Natural England and the Countryside Council for Wales will be responsible for collating the information required to assess condition, some of which may be collected by other organisations, and for judging the condition of each feature within the site, taking into account all available information and using the favourable condition table as a guide.

The conservation objectives and associated Favourable Condition Tables in this document are intended to guide relevant and competent authorities in the exercise of their functions to comply with the requirements of the Directives outlined above.

1.9 Advice on operations

1.9.1 Legal context

Natural England and 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:

- the necessary conservation measures are established which correspond to the ecological requirements of the habitats and species on the site;
- 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 Natural England and 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.[12] 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.

1.9.2 Practical requirements

Operations manifest themselves through one or more factors[13]. 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.[14] 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'.[15] 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 operations. 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.

Natural England and CCW's advice to the relevant authorities is that, as a minimum, the extent and management of the operations identified in Section 5 should be reviewed in the context of the conservation objectives. The advice should also help to 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.

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

[13] 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.)

[14] 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.

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

The advice in Section 5 of this document is not a list of prohibited operations, or operations necessarily requiring consultation with, or consent[16] from, Natural England or CCW. 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 Natural England, CCW and the relevant authorities.

Note : The advice on operations previously issued for the SPA in February 2005 is superseded by the advice given in Section 5.

[16] However, in relation to land included within the European Marine Site, which has been notified as a Site of Special Scientific Interest (SSSI), owners or occupiers require Natural England or 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 Natural England or 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).

2. Qualifying features under the EU Habitats and Birds Directives and the Convention on Wetlands of International Importance

Table 1 shows the wide range of nature conservation features for which the estuary is valued and the interrelationship of these features by designation. This table outlines features of European and International importance in their own right and others of national importance for which the Severn Estuary has been designated as a Site of Special Scientific Interest (SSSI) but which form an intrinsic part of the Severn ecosystem and therefore contribute to the overarching "estuary" feature of the SAC and Ramsar Site.

Table 1 : Summary of Notified features of each designation :

Feature	**SAC**	**SPA**	**Ramsar Site**	**SSSI (Nationally important feature)**
Estuary	Yes	*Supporting habitat to designated bird interests*	Yes	(Yes)
Subtidal sandbanks	Yes	No – outside boundary of SPA	No – outside boundary of Ramsar Site	*No – outside boundary of SSSI*
Intertidal Mud and Sand	Yes	*Supporting habitat to designated bird interests*	*Component of Ramsar "estuaries" feature and supporting habitat to designated bird interests*	Yes
Atlantic salt meadow / salt marshes	Yes	*Supporting habitat to designated bird interests*	*Component of Ramsar "estuaries" feature and supporting habitat to designated bird interests*	Yes
Reefs	Yes	No	*Intertidal Sabellaria contiguous with subtidal reefs is a component of the hard substrates subfeature of the Ramsar "estuaries" feature*	No – outside boundary of SSSI
Migratory fish (river & sea lamprey & twaite shad)	Yes	No	Yes	(Yes)
Migratory fish (salmon, eel, sea trout and Allis Shad)	*Part of notable species sub-feature of estuary feature*	No	Yes	(Yes)
Assemblage of fish species (>100 species)	*Notable species sub-feature of estuary feature*	No	*Notable species sub-feature of estuary feature)*	(Yes)
Internationally important populations of migratory bird species	*Notable species sub-feature of estuary feature*	Yes	Yes Internationally important populations of waterfowl	Yes
Internationally important populations of wintering bird species	*Notable species sub-feature of estuary feature*	Yes		Yes
Assemblage of nationally important populations of waterfowl	*Notable species sub-feature of estuary feature*	Yes	Yes	Yes
Hard substrate habitats (Rocky shores)	*Notable species sub-feature of estuary feature*	*Supporting habitat to designated bird interests*	*Component of Ramsar "estuaries" feature and supporting habitat to designated bird interests*	Yes
Freshwater grazing marsh / Neutral grassland	No	*Supporting habitat to designated bird interests within SPA but outside European Marine Site* ***and therefore not addressed in this Regulation 33 advice document***		Yes (currently England only)

2.1 Qualifying interest features of the Severn Estuary / Môr Hafren SAC

The Severn Estuary has been designated an SAC on the basis that it supports occurrences of habitat types and species listed in Annexes I and II respectively of the Habitats Directive that are considered important in a European context and meeting the criteria in Annex III of the Directive. These are the interest features of the SAC and are listed in the Table 2 and their relationships are shown in Figure 1.

The designation includes an overarching **"estuaries"** feature within which **subtidal sandbanks**, **intertidal mudflats and sandflats, Altlantic salt meadows** and **reefs** (of *Sabellaria alveolata*) and **three species of migratory fish** are defined as both features in their own right and as sub-features of the estuary feature.

In addition **hard substrate habitats** including **eel grass beds,** the estuary-wide **assemblage of fish species** and the **assemblage of waterfowl species** (for which the Ramsar Site and SPA are specifically designated) are identified as **notable estuarine assemblages** which are an intrinsic part of the estuary ecosystem – these are therefore covered by the "estuaries" feature.

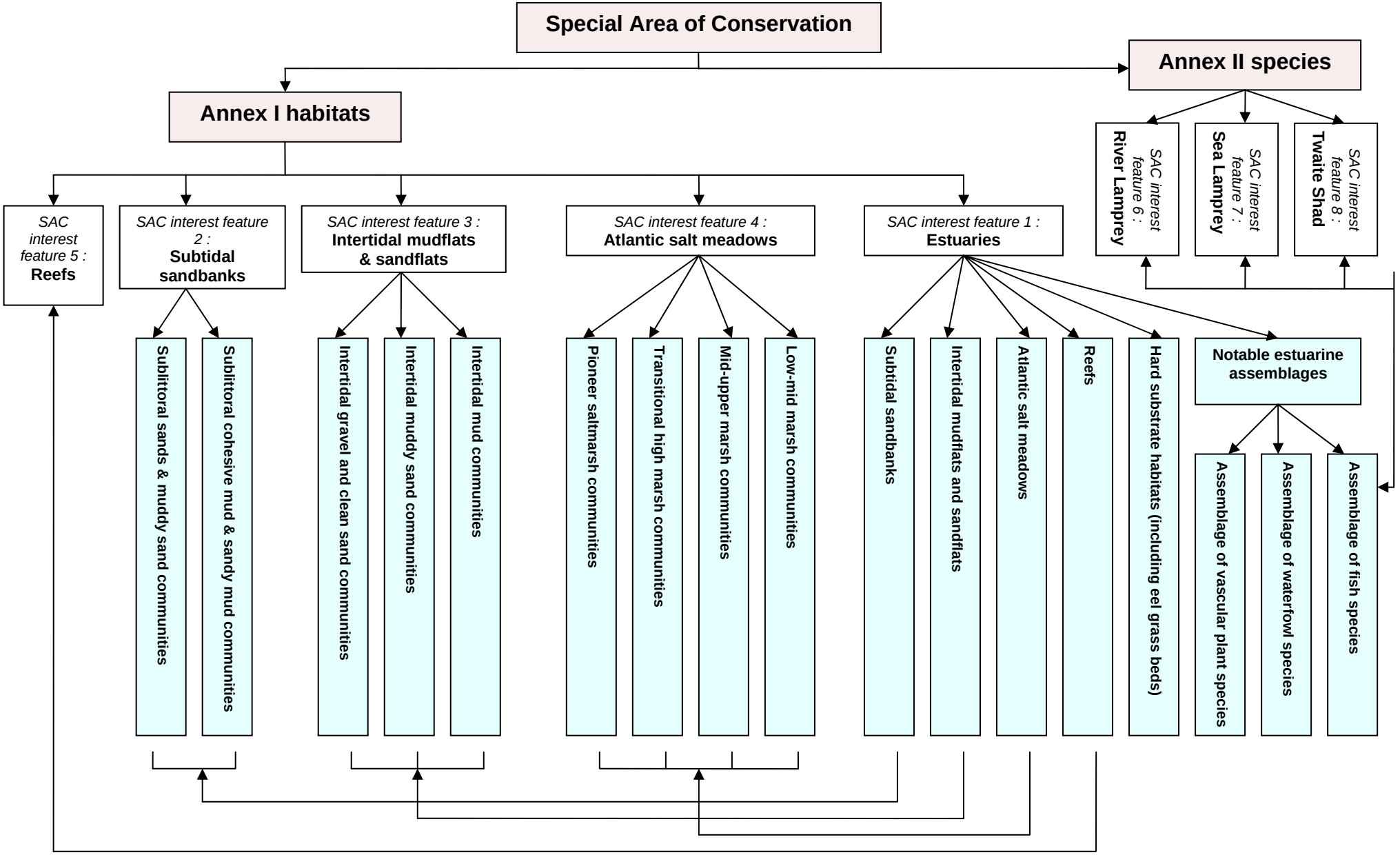
Table 2 : Interest features of the SAC

Feature name	**Scientific term**[10]	**EU Code**[17]
Annex I habitat types		
SAC interest feature 1: **Estuaries**	Estuaries	1130
SAC interest feature 2: **Subtidal sandbanks**	Sandbanks which are slightly covered by seawater all the time	1110
SAC interest feature 3: **Intertidal mudflats and sandflats**	Mudflats and sandflats not covered by seawater at low tide	1140
SAC interest feature 4: **Atlantic salt meadows**	Atlantic salt meadows (*Glauco puccinellietalia maritimae)*	1330
SAC interest feature 5: **Reefs**	Reefs	1170
Annex II species		
SAC interest feature 6: **River lamprey**	*Lampetra fluviatilis*	1099
SAC interest feature 7: **Sea lamprey**	*Petromyzon marinus*	1095
SAC interest feature 8: **Twaite shad**	*Alosa fallax*	1103

Each interest feature has a conservation objective in Section 4 of this document.

[17] European Commission (2007) Interpretation Manual of EU Habitats EUR27 July 2007, and Natura 200- Standard Data Form Explanatory Notes, Appendix C.

Figure 1 : Flow chart showing the relationship between the interest features of the Severn Estuary SAC (shown in white boxes) and their component sub features (shown in blue boxes). NB Some habitats that are sub features of the Annex II estuary feature are also features in their own right with their own sub features.



2.2 Qualifying interest features of the Severn Estuary / Môr Hafren SPA

The Severn Estuary was classified as an SPA on 13 July 1995 (subsuming a previously designated SPA called the Upper Severn Estuary) . The 1995 citation accompanying the classification is the baseline for the advice issued in this document. The qualifying interest features of the Severn Estuary SPA are shown in Table 3.

It should be noted that since designation changes in bird numbers have occurred in relation to the qualifying thresholds, which have themselves changed. These changes are highlighted by the SPA review published by the JNCC and details are also shown in Table 3. These changes are likely to be the subject of formal changes to the SPA designation in due course, however at present the legally protected species remain those in the original 1995 citation. (Note : Further information on the peak counts of the SPA species and waterfowl assemblage between 1988/9 and 2006/07 are given in Appendix 11.)

The SPA within the European Marine Site boundary includes saltmarshes and the adjacent extensive areas of intertidal mud, sand and rocky shores. All these habitats provide essential food and resting places for the wide range of wintering and migratory waterfowl and are therefore identified as key "supporting habitats" for the conservation of these species. The relationship between the features and supporting habitats supporting habitats is shown in Table 3. The supporting habitats are mapped in Appendix 8 to show their distribution and extent.

Notes relating to Table 3

**1* *Severn Estuary SPA original citation from July 1995 (though updated by Natural England in July 2002, version 2.3).*

**2* *JNCC Severn Estuary SPA Review, dated 2001 available from the JNCC www.jncc.gov.uk/pdf/SPA/UK9015022.pdf (Stroud, DA, et al., 2001)*

**3* *JNCC Natura 2000 Standard Data Form, May 2006, version 1.1.*

**4* *5 year peak mean, 1988/89 – 1992/93.*

**5* *5 year peak mean, 1991/92 – 1995/96.*

**6* *5 year peak mean, 01/04/1998.*

Table 3 : The qualifying interest features and supporting habitats of the Severn Estuary SPA.

Species	Original SPA citation (1995) *[1]	SPA Review (2001) *[2]	Natura 2000 form (2006) *[3]	Notes	Supporting habitats
Internationally important populations of regularly occurring Annex 1 species [under Article 4.1 of the EU Birds Directive].					
SPA interest feature 1 : **Bewick's swan** *Cygnus columbianus bewickii*	✓	✓	✓	Over-wintering	**Intertidal mudflats and sandflats** **Saltmarsh**
Internationally important populations of regularly occurring migratory bird species [under Article 4.2 of the EU Birds Directive].					
SPA interest feature 2 : **European white-fronted goose** *Anser albifrons albifrons*	✓	x	✓	Over-wintering	**Intertidal mudflats and sandflats** **Saltmarsh** **Hard substrate habitats** (Freshwater coastal grazing marsh, improved grassland and open standing waters also occur within the SPA but these habitats lie outside EMS boundary)
SPA interest feature 3 : **Dunlin** *Calidris alpina alpina*	✓	✓	✓		
SPA interest feature 4 : **Redshank** *Tringa totanus*	✓	✓	✓		
SPA interest feature 5 : **Shelduck** *Tadorna tadorna*	✓	✓	✓		
SPA interest feature 6 : **Gadwall** *Anas strepera*	✓	x	✓		
Curlew *Numenius arquata*	x	✓	x		
Pintail *Anas acuta*	x	✓	x		
Ringed plover *Charadrius hiaticula*	x	✓	x	On passage	
SPA interest feature 7 **: Internationally important assemblage of waterfowl** (wildfowl & waders) [under Article 4.2 of the EU Birds Directive].					
Bewick's swan *Cygnus columbianus bewickii*	✓	✓	The Natura 2000 data form does not list separate waterfowl species within this assemblage.	The wintering waterfowl assemblage includes all regularly occurring waterfowl. Species that qualify as a listed component of the assemblage include all the internationally important regularly occurring migratory species as well as the Annex 1 wintering species. The list also includes species present in nationally important numbers or species whose populations exceed 2,000 individuals In the original citation, in winter, it is stated that the area regularly supported 68,026 individual waterbirds *[4]. In the SPA Review it is stated that the area regularly supports 93,986 individual waterfowl in winter *[5]. In the Natura 2000 form, in winter, it is stated that the area regularly supports 84,317 waterfowl *[6].	**Intertidal mudflats and sandflats** **Saltmarsh** **Hard substrate habitats** (Freshwater coastal grazing marsh, improved grassland and open standing waters also occur within the SPA but these habitats lie outside EMS boundary)
European white-fronted goose *Anser albifrons albifrons*	✓	✓			
Dunlin *Calidris alpina alpina*	✓	✓			
Redshank *Tringa totanus*	✓	✓			
Shelduck *Tadorna tadorna*	✓	✓			
Gadwall *Anas strepera*	✓	✓			
Wigeon *Anas penelope*	✓	✓			
Teal *Anas crecca*	✓	✓			
Pintail *Anas acuta*	✓	✓			
Pochard *Aythya ferina*	✓	✓			
Tufted duck *Aythya fuligula*	✓	✓			
Ringed plover *Charadrius hiaticula*	✓	x			
Grey plover *Pluvialis squatarola*	✓	✓			
Curlew *Numenius arquata*	✓	✓			
Whimbrel *Numenius phaeopus*	✓	✓			

Species	Original SPA citation (1995) *[1]	SPA Review (2001) *[2]	Natura 2000 form (2006) *[3]	Notes	Supporting habitats
Spotted redshank *Tringa erythropus*	✓	x			
Lapwing *Vanellus vanellus*	x	✓			
Mallard *Anas platyrhynchos*	x	✓			
Shoveler *Anas clypeata*	x	✓			

Information on populations of bird species using the Severn Estuary European Marine Site at the time the SPA was classified is contained in Table 4 and their relationships are shown in Figure 2.

Table 4 : Information on populations of bird species using the Severn Estuary European Marine Site at the time the Severn Estuary SPA was classified (1995).

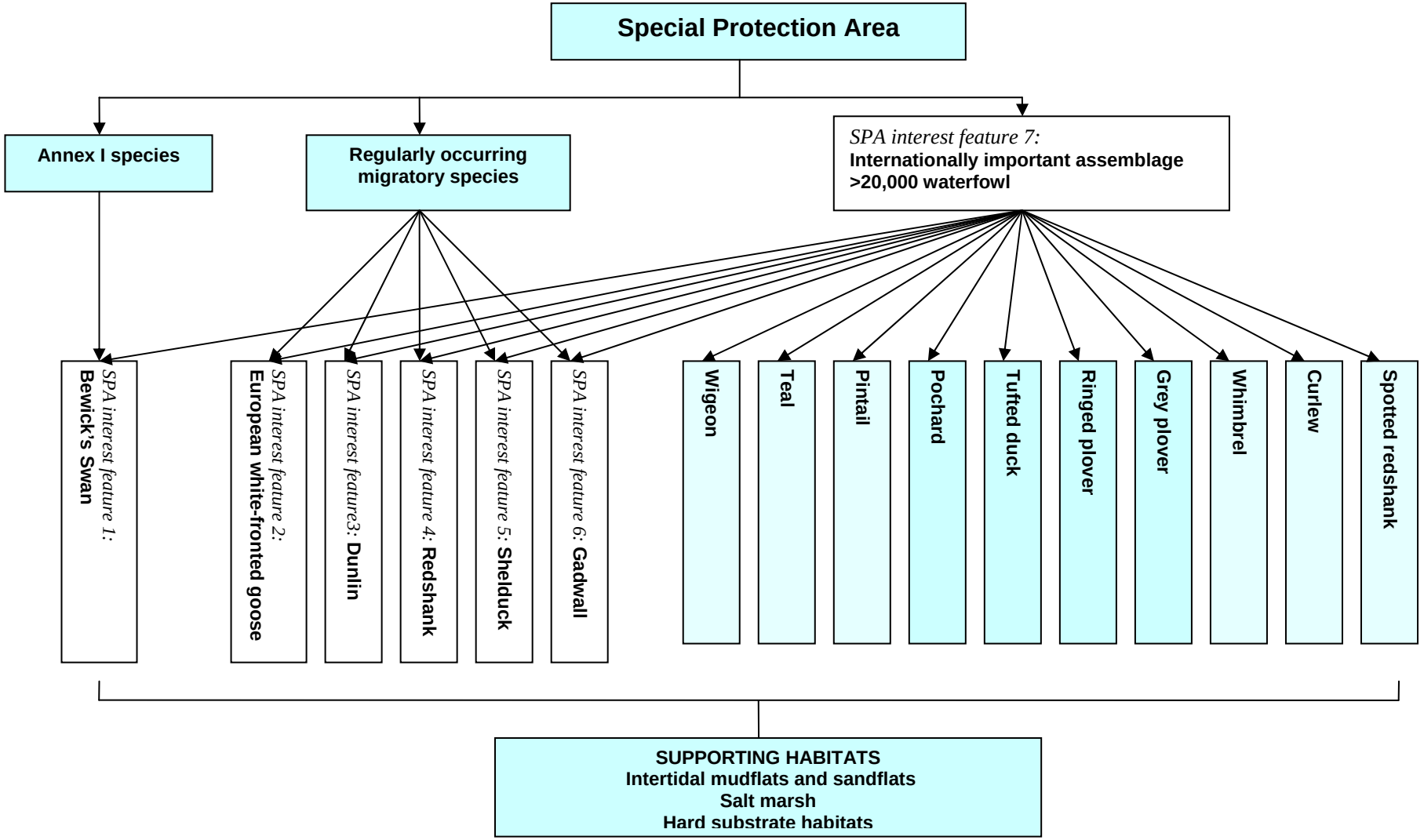
Internationally important populations of regularly occurring Annex 1 species		
Species	**Population (5 yr peak mean :1988/9 to 1992/3)**	
SPA interest feature 1: **Bewick's swan**	289 birds	4.1% Great Britain 1.7% NW Europe
Internationally important populations of regularly occurring migratory bird species		
Species (wintering)	**Population (5 yr peak mean: 1988/9 to 1992/3)**	
SPA interest feature 2: **European white-fronted goose**	3,002	50% British, 1% North West Europe
SPA interest feature 3: **Dunlin**	41,683	2.9% East Atlantic flyway
SPA interest feature 4: **Redshank**	2,013	1.3% East Atlantic flyway
SPA interest feature 5: **Shelduck**	2,892	1.2% North West Europe
SPA interest feature 6: **Gadwall**	330	2.8 % NW Europe
SPA interest feature 7: **An internationally important assemblage of waterfowl** *(Assemblage includes above species plus the following listed nationally important populations)*		
Importance	**Population (5 yr peak mean: 1988/9 to 1992/3)**	
The Severn Estuary supports over 20,000 wintering waterfowl.	68,026 individual birds comprising 17,502 wildfowl and 50,524 waders	
Nationally important bird populations within internationally important assemblage of waterfowl		
Species	**Population (5 yr peak mean: 1988/9 to 1992/3)**	
Wigeon	3,977 birds	1.6% Great Britain
Teal	1,998	2.0% Great Britain
Pintail	523	2.1% Great Britain
Pochard	1,686	3.8% Great Britain
Tufted duck	913	1.5% Great Britain
Ringed plover	227	1.0% Great Britain
Grey plover	781	3.7% Great Britain
Curlew	3,096	3.4% Great Britain
Whimbrel	246	4.9% Great Britain
Spotted redshank	3	1.5% Great Britain

Notes :
1. Previous advice issued in respect of the Severn Estuary SPA in February 2005 excluded Gadwall for the listed species of internationally important populations of regularly occurring migratory birds as they were considered not to use the European Marine Site area to any significant degree. Further recent evidence (2002/03 Low Tide Bird Counts) has demonstrated that this species does make use of areas within the European Marine Site and has consequently now been included.
2. The SPA review has identified that since the classification of the Severn Estuary SPA in 1995 the Severn Estuary now supports nationally important populations of Mallard, Lapwing and Shoveler.

(Note : Further information on the peak counts of the SPA species and waterfowl assemblage between 1988/9 and 2006/07 are given in Appendix 11.)

Each interest feature has a conservation objective in Section 4 of this document. Reference should also be made to sections of this document that relate to the Severn Estuary SAC interest features (particularly with respect to the conservation requirements of the supporting habitats) and the Severn Estuary Ramsar Site interest features.

Figure 2 : Flow chart showing the relationship between the qualifying bird species features (in white boxes) of the Severn Estuary SPA and their supporting habitats



2.3 Qualifying interest features of the Severn Estuary/ Môr Hafren Ramsar Site

The Severn Estuary was classified as a Ramsar Site on 13 July 1995 (subsuming a previously designated Upper Severn Estuary Ramsar Site). The 1995 citation is the basis for the advice issued in this document as this defines the legally protected species covered by the Ramsar designation at this time.

It should be noted that a number of changes have been made to the criteria since the listing of the Severn Estuary Ramsar Site and it is these new (2005) criteria which are now presented on the JNCC website used by many authorities as a reference source. For completeness qualification under both the criteria used at the time of 1995 Ramsar designation and the revised 2005 criteria have been outlined in Table 5 which provides a confirmation of the defined Ramsar features for which Conservation Objectives have been written.

The qualifying interest features of the Severn Estuary Ramsar Site overlap with those of the Severn Estuary SPA and SAC. To facilitate the development of integrated objectives across the designations the Ramsar criteria have been interpreted and the Ramsar features defined so that they are consistent with those already identified in the SAC and SPA sections of this document.

Table 5 : confirmation of Ramsar features in context of 1995 and 2005 Ramsar criteria

Ramsar Features (for which conservation objectives have been written)	**Criteria at designation (1995)** (original criteria)	**Revised Criteria (2005)** (criteria currently used on JNCC website)
Ramsar interest feature 1: ***Estuaries** *- characteristic physical form and flow, estuarine habitat communities and species assemblages*	**Criterion 1** : qualifies due to its immense tidal range affecting both the physical environment and biological communities present	**Criterion 1** : qualifies due to immense tidal range (second-largest in world), this affects both the physical environment and biological communities.
- estuarine habitat communities and species assemblages	**Criterion 2b** : qualifies due to its unusual estuarine communities, reduced species diversity and high productivity. The high tidal range leads to strong tidal streams and high turbidity, producing communities characteristic of the extreme physical conditions of liquid mud and tide swept sand and rock	**Criterion 3** : qualifies due to its unusual estuarine communities, reduced diversity and high productivity
Ramsar interest feature 2: **Assemblage of migratory fish species :** Sea Lamprey River Lamprey Twaite Shad Allis Shad Salmon Sea Trout Eel	**Criterion 2c** : qualifies as it is important for the run of migratory fish between sea and river via estuary. Species include Salmon *Salmo salar*, sea trout *S. trutta*, sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis*, allis shad *Alosa alosa*, twaite shad *A. fallax*, and eel *Anguilla anguilla*.	**Criterion 4** : qualifies as it is important for the run of migratory fish between sea and river via estuary. Species include Salmon *Salmo salar*, sea trout *S. trutta*, sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis*, allis shad *Alosa alosa*, twaite shad *A. fallax*, and eel *Anguilla anguilla*.
** The wider estuarine fish assemblage is covered as a "notable species assemblage" sub feature of the SAC "Estuaries" feature*		**Criterion 8** : qualifies as the fish assemblage of the whole estuarine and river system is one of the most diverse in Britain, with over 110 species recorded.

Table continued …

<table>
<tr><th>Ramsar Features
(for which conservation objectives have been written)</th><th>Criteria at designation (1995)
(original criteria)</th><th>Revised Criteria (2005)
(criteria currently used on JNCC website)</th></tr>
<tr><td>Ramsar interest feature 3:
Bewick's Swan

Ramsar interest feature 4:
European white-fronted goose

Ramsar interest feature 5: Dunlin
Ramsar interest feature 6: Redshank
Ramsar interest feature 7: Shelduck
Ramsar interest feature 8: Gadwall

ie Internationally important <u>populations</u> of waterfowl</td><td>Criterion 3c : qualifies by regularly in winter supporting internationally important populations (1% or more) of species of waterfowl

Bewick's swan
European white-fronted goose
Dunlin
Redshank
Shelduck
Gadwall</td><td rowspan="2">Criterion 6 : qualifies as it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

Species with peak counts in winter - at designation:
Tundra/Bewick's swan
Greater /European white-fronted goose
Dunlin
Common redshank
Common shelduck
Gadwall

Populations identified subsequent to designation:
Ringed plover (spring/autumn)
Eurasian teal (winter)
Northern pintail (winter)
Lesser black-backed gull (breeding)</td></tr>
<tr><td rowspan="3">Ramsar interest feature 9:
Internationally important <u>assemblage</u> of waterfowl

This feature incorporates :

• waterfowl which contribute to the total peak winter count (criterion 3a)
• the above internationally important wintering populations (qualifying under criterion 3c)
• the migratory passage species (qualifying under criterion 2c)
• the nationally important populations (identified under other notable features of the Ramsar Site citation)

The species are as follows :
(w = wintering and p = passage):

Bewick's swan (w)
European white-fronted goose (w)
Shelduck (w)
Dunlin (w, p)
Redshank (w, p)
Gadwall (w)
Ringed plover (w, p)
Whimbrel (p)
Teal (w)
Pintail (w)
Wigeon (w)
Pochard (w)
Tufted duck (w)
Grey plover (w)
Curlew (w)
Spotted redshank (w)</td><td>Qualifies under Criterion 2c as it is particularly important for migratory birds during passage periods in spring and autumn. Nationally important populations of :

Ringed plover
Dunlin
Whimbrel
Redshank</td></tr>
<tr><td>Criterion 3a : qualifies by regularly supporting in winter over 20,000 waterfowl - (1988/89 to 1992/93 average peak count was 68,026 waterfowl: 17,502 wildfowl and 50,524 waders)</td><td>Criterion 5 : qualifies as it supports an assemblage of international importance - (1998/99-2002/2003 5 year peak mean was 70,919 waterfowl</td></tr>
<tr><td>Other notable features :
Nationally important wintering populations of:

Wigeon, teal, pintail, pochard, tufted duck, ringed plover, grey plover, curlew and spotted redshank. Also nationally important breeding population of Lesser Black backed gull</td><td></td></tr>
</table>

Each interest feature has a conservation objective in Section 4 of this document.

Reference should also be made to sections of this document that relate to the Severn Estuary SAC interest features (particularly with respect to the conservation requirements of the supporting habitats) and the Severn Estuary SPA interest features.

Information on the populations of bird species using the Severn Estuary Ramsar Site at the time of designation is contained in Table 6 and their relationships are shown in Figure 3. Ramsar interest feature 9 incorporates both wintering and passage populations of some birds and hence some species are included more than once in the lists given in Table 6.

Table 6 : Information on populations of bird species using the Severn Estuary Ramsar Site at the time of classification (1995)

Ramsar interest features3 to 8: **Internationally important <u>populations</u> of wintering waterfowl** (1995 Ramsar Criterion 3c)		
Species	**Population (5 yr peak mean: 1988/9 to 1992/3)**	
Ramsar interest feature 3: **Bewick's swan**	289	4.1% Great Britain, 1.7% North West Europe
Ramsar interest feature 4: **European white-fronted goose**	3,002	50% British, 1% North West Europe
Ramsar interest feature 5: **Dunlin**	41,683	2.9% East Atlantic flyway, 9.6% British
Ramsar interest feature 6: **Redshank**	2,013	1.3% East Atlantic flyway, 2.6% British
Ramsar interest feature 7: **Shelduck**	2,892	1.2% NW European, 3.9 % British
Ramsar interest feature 8: **Gadwall**	330	2.8 % NW European, 5.5 % British

Ramsar interest feature 9: **Internationally important <u>assemblage</u> of waterfowl (**1995 Ramsar Criterion 2c, 3a and 3c) *(Assemblage includes above wintering species populations plus the following listed nationally important populations (migratory passage and wintering species)*	
International importance (1995 Ramsar Criterion 3a)	**Population (5 yr peak mean: 1988/9 to 1992/3)**
Regularly supporting in winter over 20,000 waterfowl.	68,026 individual birds comprising 17,502 wildfowl and 50,524 waders

Nationally important bird populations within internationally important assemblage of waterfowl (1995 Ramsar Criterion 2c and other nationally important populations)		
Species	**Population (5 yr peak mean: 1987/8 to 1991/2)**	
Dunlin	3,510 (spring migration) 5,500 (autumn migration)	1.7 % British passage 2.7 % British passage
Redshank	2,456 (autumn migration)	2 % British passage
Ringed plover	442 (spring migration) 1,573 (autumn migration)	1.4 % British passage 5.2 % British passage
Whimbrel	246 (spring migration) 66 (autumn migration)	4.9 % British passage 1.3 % British passage
	Population (5 yr peak mean: 1988/9 to 1992/3)	
Wigeon	3,977 birds	1.6% Great Britain
Teal	1,998	2.0% Great Britain
Pintail	523	2.1% Great Britain
Pochard	1,686	3.8% Great Britain
Tufted duck	913	1.5% Great Britain
Grey plover	781	3.7% Great Britain
Curlew	3,096	3.4% Great Britain
Spotted redshank	3	1.5% Great Britain

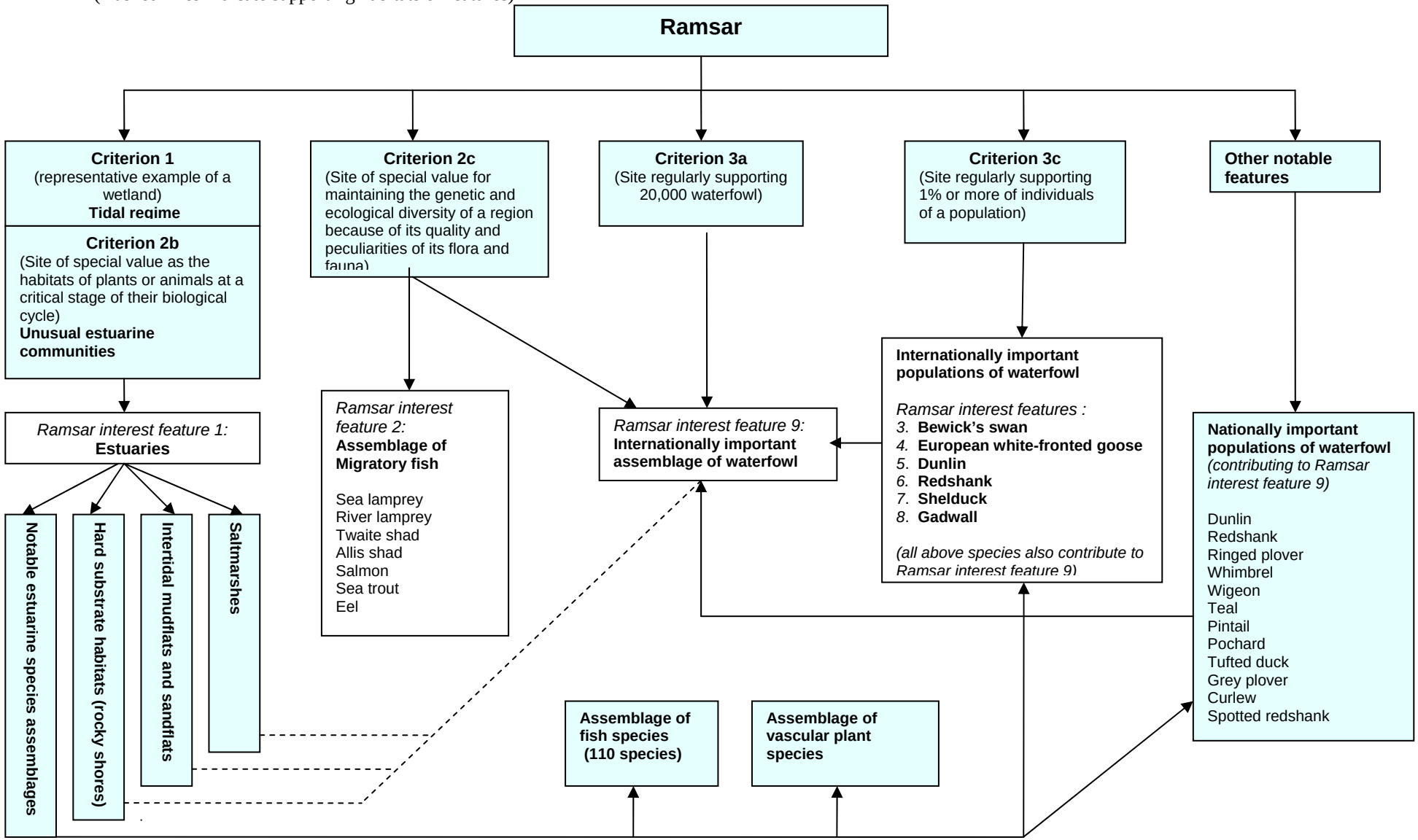
(Note : Further information on the peak counts of the SPA species and waterfowl assemblage between 1988/9 and 2006/07 are given in Appendix 11.)

The Ramsar Site within the European Marine Site boundary includes saltmarshes and the adjacent extensive areas of intertidal mud, sand and rocky shores. All these habitats provide essential food and resting places for the wide range of wintering and migratory waterfowl and are therefore identified as key "supporting habitats" for the conservation of these species. The relationship between the Ramsar Site bird features (Ramsar interest features 3 to 9) and their supporting habitats is shown in Table 7. The supporting habitats are mapped in Appendix 8 to show their distribution and extent.

Table 7 : A summary of the qualifying bird features and associated supporting habitats within the Severn Estuary Ramsar Site

Designation	**Qualifying feature**	**Protected Supporting habitats**		
		Estuary		
		Intertidal mudflats and sandflats	**Hard substrate habitats (rocky shores)**	**Saltmarsh**
Ramsar Site (*classified 13 July 1995)*	*Ramsar interest features 3 to 8 :* Internationally important populations of individual species of waterfowl	✓	✓	✓
	Ramsar interest feature 9: Internationally important assemblage of waterfowl	✓	✓	✓

Figure 3 : Flow chart showing the relationship between the interest features (in white boxes) for which the Severn Estuary Ramsar Site qualifies.
(Dashed lines indicate supporting habitats of features)



3. General description of the Severn Estuary and its designated features

Introduction

The Severn Estuary is the largest example of a coastal plain estuary in the United Kingdom and one of the largest estuaries in Europe. The overall area of the European and International conservation designations is 73,715.4 ha (see Appendix 1) of which roughly two thirds is composed of subtidal habitats (stable sandbanks and shifting sediments of gravel, sand and mud) and one third is composed of intertidal habitats (tide washed mud and sand, saltmarshes and rocky shores).

The estuary lies in the broad Severn Vale, with most of the sediments on the margins of the estuary having accumulated since the last ice age. As with many other estuaries in England and Wales, it has been a focus for human activity, a location for settlement, a source of food, water and raw materials and a gateway for trading and exploration. The Estuary and its coastal hinterland support the cities of Cardiff, Bristol, Newport and Gloucester. Today, major industries are sited around the Estuary's shores. There are modern port installations, chemical processing companies and nuclear power stations among others. Exploitation of the natural resources includes commercial shrimp fishing and fishing for salmon using putchers, lave nets, draught nets and bag nets. The Severn supports an important eel and elver fishery. Aggregate extraction also occurs within the estuary.

Alongside all these competing activities, the Estuary also supports a wide array of habitats and species of international importance for nature conservation.

Human activity has increasingly influenced the character of the marginal wetland mudflats and marshes, with extensive land claim occurring during and since the Roman period. Sediment flows and fluxes affecting the estuary are of particular importance for estuarine processes and ecology and the morphology of the estuary is constantly changing due to the complex hydrodynamics. Sediment deposits provide essential material to maintain the mudflats, sandflats and saltmarsh. Estuary-wide fluctuations in the wind-wave climate over recent centuries have led to major movements of the high-tide shoreline, and some reclaimed lands have been lost (Allen, 1990, Atkins, W.S. 2004). In addition, the Severn Estuary CHaMP (ABPMer, 2006) predicts losses of intertidal mudflats and sandflats and saltmarsh habitats over the next 100 years in response to rising sea-level.

A number of habitats and species have also been recognised through the designation of several Sites of Special Scientific Interest (most notably, the Upper Severn Estuary, Severn Estuary and Bridgwater Bay SSSIs in the 1980's) which underpin the European and International designations.

The following sections briefly describe each of the main habitat and species features covered by the three designations and the inter-relationships between them. All feature descriptions are based on best available knowledge at the present time and in some cases this is limited. For example there is limited information on the extent of the subtidal reef habitat within the estuary. Maps showing the distribution of the habitats are indicative only and the advice in this document is provided on the basis of current knowledge and may be subject to change as knowledge improves.

3.1 Estuaries

3.1.1 Range

Estuaries are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats, which are closely associated with surrounding terrestrial habitats. Many of these habitats, such as mudflats and sandflats not covered by sea water at low tide, saltmarshes, sandbanks which are slightly covered by sea water all the time and reefs, are identified as Annex I habitat types in their own right.

Estuaries are defined as the downstream part of a river valley, subject to the tide and extending from the limit of brackish water. There is a gradient of salinity from freshwater in the river to increasingly marine conditions towards the open sea.

Estuaries are widespread throughout the Atlantic coasts of Europe. Approximately one-quarter of the area of estuaries in north-western Europe occurs in the UK. The UK has over 90 estuaries[18].

The selection of estuary sites has taken account of the UK's EU responsibility for this habitat type, and the SAC series contains a high proportion of the total UK resource. Sites have been selected to represent the geographical range of estuaries in the UK, and to encompass examples of the four geomorphological sub-types (coastal plain, bar-built, complex, and ria estuaries) and the associated range of communities. Selection has generally favoured larger estuaries, as they display a wider variety of habitats, but smaller estuaries have also been selected where they have specific features of interest, such as undisturbed transitions from marine to terrestrial habitats, or are representative of a particular geomorphological sub-type.

The Severn Estuary is the largest example of a coastal plain estuary in the UK, and one of the largest estuaries in Europe. It contributes approximately 30% of the UK Natura 2000 resource for estuaries, by area.[19]

3.1.2 Extent and Distribution

The extent of the Estuary feature is 73678 ha.

The Severn Estuary SAC covers the extent of the tidal influence from an upstream limit between Frampton and Awre in Gloucestershire out seawards to a line drawn between Penarth Head in Wales and Hinckley point in Somerset. It includes subtidal and intertidal areas landward to the line of high ground and flood defences (banks and walls) that provide the limit of tidal inundation.

The Estuary is an over-arching feature which incorporates all aspects of the physical, chemical and biological attributes of the estuary as an ecosystem. The physical nature of the tidal regime determines not only the structure of the estuary and individual habitats but also the conditions affecting it and the biological communities it therefore supports.

3.1.3 Structure and Function

The Severn Estuary is important for its immense tidal range, which affects both the physical environment and the diversity and productivity of the biological communities. The tidal range is the second largest in the world, reaching in excess of 13 m at Avonmouth[20]. This macrotidal environment is partly due to the estuary's funnel shape which concentrates the tidal wave as it moves up the Bristol Channel. Tidal currents

[18] JNCC website

[19] Based on Natura 2000 Standard data forms for all UK Natura 2000 sites which have estuaries as a feature- source: JNCC website http://www.jncc.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=H1130

[20] Data on tidal range can be found on the Proudman Oceanographic Laboratory website http://www.pol.ac.uk/ntslf/tides/?port=0060 .

are also amplified and exceed 7 metres per second close to Avonmouth (British Geological Survey, 1996). These factors make the estuary important in representing one of the most dynamic estuarine systems in the UK , Europe and the world.

There are several major rivers, including the Taff, Usk, Wye, Severn, Avon and Parrett which feed into the estuary, and influence the salinity regime. Together these rivers tend to produce a marked east-west salinity gradient and a range of conditions varying from brackish to fully saline, depending on the season and rainfall, which in turn influences the occurrence and distribution of habitats and species throughout the estuary and its fringes.

Fine sediments which are mainly derived from erosion of the intertidal zone and suspended sediments in river water entering the estuary create high turbidity, which has its highest average level between Avonmouth and the outer part of Bridgwater Bay (British Geological Survey, 1996, ABPMer, 2006). The strong tidal currents create a highly dynamic environment and the resultant scouring of the seabed and high turbidity give rise to low diversity communities. The Severn has an extreme type of hydrodynamic and sedimentary regime which distinguishes it from other estuaries and which dominates the whole system. It is estimated that the estuary carries 10 million tons of suspended sediments on spring tides (Kirby & Parker,1983; Kirby, 1986). Such conditions were initiated by the start of sea-level rise in late glacial times, with some evidence for steady sedimentation persisting for at least 5000 years, during which there has been a steady rise in sea level of 5 m, a trend which is continuing at present (British Geological Survey, 1996). Defra guidance[21] indicates sea –level rise for Wales and the South West to be 3.5 mm per annum to 2025, rising to 8 mm per annum (2025-2055), 11.5 mm (2055-2085) and 14.5 mm (2085-2115).

3.1.4 Typical Habitats and Species

The extreme hydrodynamic and sedimentary conditions essentially determine the type of habitats and species present and result in characteristic animal and plant communities. Typical species for each habitat are given in the individual habitat sections.

The predominant unconsolidated sediments are muds and sands which form the basis of the structure of the estuarine habitats which include saltmarshes (section 3.5), intertidal mud and sand flats (section 3.4) and subtidal sand banks (section 3.3), mixed mud and sand, rock outcrops, boulder and shingle shores (section 3.7) as well as biogenic (worm built) reefs (section 3.6). There are also sandy beaches on the southern shores in the outer part of the estuary, backed by sand dunes.

The intertidal zone of mudflats, sandbanks, rocky platforms and saltmarsh is one of the largest and most important in Britain and this range of habitats provide an ecosystem of great importance for a wide range of fish (section 3.8) and bird (section 3.9) species – for feeding, breeding, resting and migration.

3.1.5 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

[21] Defra, 2006. Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts October 2006

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 migrate 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 Common Standards Monitoring Guidance for 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[22]; 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.

3.2 Subtidal sandbanks

3.2.1 Range

Sandbanks which are slightly covered by sea water all the time (subtidal sandbanks) consist of sandy sediments that are permanently covered by shallow sea water, typically at depths of less than 20 m below chart datum (but sometimes including channels or other areas greater than 20 m deep). The habitat comprises distinct banks (i.e. elongated, rounded or irregular 'mound' shapes) which may arise from horizontal or sloping plains of sandy sediment. Where the areas of horizontal or sloping sandy habitat are closely associated with the banks, they are included within the Annex I type.

Sandbanks which are slightly covered by sea water all the time occur widely on the Atlantic coasts of north-west Europe, and occur widely around the UK coast. They are widespread in inshore waters (within 12 nautical miles of the coast) and also occur offshore in the southern North Sea and in the Irish Sea (between 12 and 200 nautical miles).

The UK SAC series includes large sublittoral sandbanks showing good habitat structure and function. The selected sites represent the range of variation within the four main sub-types (gravelly and clean sands, muddy sands, eelgrass beds, and maerl beds), which are often associated with different physiographic features (e.g. estuaries, open coast, bays, sea lochs). The differing character of this habitat around the UK coast has also been taken into account.

The Severn Estuary subtidal sandbanks can be considered to contribute to the gravelly and clean sand sandbank resource. The Severn Estuary contributes approximately 3% of the UK Natura 2000 resource for subtidal sandbanks, by area.[23]

[22] A flood hydrograph is a dual plot of river discharge (line) and rainfall (bars) over time

[23] Based on Natura 2000 Standard data forms for all UK Natura 2000 sites which have estuaries as a feature- source: JNCC website http://www.jncc.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=H1130

3.2.2 Extent and Distribution

The subtidal sandbanks are largely restricted to the middle and outer parts of the estuary. The sand banks of the Middle and Welsh Grounds are relatively permanent sandbank features in the Severn Estuary, along with other long established sandbank features at Cardiff Grounds and in Bridgwater Bay. The tops of these banks are intertidal, and the permanently submerged parts of the banks are considered to contribute to the subtidal sandbanks habitat

There are other areas of subtidal sandbank habitat within the Estuary, again sometimes the top of the bank may be exposed at low tide, with the submerged sections contributing to the subtidal sandbanks habitat. These banks are more ephemeral in nature, but are still considered part of the feature, and reflect the dynamic nature of the Severn Estuary. The areas where ephemeral subtidal sandbanks are known to occur include areas offshore from Avonmouth and at English Grounds (near Clevedon).

The approximate area of the more permanent subtidal sandbanks is 1,300 hectares and there are approximately 10,440 hectares of associated ephemeral sandbanks. Areas of associated sediments have been defined by using the sediment environments of the Bristol Channel Marine Aggregates Resources and Constraints project, commissioned by the National Assembly for Wales (Posford Duvivier and ABP, 2000). Further detail is given in section 4.1.2.1.

3.2.3 Structure and Function

The subtidal area of the Severn Estuary is subject to strong tidal currents resulting in the high mobility of sediments which range from gravely to muddy sands. The high mobility of the sediments and high turbidity means that these habitats only support animals that can tolerate the shifting seabed and scouring action of suspended sand.

As described above the subtidal sandbanks habitat includes some long established and relatively permanent sandbank features and associated sediments which form more ephemeral sandbanks. The sediments of both the more permanent sandbank features and the associated sediments (ephemeral banks) together comprise the subtidal sandbanks feature of the SAC (see map in Appendix 3).

These subtidal areas play an important role in holding and supplying sediment for other habitats notably the intertidal mud and sandflats, saltmarshes and reef features and it is likely that subtidal invertebrate communities play a role as a food resource for some species of the fish assemblage feature of the SAC and Ramsar Site.

3.2.4 Typical species

The subtidal sandbanks feature has two distinct sub-features composed of communities which are determined principally by the degree of sediment mobility, grade of sediments, mix of sediments (in terms of proportions of sand and mud) and salinity.

The first sub-feature is composed of sand and muddy sand communities dominated by worms, and burrowing shrimps which can tolerate the high sediment mobility. The second sub feature is composed of mud and sandy mud dominated communities which are slightly more stable and support a greater abundance of burrowing worms.

The typical species of these communities include a range of worms, shrimps, snails and bivalves. The species diversity of these habitats is often low but overall biomass can be high.

3.2.5 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.

3.3 Intertidal mudflats and sandflats

3.3.1 Range

Intertidal mudflats and sandflats are submerged at high tide and exposed at low tide. They form a major component of Estuaries and Large shallow inlets and bays in the UK but also occur extensively along the open coast and in lagoonal inlets. The physical structure of the intertidal flats ranges from mobile, coarse-sand beaches on wave-exposed coasts to stable, fine-sediment mudflats in estuaries and other marine inlets. This habitat type can be divided into three broad categories (clean sands, muddy sands and muds), although in practice there is a continuous gradation between them. Within this range the plant and animal communities present vary according to the type of sediment, its stability and the salinity of the water.

Mudflats and sandflats not covered by sea water at low tide are a widespread habitat type on coasts of Atlantic Europe, particularly around the North Sea, and occur widely throughout the UK.

Sites have been selected to encompass the range of geographical, physical and ecological variation shown by this habitat type in the UK. Examples of clean sands, muddy sands, and mudflats have all been included. Sites with large areas of intertidal flats, as well as a range of environmental conditions and an associated diversity of communities, were favoured.

The intertidal part of the Severn Estuary supports extensive mudflats and sandflats. These cover an area of approximately 20,300 ha - the fourth largest area in a UK estuary and representing approximately 7 % of the total UK resource of this habitat type (approximately 10% of the UK Natura 2000 resource for Intertidal mudflats and sandflats, by area.[24])

The intertidal mudflats and sandflats of the Severn Estuary are representative of estuarine mudflats and sandflats influenced by strong tidal streams and extreme silt loading.

3.3.2 Extent and Distribution

The Intertidal mudlfats and sandflats feature in the Severn Estuary covers an area of approximately 20,300ha.

The Intertidal mudflats and sandflats feature is distributed throughout the Severn Estuary with extensive mudflats fronting the Welsh shore and Bridgwater Bay, and large banks of clean sands in the more central parts of the estuary at Middle and Welsh Grounds.

3.3.3 Structure and Function

This habitat type can be divided into three broad categories (which form the three main sub-features identified for this feature in the Severn Estuary), clean sands and gravels, muddy sands, and muds, although in practice there is a continuous gradation between them (Countryside Council for Wales, 2006; English Nature, 2006). The composition of the sediments and level of consolidation are the most important factors in determining the fauna of these communities and individual species distribution is largely dependant on the salinity which limits the penetration of marine species upstream where freshwater influences are strongest.

[24] Based on Natura 2000 Standard data forms for all UK Natura 2000 sites which have estuaries as a feature- source: JNCC website http://www.jncc.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=H1130

The gravel and clean sand communities occur predominantly in the mid and upper parts of the estuary forming large banks in the centre the estuary (Frampton Sands, Lydney Sands, Oldbury Sands, Bedwyn Sands and the Welsh Grounds) through which the main tidal channel flows keeping sediments mobile.

The sandy mud communities occur in restricted locations forming the transition between the clean sand and mud communities particularly in the mid estuary and at the lowest extremes of the tide and at the flanks of the main channel.

The mud communities form in the sheltered edges of the estuary particularly where the coastline forms natural embayments and are predominantly found in the mid to outer estuary at Bridgewater Bay and on the Cardiff and Newport frontages although a narrow fringe of these communities is present throughout the estuary. These communities take the form of firm mud banks adjacent to the saltmarshes often with a liquid mud surface kept fluid by the high tidal currents.

3.3.4 Typical Species

Muddy areas in the Estuary such as those between Cardiff to Newport are generally soft and mobile, colonised by high densities of relatively few species characterised by *Hediste diversicolor* and *Macoma balthica.* Other typical species include *Nephtys hombergii*, *Hydrobia ulvae*, *Tubificoides benedii*, *Streblospio shrubsolii*, *Pygospio elegans*, and Enchytraeidae. *Corophium volutator* is also widespread in these muddy areas especially near the mudflat saltmarsh boundary. In some mid shore areas with sandier sediments *Arenicola marina*, and *Macoma balthica* are present.

Lower shore coarse sand banks such as Bedwyn and Oldbury, are dominated by mobile species such as *Bathyporeia pelagica*, *Eurydice pulchra*, and *Nephtys cirrosa.* The south side of the lower estuary has pockets of littoral muddy sand on the upper shore characterised by *Macoma balthica*, *Hydrobia ulvae*, *Bathyporeia pelagica*, and *Nephtys hombergii*. Lower down the shore the sediments become muddier and support species such as *Scoloplos armiger*, *Aphelochaeta marioni* and *Hediste diversicolor.*

Upstream of Sudbrook the infauna becomes less diverse as the salinity decreases. Mud flats here support ragworm *Hediste diversicolor*, patchy Baltic tellin *Macoma balthica* and laver spire shell *Hydrobia ulvae*, with occasional peppery furrow shell *Scrobicularia plana* near the back of the shore. Within the pills along the site and in the upper reaches towards the road crossing the soft mud often supports few species including *Hediste diversicolor* and *Oligochaeta* spp.

The high biomass of invertebrates in the mudflats of the Severn provide an important food source for a diverse range and large number of fish and benthic predators. These intertidal areas are therefore important in supporting the fish assemblage subfeature of the SAC and Ramsar Site.

Mudflats also provide a valuable feeding, roosting and resting area for a wide range of species of wading birds and waterfowl and are therefore important supporting habitats for the wintering and passage bird features of the SPA and Ramsar Site.

3.3.5 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.

3.4 Atlantic salt meadow

3.4.1 Range

Atlantic salt meadows develop when halophytic vegetation colonises soft intertidal sediments of mud and sand in areas protected from strong wave action. This vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation still occurs but with decreasing frequency and duration. A wide range of community types is represented and the saltmarshes can cover large areas, especially where there has been little or no enclosure on the landward side. The vegetation 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, for invertebrates and for wintering or breeding waterfowl.

This Annex I type is predominantly found on Atlantic coasts in western Europe. Atlantic salt meadows occur on North Sea, English Channel and Atlantic shores. There are more than 29,000 ha of the habitat type in the UK, mostly in the large, sheltered estuaries of south-east, south-west and north-west England and in south Wales. Smaller areas of saltmarsh are found in Scotland.

Sites have been selected to cover the geographical range and ecological variation of Atlantic salt meadows in the UK. The sites selected are for the most part the largest examples of this habitat type, with good structure and function, and which support a well-developed zonation of plant communities within the saltmarsh. There are transitions to other high-quality habitat assemblages at many of the sites that have been selected. Sites with complete sequences of vegetation and transitions to other habitats, such as sand dunes, represent the range of variation of the habitat type, and this has been an important consideration in site selection.

The Severn Estuary holds the largest aggregation of saltmarsh in the south and south-west of the UK. It covers approximately 1,400 ha, representing about 4% of the total area of saltmarsh in the UK (Dargie, 2000).

3.4.2 Extent and Distribution

The Severn Estuary is fringed by saltmarsh. The huge tidal range in the Severn Estuary has led to extensive saltmarsh community development with an expanded zonation.

3.4.3 Structure and Function

The saltmarshes of the Severn Estuary have four principal zones corresponding to the four main sub-features that have been identified for this feature. Two of these zones (the lower to mid marsh communities and the mid to upper marsh communities) contain the principle saltmarsh types which are defined as Atlantic salt meadow as per the Annex 1 habitat description. However these occur in an intimate mosaic and in transition with the communities of the other two zones (in the pioneer saltmarsh and transitional high marsh communities) which are therefore considered in this advice as part of the feature. Section 4.1.4.1 and Table 11 provide further details of these zones and their typical species.

The pioneer saltmarsh communities play an important role in saltmarsh development as colonising plants (*eg Spartina sp.and Salicornia sp*.) stabilise and trap sediments. The upper marsh transitions to terrestrial and freshwater habitats support a range of nationally scarce and uncommon plant species and support tidal debris strandlines of value for invertebrates which are important components of the estuary feature.

Some of the saltmarshes show a sequence of saltmarsh cliffs or steps related to past cycles of accretion and erosion and in places the saltmarshes are also cut transversely by "pills" where freshwater streams enter the estuary. These features add diversity to the saltmarsh by initiating new patterns of species zonation. Recent monitoring has identified that there is a complicated present day pattern of erosion and accretion of the saltmarshes throughout the estuary and some parts appear to be exhibiting the effects of coastal squeeze – the constriction of saltmarsh habitats between rising sea levels and hard defences at the back of the saltmarsh .

Saltmarshes and mudflats have an important role to play in estuarine processes, both through the recycling of nutrients within the estuary and through their role as soft sea defences, dissipating wave energy. They are highly productive biologically, providing organic material that support other features within the marine ecosystem and they also have an important physical role, acting as a sediment store to the estuary as a whole.

Saltmarshes also provide a valuable feeding and roosting and resting areas (particularly at high tide) for a wide range of species of waterfowl and are therefore very important supporting habitats for the wintering and passage bird features of the SPA and Ramsar Site. The habitats within the "pills" provide important shelter and feeding habitats for both fish and bird species.

The Severn Estuary saltmarshes are generally grazed by sheep and/or cattle. Grazing is a significant factor in determining the plant communities found within them and their value for dependant species such as birds and rare plants.

3.4.4 Typical Species

The saltmarsh communities present relate to the four principal zones referred to above.

The low to mid marsh communities include transitional low saltmarsh with *Puccinellia maritima*, annual *Salicornia* sp. and *Suaeda maritima; Aster tripolium* (rayed) saltmarsh; *Puccinellia maritima* saltmarsh; *Atriplex portulacoides* saltmarsh; and *Juncus maritimus - Triglochin maritima* saltmarsh.

The mid to upper marsh communities include *Festuca rubra* saltmarsh; *Artemisia maritime* saltmarsh; and *Juncus maritimus* salt-marsh.

The transitional high marsh communities include *Spergularia marina - Puccinellia distans* saltmarsh; *Elytrigia atherica* saltmarsh; *Elytrigia repens* saltmarsh; *Festuca rubra - Agrostis stolonifera - Potentilla anserina* inundation grassland; *Festuca arundinacea* coarse grassland; *Agrostis stolonifera - Alopecurus geniculatus* inundation grassland; *Phragmites australis* reedbed; *Bolboshoenus maritimus* swamp; and *Agrostis stolonifera* sub-community.

The pioneer saltmarsh communities include *Spartina anglica* saltmarsh; Annual *Salicornia* saltmarsh; and *Suaeda maritima* saltmarsh.

Several notable species are also present *Alopecurus bulbosus, Althaea officinalis, Bupleurum tenuissimum, Hordeum marinum, Puccinellia rupestris, Trifolium squamosum, Lepidium latifolium, Allium oleraceum, and Petroselinum segetum (Dargie 1998).*

3.4.5 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.

The Severn Estuary saltmarshes do not generally contain a pattern of creeks and pans more typical of extensive saltmarshes in estuaries with less extreme tidal ranges. Instead the saltmarshes are dissected by "pills" (steep sided natural drainage channels cutting through the saltmarsh) where freshwater streams flow into the estuary. These are often deep and steep sided funnel shaped features, often with pioneer vegetation established along their banks although in many cases the natural structure of the pill is truncated by tidal flaps or flow valves. In a few locations natural salt pans occur within the saltmarshes.

Major erosion of saltmarsh is indicated by internal dissection and enlargement of the drainage network, ultimately leading to the creation of mud basins.

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.

3.5 Reef

3.5.1 Range

Reefs are rocky marine habitats or biological concretions that rise from the seabed. They are generally subtidal but may extend as an unbroken transition into the intertidal zone, where they are exposed to the air at low tide. Intertidal areas are only included within this Annex I type where they are connected to subtidal reefs. Reefs are very variable in form and in the communities that they support. Two main types of reef can be recognised: those where animal and plant communities develop on rock or stable boulders and cobbles, and those where structure is created by the animals themselves (biogenic reefs).

Rocky reefs are extremely variable, both in structure and in the communities they support. A wide range of topographical reef forms meet the EU definition of this habitat type. These range from vertical rock walls to horizontal ledges, sloping or flat bed rock, broken rock, boulder fields, and aggregations of cobbles. In contrast to the variety of rocky reefs, there is somewhat less variation in biogenic reefs, but the associated communities can vary according to local conditions of water movement, salinity, depth and turbidity. The main species which form biogenic reefs in the UK are blue mussels *Mytilus edulis*, horse mussels *Modiolus modiolus*, ross worms *Sabellaria* spp., the serpulid worm *Serpula vermicularis*, and cold-water corals such as *Lophelia pertusa*.

Reefs occur widely around the UK coast, and are found in both inshore and offshore waters. There is a far greater range and extent of rocky reefs than biogenic concretions. Only a few invertebrate species are able to develop biogenic reefs, and these have a restricted distribution and extent in the UK.

The Severn Estuary has areas of biogenic reefs, formed by the tube-dwelling polychaete worm *Sabellaria alveolata*. *Sabellaria alveolata* reefs in the UK are predominantly an intertidal habitat but the Severn Estuary

is one of the few places where *Sabellaria alveolata* reefs occur extensively in the subtidal, as well as the intertidal.

3.5.2 Extent and Distribution

There are patches of intertidal *Sabellaria alveolata* reef throughout the Estuary, although it tends to be more common on the English side. The subtidal *Sabellaria alveolata* tends to be in the outer parts of the Estuary, southwest of a line between Clevedon and Newport. The exact distribution of subtidal *Sabellaria alveolata* reef in the Severn Estuary is unknown, partly due to the difficulties in sampling this habitat.

3.5.3 Structure and Function

Sabellaria alveolata is a species of small worm which constructs tubes using sand particles, to build honeycomb-like structures. *Sabellaria alveolata* reefs are often also known as honeycomb worm reefs.

These biogenic reefs tend to increase habitat diversity for other species (Holt et al 1998), sometimes leading to higher species diversity within *Sabellaria* reefs compared to the surrounding sediment or rock habitats (Dubois et al 2002). *Sabellaria alveolata* reefs cycle through different phases, from newly settled worms through vigorous fast growing reef to older, more biodiverse hummocks (Cunningham et al, 1984). At other sites each of these phases tends to have a different community of plants and animals associated with it, so all phases are considered important for biodiversity (Collins, 2001; Dubois et al, 2002).

In order to thrive, *Sabellaria alveolata* requires an abundance of suitable coarse sand to support tube building (and therefore reef growth), as well as the availability of suitable substrates (pebbles, cobbles, boulders, bedrock) to attach to. Larval supply is also important and *Sabellaria* larvae are thought to stay in the water column for one to six months (Jackson 2008). The worms are filter feeders and therefore food within the water column (suspended detritus material) is also needed. *Sabellaria* larvae are thought to settle preferentially in areas where *Sabellaria* reef has been present in the past (Holt et al, 1998).

3.5.4 Typical Species

The *Sabellaria alveolata* reef biotopes which have been recorded in the Severn Estuary are *Sabellaria alveolata on variable salinity sublittoral mixed sediment* and *Sabellaria alveolata reefs on sand-abraded eulittoral rock.*

In the Severn Estuary (both subtidal and intertidal) the presence of *Sabellaria alveolata* reefs generally increases species diversity, relative to the surrounding rock or sediment, although the diversity of *Sabellaria alveolata* reefs in the Severn is still thought to be comparatively low compared to other areas of the UK. Species commonly found associated with subtidal *Sabellaria alveolata* reef from infaunal samples include *Eulalia tripunctata, Mediomastus fragilis, Typosyllis armillaris, Melinna cristata, Harpinia pectinata, Ampharete grubei, Golfingia vulgaris, Pygospio elegans, Arenicola marina, Autolytus sp, Sphenia binghami* and *Harmothoe impar* (Mettam et al. 1994 and Marine Recorder database).
Species found in intertidal *Sabellaria alveolata* reefs in the Severn Estuary at Goldcliff and Lavernock point include *Crangon crangon, Actinia equina, Cancer pagarus, Porcellana platycheles, Littorina spp., Pholas dactylus, Elminius modestus, Fucus serratus, Corralina officinalis and Enteromorpha spp.*(O'Riordan, 2006).

3.5.5 Natural Processes

Little is known about the nature of the *Sabellaria alveolata* reef in the Severn Estuary, especially in the subtidal. However, at other sites *Sabellaria alveolata* is known to have a very variable recruitment and the cover in any one area may vary greatly over a number of years (Wilson, 1974). A typical life span of 4-5 years for worms in colonies forming reefs on bedrock and large boulders has been reported from other areas (Wilson, 1971), with a likely maximum of around 9 years (Gruet, 1982; Wilson, 1971). However, it is suspected that there are many colonies on intertidal cobble and small boulder scars on moderately exposed shores where shorter lifespans are likely due to the unstable nature of the substratum (Holt et al, 1998). As

mentioned above, *Sabellaria alveolata* reefs cycle through several different phases, all of which are considered important for biodiversity.

3.6 Other estuarine habitats : Hard substrate habitats (rocky shores) and eel grass beds

3.6.1 Extent and Distribution

There is approximately 1,500 ha of hard substrate habitat within the Severn Estuary, consisting of boulders, rock, mussel/cobble scars, rocky pools and shingle (Countryside Council for Wales, 2006; English Nature, 2006). The largest areas of hard substrate are located towards the outer estuary at Brean Down, Anchor Head and Sand Point together with rocky platforms and cliffs at Clevedon and Portishead. There are also extensive rock platforms at English stones, Aust and Beachley.

Beds of eelgrass (*Zostera* spp.), the largest in Wales, occur on some of the more sheltered mixed hard substrate areas around the Welsh side of the Second Severn Crossing.

3.6.2 Structure and Function

Hard substrate habitats in the Severn Estuary display different characteristics to other areas in Wales. Where there is bedrock, fucoid algae cover is dense but with little associated flora and fauna. Areas of soft clay rock around Penarth also support the boring bivalves *Barnea candida* and *Pholas datylus*. Pebble and cobble shores tend to be dominated by barnacles mostly *Elminius modestus*, and sparse rough periwinkles and winkles. In the sublittoral fringe on bedrock, cobbles and pebbles, hydroids, bryozoans, sponges and barnacles dominate. These species form communities that are usually associated with subtidal habitats (adapted from Brazier et al 2007).

These habitats provide a wide range of services for estuarine species. They are important components of the SAC Estuary feature, important supporting habitats for the wintering and passage bird features of the SPA and Ramsar Site and also important supporting habitats for the fish assemblage of the SAC and Ramsar designations.

Seagrass beds are one of the most productive habitats of shallow water coastal ecosystems supporting large numbers of algae, invertebrates and fish and are an important food source for several species of ducks and geese including wigeon and European white-fronted geese. The *Zostera* beds in the Severn are unusual in that they occur in an area of mixed cobbles, sand and mud with large boulders, in other parts of Wales they are associated with mudflats. Both species of *Zostera* occur within the bed. On more dry elevated areas of sediment *Zostera noltii* can be found, whereas wet depressions and channels are dominated by *Zostera marina*. *Zostera* coverage can be patchy but locally abundant. Hard substrata within the *Zostera* bed is dominated by fucoid algae, ephemeral green algae and barnacles.

3.6.3 Typical Species

Typical fauna and flora of rocky and mixed shore areas of the Severn include spiral wrack, bladder wrack, eggwrack and serrated wrack, periwinkles, limpets, barnacles and whelks. On lower shore rock, cobbles and pebbles barnacles dominate including the barnacle *Balanus crenatus* and hydroids *Tubularia indivisa* and *Sertularia cupressina* the bryozoan *Alcyonidium diaphanum* and mermaids glove sponge *Haliclona oculata* .

Both species of eelgrass, *Zostera marina*, and *Z. noltii* have been recorded in the estuary. These are of restricted distribution in British estuaries. It is unusual to have both species in one location.

3.6.4 Natural Processes

The extent and distribution of the rocky shore habitat is 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 rocky habitats throughout the estuary.

Seagrass beds typically occur in sheltered environments such as shallow inlets and are usually found on soft sediments. The Zostera beds in the Severn are unusual in that they occur in an area of mixed cobbles gravel sand and mud.

3.7 Fish

3.7.1 Introduction

The fish fauna of the Severn Estuary is very diverse (Potts & Swaby 1994, Bird 2008). More than 110 species of fish have been identified including a wide range of migratory species and estuarine specialists and some more typically marine and freshwater species reflecting the influence of the wider Bristol Channel and major rivers entering the estuary (Severn, Wye, Usk, Avon Parrett).

3.7.2 Fish features of the Severn Estuary European Marine Site

The Severn Estuary is of particular importance for migratory fish. The estuary is one of the most important British estuaries for three rare species - river lamprey *Lampetra fluviatilis,* sea lamprey *Petromyzon marinus* and twaite shad *Alosa fallax* which are designated features of the SAC. These species together with salmon *Salmo salar*, sea trout *Salmo trutta*, eel *Anguilla anguilla* and allis shad *Alosa alosa* are also a designated feature of the Ramsar Site.

The wider assemblage of fish species, which includes the migratory species, estuarine specialists and the more typically marine and freshwater species, is a designated feature of the Ramsar Site and a component of the estuary feature of the SAC.

3.7.3 Supporting habitats

The estuary habitats, tidal stretches of the feeding rivers and saltmarsh morphological features such as drainage channels, known locally as “pills” and “rhines” (“reens” in Wales) provide important feeding, breeding and sheltered nursery areas for a wide range of fish.

3.7.4 Migratory fish

The river and sea lamprey are a primitive type of fish having a distinctive suckered mouth but no jaws. Although numbers of lamprey have declined over the last 100 years, the UK is still one of their strongholds. Sea and river lampreys spend their adult life in the sea or estuaries but spawn and spend the juvenile phase in rivers. They use the Severn Estuary as a migratory passage to and from their spawning and nursery grounds in the rivers.

Allis and twaite shad are the only two members of the herring family found in fresh water in the UK. Both look like large herring and were formerly eaten in this country before numbers declined and the fisheries collapsed. In the middle of the 19th Century, the value of shad rivalled that of salmon, and in the River Severn, shad made up about one-third of all catches. Three of the four confirmed UK spawning populations of twaite shad are in the rivers Severn, Usk and Wye respectively. The major part of the spawning population of Twaite shad consists of fish that have spawned and passed up and down through the estuary more than once. The shad enter estuaries in spring and move up into the rivers to spawn. The estuary serves as a nursery area for juvenile shad where they feed on plankton.

The Severn Estuary supports an important run of migratory salmon and sea trout which pass through the estuary on their way to and from their spawning grounds in the upper reaches of the rivers and the open sea. The Severn Estuary has the largest eel run in Great Britain.

3.7.5 Assemblage of fish species

The assemblage of fish species includes the migratory species (referred to in section 3.8.4 above), as well as the following:

- Estuarine species
    - Species typically occurring and breeding in estuaries (Bird, 2008)
    - Marine species occurring in large numbers in estuaries (Bird, 2008)
- Marine species
    - Predominantly marine species occurring infrequently in the Severn (Bird, 2008)
- Freshwater species
    - Species typically occurring and breeding in freshwater and recorded within the Severn cSAC (Bird, 2008)

Estuarine species

These species of fish rely on the estuary for some aspect of their life-cycle. As a result of this dependence, these species are often the most vulnerable to anthropogenic and environmental factors that could affect the habitat and ecology of the estuary. Marine species occurring in large numbers in estuaries are all marine species who spend the first few years of life in the sheltered waters of the estuary where suitable food is abundant and there are fewer predators. The Severn Estuary ranks as one of the top ten estuaries in the UK for the number of marine estuarine-opportunistic species it supports (Potts & Swaby 1993). Marine estuarine-opportunists can be present in the estuary in very large numbers at particular times of year. These include sprat, herring, whiting, bib, poor cod, bass and common goby (Bird, 2008).

There are a few species that spend their entire life-cycle within the estuary. These include common goby, black goby, sand smolt and 3- spined stickleback (Bird, 2008).

Marine species

These fish normally spend their entire life-cycle in the sea and only occasionally enter estuaries. Therefore, they have only a minor role to play in the estuarine ecosystem. Thus, only four species, the conger eel, Norway pout, red mullet and plaice; are ever caught in numbers exceeding about 10 per year in power station samples. They probably have little impact, either as prey or as predators on other estuarine species. While they add to the biodiversity of the fish assemblage, their main populations occur in the sea. (Bird, 2008)

Freshwater species

These species typically occur and breed in freshwater, but have occasionally been recorded within the Severn Estuary. The specimens recovered at Oldbury and/or Berkeley power stations are presumably fish that have inadvertently been swept downstream and entered brackish water. They include perch, three-spined stickleback, tench, roach and chub. The numbers of freshwater species recovered at Oldbury is always low, and usually related to increases in fresh water discharge in the spring and autumn months after heavy rain. The only exception to this generalisation concerns the three-spined stickleback which occurs in considerable numbers at Oldbury and can be regarded as both a freshwater and an estuarine species (Bird, 2008)

3.8 Birds

3.8.1 Introduction

Many estuaries in the UK are of great importance to migratory and wintering wildfowl and waders. The Severn Estuary forms part of the complex chain of estuary sites along the western coast of the UK that provide habitats for migratory waterfowl. The relatively mild winter weather conditions found here compared to continental Europe at similar latitudes can be of additional importance to the survival of wintering waterfowl during periods of severe weather. It is especially important when there is severe weather affecting other sites further north and on the east coast of Britain.

The Severn Estuary ranks amongst the top ten British estuaries for the size of visiting waterfowl populations that it supports over winter (Musgrove *et. al*., 2001). Outside of this period, it is of particular importance as a staging area in autumn and spring for migratory waterfowl species as it lies on the East Atlantic Flyway route. Bird communities are highly mobile and exhibit patterns of activity related to tidal water movements and many other factors. Different bird species exploit different parts of a marine area and different prey species.

3.8.2 Bird features of the Severn Estuary European Marine Site

The migratory wintering and passage populations of birds in the Severn Estuary are designated features of the SPA (see section 2.2) and Ramsar Site (see section 2.3) which supports in excess of 70,000 birds in winter. These include internationally and nationally important populations of key bird species in winter for which the UK has particular importance in both Europe and the world. The bird assemblage is also part of the Estuaries feature of the SAC.

3.8.3 Low-tide distribution of waterbirds on the Severn Estuary SPA and Ramsar Site

Natural England and the CCW commissioned the British Trust for Ornithology (BTO) to organise , as part of the series of WeBS Low Tide Counts, a complete low tide survey of the Severn Estuary during the winter of 2002/03 (Burton et al., 2003). The mean numbers and distribution of total waterbird species recorded on each count section on the Severn Estuary in the winters 1987/88 to 1991/92 and in 2002/03 from this BTO low-tide count data for various individual species and the bird assemblage are illustrated in Appendix 9. The Figures generally indicate that the waterfowl are distributed extensively across virtually the entire intertidal area with some obviously high concentrations in specific areas.

These maps are indicative only and several constraints on their use should be noted when attempting to interpret them. Firstly, it should be noted that in each winter only a maximum of four counts were made of each count section, one a month from November to February. Observation of the central areas of the estuary is also very difficult with all observations being made from land and it is possible that the numbers of birds using these areas were underestimated. Gulls were only recorded in the 2002/03 survey. However, even in that survey, coverage of these species was patchy. The Severn is a highly dynamic estuary and thus the location and extent of many of the intertidal areas may have changed since the Ordnance Survey maps used for this project were created. The movements of sediments may potentially also cause marked differences in the distributions of invertebrates and thus waterbirds between years. It should also be noted that the numbers of birds recorded on the Severn Estuary may vary annually due to weather conditions. In cold winters, the west coast of Britain may act as a refuge for many waterbirds that in milder winters would occur on the east coast or on the Continent. In cold winters, therefore, waterbirds may be more widely distributed across the estuary than they would in milder winters. Lastly, in assessing the importance of different intertidal mudflats, it is also essential to note that some species may use different areas during the night to those where they are recorded in the day.

3.8.4 Relationship between bird populations and supporting habitats

In recognition of the fact that bird populations on a site may change in response to wider national or international trends or events, this Regulation 33 advice addresses the habitat conditions on the site necessary to support the bird populations, as well as the bird populations themselves. “Supporting habitats” are

identified which describe the key habitats within the European Marine Site necessary to support the interest features i.e. the qualifying bird species (see Table 3 for the SPA and Tables 5 and 7 for the Ramsar Site. The Favourable Condition Tables (section 4.2; Table 15 for the SPA and Section 4.3 Table 20 for the Ramsar Site) contain further details on habitat conditions.

The key supporting habitats are the intertidal mudflats and sandflats, saltmarshes and hard substrate habitats (rocky shores). Reference should also be made to sections of this document that relate to the Severn Estuary SAC interest features which provides advice in respect of these habitats (section 4.1 and Tables 8, 10 and 11).

Bird communities are highly mobile and exhibit patterns of activity related to tidal water movements and many other factors. Different bird species exploit different parts of a marine area and different prey species. Changes in the habitat may therefore affect them differently. The most important factors related to this are:

- current extent and distribution of suitable feeding and roosting habitat (eg saltmarsh, mudflats, shingle and rocky shores);
- sufficient prey availability (eg crustaceans, small fish, molluscs, worms and seeds);
- levels of disturbance maintained at or below levels necessary to provide favourable conditions for birds' feeding and roosting areas;
- water quality necessary to maintain intertidal plant and animal communities; and
- fresh water quantity, tidal flows, salinity gradients and grazing necessary to maintain saltmarsh conditions suitable for bird feeding and roosting.

There are also a number of habitats, such as the wet coastal grazing marsh, improved grassland and open standing waters that support the qualifying bird species and occur within the SPA and Ramsar Site boundary. However, these habitats lie above highest astronomical tide and therefore are not within the European Marine Site. Objectives to maintain these aspects of bird interest in favourable condition are found within Natural England and CCW's conservation objectives for the relevant SSSI within the SPA and Ramsar site boundary and will be dealt with through relevant procedures outlined in the Conservation (Natural Habitats &c.) Regulations 1994.

Some species will also use areas of land and coastal waters outside the boundaries of both the European Marine Site, SPA and Ramsar Site. Relevant authorities need to have regard to such adjacent interests, as they might be affected by activities taking place within, or adjacent to the European Marine Site.

3.8.5 Bird count data and assessing condition of bird features and their habitats

Natural England and CCW's conservation objectives at the site level focus on maintaining both the populations of the qualifying species and the habitats used by them. Site management should therefore aim to avoid both damage to the supporting habitats and disturbance to the birds. In reporting on the conservation status, account will need to be taken of both habitat conditions and the status of the bird populations.

Accordingly, Natural England and CCW will use annual counts, in the context of five year peak means for qualifying species, together with available information on population and distribution trends, to assess whether an SPA is continuing to make an appropriate contribution to the Favourable Conservation Status of the species. Count information will be assessed in combination with information on habitat condition, at the appropriate time within the reporting cycle, in order to report to the European Union.

In addition to focusing on avoiding deterioration to the habitats of the qualifying species, the Habitats Directive also requires that actions be taken to avoid significant disturbance to the species for which the site was designated. Such disturbance may result in alterations in population trends and/or distribution patterns. Avoiding disturbance to species requirements is mentioned in the favourable condition table accompanying the conservation objectives for the SPA and Ramsar Site (Tables 16 and 21). In this context, five-year peak mean information on populations will be used as the basis for assessing whether disturbance is damaging.

Attention is also directed to the inclusion of disturbance in the advice on operations provided in Section 5. Where disturbance is highlighted in such advice, relevant authorities need to avoid damaging disturbance to qualifying species when exercising their functions under the Directive.

3.8.6 Description of the Severn Estuary bird features and their supporting habitats

3.8.6.1 Internationally important populations of waterfowl

This comprises:

A. Internationally important populations of regularly occurring Annex 1 species : Bewick's Swan
B. Internationally important populations of regularly occurring migratory species of the SPA
C. Internationally important populations of waterfowl of the Ramsar Site

A. Annex 1 species of the SPA

Description of the Feature

The species listed in Annex 1 of the Birds Directive are the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution. Species listed on Annex 1 are in danger of extinction, rare or vulnerable. Annex 1 species that regularly occur at levels over 1% of the national population meet the SPA qualifying criteria. The Severn Estuary SPA supports internationally important populations of one Annex I species

- **Bewick's swan** *Cygnus columbianus bewickii*
  (Note : this species is also part of C. internationally important populations of waterfowl of the Ramsar Site)

Key supporting habitats for Bewick's swan

Intertidal mudflats and sandflats - The focal area for the Bewick's swans is the upper Severn Estuary in the vicinity of the New Grounds, Slimbridge area. The mudflats and sandflats exposed as the tide falls where the estuary widens in the upper reaches of the site at Waveridge Sands, Frampton Sands and The Noose are used as a safe refuge areas when the birds are disturbed.

Saltmarsh communities - The birds feed on the saltmarsh and the transition from saltmarsh to coastal grazing marsh in front of the sea defences in the upper estuary at The Dumbles, where areas of the high marsh are mainly affected only by brackish water during tidal inundation. They favour areas that have unrestricted views for the early detection of predators.

Bewick's swan graze on a range of 'soft' meadow grasses such as *Agrostis stolonifera* and *Alopecurus geniculatus* found in wet meadows which are outwith the European Marine Site boundary.

B. Internationally important populations of regularly occurring migratory species of the SPA and C. Internationally important populations of waterfowl of the Ramsar Site

Description of the features

Migratory species that regularly occur at levels of 1% or more of the total biogeographic population meet the SPA criteria and qualify for designation in their own right.

Wintering species that regularly occur at levels of 1% or more of the total biogeographic population meet the Ramsar criteria (3c) and qualify for designation in their own right.

The following qualifying species of both the SPA and Ramsar are:

- **European white-fronted goose** *Anser albifrons*
- **Dunlin** Calidris alpina alpina
- **Redshank** Tringa totanus totanus
- **Shelduck** Tadorna tadorna
- **Gadwall** Anas strepera

Note : previous Regulation 33 advice issued in respect of the Severn Estuary SPA in February 2005 excluded gadwall as they were considered not to make use of the European Marine Site to any significant degree but further recent evidence (2000/01 Low Tide Bird Counts) has demonstrated that this species does make use of the EMS and has consequently now been included.

Key supporting habitats

Intertidal mudflats and sandflats - The extensive mudflats and sandflats of the Severn Estuary provide undisturbed refuge and a rich resource of intertidal invertebrates as food for many species of migratory birds. The Severn supports massive populations of birds, many of which are highly mobile, feeding and roosting in different areas, depending on food availability and the state of the tide.

The European white-fronted geese roost at night on estuarine sandbanks and usually fly less than 10km to the daytime feeding grounds. Therefore conservation of traditional roosting sites is necessary to enable the population to exploit potential feeding habitats. The sandbanks adjacent to the New Grounds at Slimbridge are a long established, traditional wintering area for the European white-fronted geese (Owen *et al.,* 1986) where they use Waveridge Sand, Frampton Sand and the Noose. Only occasionally will small numbers occur at other localities within the Severn Estuary. Shelduck exploit the rich resources of invertebrates found in the intertidal mudflats where they forage for molluscs and other invertebrates such as the mudsnail *Hydrobia* spp, mussels *Mytilus edulis* and small crustaceans such as the common shore crab *Carcinus maenas.* They feed in groups, and are distributed widely throughout the estuary where there are extensive areas of intertidal flats, but there are major concentrations on Bridgwater Bay, around the mouth of the Rhymney river and, prior to construction of the Cardiff Barrage, in Cardiff Bay (Ferns, 1980a; Fox & Salmon, 1988a; Clarke, 1989; WWT Wetlands Advisory Service, April 2003). Bridgwater Bay is a long established traditional moulting area for shelduck during late summer and autumn (Eltringham & Boyd, 1960, 1963; Morley, 1966; Fox & Salmon, 1988a). It is the largest single moulting area in Europe away from Waddensea.

Redshank and dunlin are distributed widely and feed throughout the estuary on marine polychaete worms, crustaceans and molluscs such as the Baltic tellin *Macoma balthica*. They frequently feed along undisturbed strandlines throughout the estuary. They favour areas that have abundant invertebrate prey species and unrestricted views for the early detection of predators. The location of

feeding birds on the intertidal flats is a reflection of the invertebrate species found there which, in turn, are dependent on the sediment type. Dunlin and redshank mainly feed on invertebrates in the muddier finer sediments. Dunlin are found mostly on the mid shore whereas redshank are more thinly distributed and are often found in smaller groups in the creeks and sub-estuaries. The Severn has the third largest wintering population of Dunlin in Britain. Feeding flocks are widely distributed around the estuary particularly downstream of the first Severn Bridge, with particular concentrations at Rhymney/Peterstone, Uskmouth, Welsh Grounds, Undy, Clevedon and Bridgwater Bay (Ferns, 1977; Mudge, 1979; Ferns, 1980a; Clark, 1989). There are notable concentrations of redshank at the mouths of the Rhymney, Wye, Avon and Parrett rivers (Ferns, 1977, 1980a; Clark, 1989; WWT Wetlands Advisory Service, April 2003).

Gadwall are predominantly a frewshwater species preferring the wetland habitats tht occur within the SPA behind the flood defences and therefore outside the European Marine Site- most notably the freshwater wetlands at Slimbridge and Bridgwater bay. However, they do make use of the estuary but this is largely restricted to areas where freshwater flows come into the estuary, particularly larger pills and rivers- most notably at Avonmouth, between the two Severn Bridges and at Woodspring and Weston Bays.

Saltmarsh - Upper and lower saltmarsh provide important feeding and roosting areas for the internationally important migratory birds throughout the estuary. The saltmarshes provide a rich feeding habitat for redshank and shelduck, which feed on invertebrate species in the sediments, such as the mudsnail *Hydrobia.* The European white-fronted geese graze on a range of saltmarsh grasses and herbs such as common saltmarsh grass *Puccinellia maritima* and sea barley *Hordeum marinum*. The birds feed on the saltmarsh and the transition to coastal grazing marsh in front of the sea defences in the upper estuary and particularly at the The Dumbles.

The saltmarshes also have an important function providing a safe haven from the tides that flood the mudflats twice a day. The low-growing dense vegetation provides a suitable roosting habitat for redshank and dunlin, which prefer to roost on areas of short vegetation ensuring good visibility. The saltmarshes throughout the estuary provide an important communal roosting site for redshank, dunlin and shelduck. Upper saltmarsh in particular makes ideal highwater roost sites and there are main high tide roosts in some areas with little human disturbance where waders congregate from their feeding areas.

Hard substrate habitats (rocky shores) - the shingle and rocks in the estuary provide feeding areas for dunlin and redshank and some limited foraging at high tide. It is also provides important roost sites at high tide particularly for the dunlin and redshank. Many of the rocks are off shore and are therefore generally free from human disturbance. These include Guscar Rocks in the upper reaches, Blackstone Rocks at Clevedon and Stert Island in Bridgwater Bay.

Freshwater coastal grazing marsh, improved grassland and open standing waters – these supporting habitats lie outside the European Marine Site boundary but within the SPA. They provide key areas for feeding and roosting for all the migratory species particularly at high tide, and mainly on the English side of the Estuary.

3.8.6.2 Internationally important assemblage of waterfowl

Description of the feature

In addition to supporting internationally important populations of individual birds, the Severn Estuary also qualifies under Article 4.2 as a wetland of international importance by regularly supporting over 20,000 waterfowl (Cranswick *et al.*, 1999, JNCC website). A peak count of over 100,000 waterfowl was recorded in the winter season of 1992-93 (Waters *et al*., 1993). The wintering waterfowl assemblage (consisting of over 68,000 birds) includes all regularly occurring waterfowl.

Species that qualify as a listed component of the assemblage include all the birds covered by section 3.8.6.1 and species present in nationally important numbers.

These species are:

- **Dunlin** (migratory passage populations)
- **Redshank** (migratory passage populations)
- **Wigeon**
- **Teal**
- **Pintail**
- **Pochard**
- **Tufted duck**
- **Ringed plover**
- **Grey plover**
- **Curlew**
- **Whimbrel**
- **Spotted redshank**

The JNCC website also lists lapwing, *m*allard and shoveler as qualifying for future inclusion as part of this assemblage (Stroud, DA, et al., 2001. *The UK SPA network: its scope and content.* JNCC, Peterborough)

Key supporting habitats for the waterfowl assemblage

Since a number of species comprising the waterfowl assemblage are qualifying species in their own right, their habitat requirements are described in sections 3.4 and 3.5 above. This section therefore mainly deals with the habitat requirements of the other assemblage species which form part of the waterfowl assemblage.

Intertidal mudflats and sandflats - Many of the bird species found within the Severn Estuary are highly mobile, feeding and roosting in different areas, depending on food availability, weather and tides. They favour areas that have abundant prey species and unrestricted views for the early detection of predators. Some species of wader such as ringed plover and turnstone will feed on the rich invertebrate fauna associated with rotting seaweed occurring along undisturbed strandlines.

Pintail and Teal are widely distributed around the estuary with a notable concentration at the New Grounds. Pintail are also found at Peterstone/Rhymney. Pochard and tufted duck have a highly clumped daytime distribution mainly at New Grounds with most others at Peterstone and the mouth of the Rhymney. Large numbers of pochard move onto the estuary in periods of sustained cold weather. There is a large number of wintering ringed plover on the estuary and these numbers swell during the spring and autumn when there is a considerable passage of migrants through the Severn Estuary. There are major concentrations of curlew on the flats above the first Severn Bridge as well as Bridgwater Bay and the Welsh Grounds. The Severn Estuary is a particularly important staging post for whimbrel during autumn and spring passage periods where some birds feed on the mudflats. Spotted redshank are occasionally found on the Axe and Yeo estuaries.

Saltmarsh - Upper and lower saltmarsh provide important feeding and roosting areas for the internationally important assemblage of waterfowl throughout the estuary. The European white-fronted geese graze on a range of saltmarsh grasses and herbs. The birds feed on the saltmarsh and the transition to coastal grazing marsh in front of the sea defences in the upper estuary.

There are areas of well grazed saltmarsh with saltpans at the River Axe and in the upper reaches of the estuary, which are used by wigeon and other wildfowl. Pools in the higher marsh at Bridgwater Bay and in the saltmarsh above the Severn bridges are also attractive to waders and wildfowl, providing invertebrates and shelter. In the winter, ducks such as teal and pintail feed on seeds of saltmarsh plants such as *Salicornia* sp. and *Atriplex* sp. Probing waders such as curlew also feed on the saltmarsh.

The saltmarsh provides a safe haven for the feeding waders and wildfowl from the tides that flood the mudflats twice a day. Upper saltmarsh in particular makes ideal high water roost sites and there are main high tide roosts in some areas with little human disturbance where waders congregate from their feeding areas. Waders in particular, require very short vegetation to afford unrestricted views for the early detection of predators.

Hard substrate habitats (rocky shores) - The shingle and rocks in the estuary provide feeding areas for many wildfowl and waders and important roost sites at high tide. Many of the rocks are off shore and are therefore generally free from human disturbance. These include Guscar Rocks in the upper reaches, Blackstone Rocks at Clevedon and Stert Island in Bridgwater Bay. Whimbrel have major night roosts at Collister Pill and Stert Island and the Stert Island roost is the largest of its kind in Britain. Spotted redshank are also found around Stert Island. Some areas of hard substrate support eelgrass beds which provide a food source for grazing wildfowl species particularly European white-fronted goose and wigeon.

Freshwater coastal grazing marsh, improved grassland and open standing waters – these supporting habitats lie outside the European Marine Site boundary but within the SPA. They provide key areas for breeding, feeding and roosting for all the assemblage species particularly at high tide.

4. Conservation Objectives and Favourable Condition Tables For the European Marine Site

4.1 Conservation objectives for the Severn Estuary / Môr Hafren SAC

The protection and management of the SAC in accordance with Article 6 of the Habitats Directive, including in particular the consideration of plans and projects under Article 6(3) and 6(4), should be carried out in view of the conservation objectives in this section.

4.1.1 SAC interest feature 1: Estuaries

The conservation objective for the "estuaries" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[1], each of the following conditions are met

i. the total extent of the estuary[2] is maintained;

ii. the characteristic physical form (tidal prism/cross sectional area) and flow (tidal regime) of the estuary is maintained;

iii. the characteristic range and relative proportions of sediment sizes and sediment budget[3] within the site is maintained;

iv. the extent, variety and spatial distribution[4] of estuarine habitat communities[5] within the site is maintained[6];

v. the extent, variety, spatial distribution[4] and community composition of hard substrate habitats and their notable communities[5(v)] is maintained;

vi. the abundance of the notable estuarine species assemblages[7] is maintained or increased;

vii. the physico-chemical characteristics[8] of the water column[9] support the ecological objectives described above;

viii. Toxic contaminants in water column[9] and sediment are below levels which would pose a risk to the ecological objectives described above.

ix. Airborne nutrient and contaminant loads are below levels which would pose a risk to the ecological objectives described above

The meaning of terms [1-9] above is explained in **section 4.1.1.1**

Appendix 2 shows the extent of the "estuaries" feature within the Severn Estuary SAC European Marine Site.

4.1.1.1 Explanatory information for the "estuaries" conservation objective

[1] Natural processes in respect of the SAC

Each feature may be subject to both natural processes and human influence. Human influence on the interest features is acceptable provided that it is proved to be / can be established to be compatible with the achievement of the conditions set out under the definition of favourable condition for each interest feature. A failure to meet these conditions, which is entirely a result of natural process will not constitute unfavourable condition, but may trigger a review of the definition of favourable condition.

Dynamic physical process within estuaries can stem from variable weather conditions including one off storm events, and result in changes in wave exposure, riverine floods or tidal surges. These events can move large quantities of sediments and alter channel morphology, which affect current patterns and sediment transport within the estuary.

Where these processes occur without significant anthropogenic influence they fall under the umbrella of 'natural change'. Because estuaries are dynamic systems we can expect the amount and gross distribution of habitats to change in the future. In general estuarine communities and their supporting habitats are intrinsically more dynamic over short timescales when compared to other marine and terrestrial habitats. Some estuarine communities occur in cycles dependent upon the prevailing physical conditions. Features should not necessarily be considered in unfavourable condition caused by to the short term disappearance of a particular community due to natural processes.

An important example of natural processes occurring over a longer timescale is that estuaries have a natural tendency to accumulate sediment, thereby changing their form from their original glacial morphology to a state where tidal energy is dissipated by sediment banks and other features such as saltmarsh. This, with other forces of natural change, will therefore cause the width and depth of the estuary to change over time, moving towards a state of dynamic equilibrium or 'most probable state'. As part of this process, the location and extent of saltmarshes and mudflats may change, provided there is capacity to accommodate readjustment. Future developments should aim to avoid impact on the future evolution of the system as where this process is constrained by human influence, the capacity of habitats to accommodate readjustment may be affected.

[2] Extent of the estuary

The landward limit of the estuary feature is the limit of highest astronomical tide or the site boundary where it is below highest astronomical tide, except where the landward limit is defined as straight lines across the mouths of rivers entering the estuary. The seaward limit is as shown in the map in Appendix 2. Where other Habitats Directive Annex I habitat types occur within the estuary, they also form part of the estuary feature. In addition, there are areas of the estuary which do not form part of other Annex I habitat types.

[3] Sediment budget

The sediment budget refers to the total amount of sediment within the Severn Estuary taking into account the balance of sediment inputs and outputs.

[4] Spatial distribution

Spatial distribution of estuarine communities refers to the macro spatial pattern in which communities are distributed around the estuary. This statement does not require micro-distribution of communities e.g. the exact mapped positions of specific communities to be maintained.

[5] Estuarine habitat communities

> ***Note:*** *sections i – iv below list the habitat types which are also features of the Severn Estuary SAC in their own right as well as being 'sub-features' of the estuary feature. The detailed definitions of favourable conservation status for these features are provided under their respective conservation objectives.*

i. Subtidal sandbanks *(see section 4.1.2 for the conservation objective for this feature)*
   - Sublittoral Sands and Muddy Sands
   - Sublittoral cohesive mud and sandy mud communities

ii. Intertidal mudflats and sandflats (*see section 4.1.3 for the conservation objective for this feature)*
   - Intertidal gravel and clean sands
   - Intertidal muddy sands
   - Intertidal muds

iii. Atlantic saltmeadows (*see section 4.1.4 for the conservation objective for this feature)*
- Low – mid marsh communities
- Mid – upper marsh communities
- Transitional high marsh communities
- Pioneer marsh communities

iv. Reefs of *Sabellaria alveolata (see section 4.1.5 for the conservation objective for this feature)*
- *Sabellaria alveolata* on variable salinity sublittoral mixed sediment (subtidal)
- *Sabellaria alveolata* reefs on sand-abraded eulittoral rock (contiguous subtidal and intertidal)

v. Hard substrate habitat notable communities
- *Sabellaria alveolata reefs on sand-abraded eulittoral rock* (MLR.Sab.Salv)
- *Hydroids, ephemeral seaweeds and Littorina littorea in shallow eulittoral mixed substrata pools.* **(**LR.RkpH)
- *Balanus crenatus and Tubularia indivisa on extremely tide-swept circalittoral rock.* (ECR.BS.BalTub)
- *Fucus serratus* and piddocks on lower eulittoral soft rock (MLR.Fser.Pid)
- *Mytilus edulis* and piddocks on eulittoral firm clay (MLR.MytPid)
- *Balanus crenatus*, *Halichondria panacea* and *Alcyonidium diaphanum* on extremely tide-swept sheltered circalittoral rock (ECR.BalHpan)
- *Sertularia cupressina* and *Hydrallmania falcate* on tide-swept sublittoral cobbles or pebbles in coarse sand (IGS.ScupHyd).
- *Corrallina officinalis* and coralline crusts in shallow eulittoral rockpools (LR.Rkp.Cor)
- Eel grass (*Zostera*) beds
- Peat and clay exposures
- Any other notable hard substrata communities that may be identified.

[6] Maintained

Since the late 1990s Natural England's condition assessment has identified that parts of the saltmarsh within the Severn Estuary appear to be exhibiting the effects of coastal squeeze. For this reason NE and CCW do not consider it sufficient simply to seek to maintain the existing saltmarsh resource, rather it is our advice that measures will be required which seek to recreate the approximate extent of saltmarsh habitat present within the estuary in 1995 (the year the Severn Estuary was first identified as a proposed SAC); whilst at all times working within the framework of seeking a sustainable estuary form. N.B. This is based upon a site specific consideration of the state of habitats within the Severn Estuary, and should not be extended to other sites on the basis of this advice.

[7] Notable estuarine species assemblages

i. Assemblage of fish species:
- Migratory species
    - River and Sea Lamprey and Twaite shad (Annex 1 species) and Allis shad
    - Sea trout, salmon, eel,
- Estuarine species
    - Species typically occurring and breeding in estuaries (Bird, 2008)
    - Marine species occurring in large numbers in estuaries (Bird, 2008)
- Marine species
    - Predominantly marine species occurring infrequently in the Severn (Bird, 2008)
- Freshwater species
    - Species typically occurring and breeding in freshwater and recorded within the Severn cSAC (Bird, 2008)

ii Assemblage of waterfowl species (refer also sections 4.2 and 4.3 on the SPA and Ramsar Site):
- Regularly occurring Annex 1 species - Bewicks' swan
- Regularly occurring migratory species - European white-fronted goose, dunlin, redshank, shelduck, gadwall
- Nationally important bird populations - wigeon, teal, pintail, pochard, tufted duck, ringed plover, grey plover, curlew, whimbrel and spotted redshank

iii. Assemblage of vascular plant species:
- Salt marsh species (refer to notes 5 and 6 in section 4.1.4.1 - explanatory information on the conservation objective for the Atlantic salt meadows feature)
- Eel grass *(Zostera)* species.

[8] Physico-chemical characteristics

These include nutrients, oxygen, turbidity, pH, temperature and salinity.

[9] Water column

Water column should be read to include contributory water flows into the estuary including surface flows over mudflats and saltmarsh.

4.1.2 SAC interest feature 2: Subtidal sandbanks which are covered by sea water all the time (subtidal sandbanks)

The conservation objective for the "subtidal sandbanks" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[1], each of the following conditions are met:

i. the total extent of the subtidal sandbanks[2] within the site is maintained;

ii. the extent and distribution[3] of the individual subtidal sandbank communities[4] within the site is maintained;

iii. the community composition[5] of the subtidal sandbank feature within the site is maintained;

iv. the variety and distribution[3] of sediment types across the subtidal sandbank feature is maintained;

v. the gross morphology (depth, distribution and profile) of the subtidal sandbank feature within the site is maintained.

The meaning of terms [1-5] above is explained in **section 4.1.2.1**

Appendix 3 shows the extent of the "subtidal sandbanks" feature within the Severn Estuary SAC European Marine Site.

4.1.2.1 Explanatory information for the "subtidal sandbanks" conservation objective

[1] Natural processes in respect of the SAC

The meaning of 'natural processes' is explained in **section 4.1.1.1**

[2] Extent of subtidal sandbanks

The subtidal sandbanks in the Severn Estuary change their shape over time and many are ephemeral in nature, although some are relatively stable and long established. The extent of the Annex 1 habitat is considered to include both the actual sandbanks and their associated sediments. Areas of associated sediments have been defined by using the sediment environments of the Bristol Channel Marine Aggregates Resources and Constraints project, commissioned by the National Assembly for Wales (Posford Duvivier and ABP, 2000) Associated sediments have been defined as any area of of subtidal sand-sized sediment within the same sediment environment as a subtidal sandbank. Mobile sediments that form temporary sandbanks are considered to be associated sediments that should be retained in the system, but their location may change. Areas of holocence valley infill (relict sediment) are not mobile under present day estuarine conditions. Therefore, where Holocence infill is exposed, it is not considered to form part of the associated sediments. However, any mobile sand deposited over the infill does contribute to the associated sediments.

[3] Distribution

Distribution of sandbank communities and sediments refers to the macro spatial pattern in which these are distributed around the estuary. This statement does not require micro-distribution of communities or sediments e.g. the exact mapped positions of specific communities or sediments to be maintained.

The sand banks of the Middle and Welsh Grounds are relatively permanent sandbank features in the Severn Estuary, along with other long established sandbank features at Cardiff Grounds and in Bridgwater Bay. The tops of these banks are intertidal, and the permanently submerged parts of the banks are considered to contribute to the subtidal sandbanks habitat.

There are other areas of subtidal sandbank habitat within the Estuary, again sometimes the top of the bank may be exposed at low tide, with the submerged sections contributing to the subtidal sandbanks habitat. These banks are more ephemeral in nature, but are still considered part of the feature, and reflect the dynamic nature of the Severn Estuary. The areas where ephemeral subtidal sandbanks are known to occur include areas offshore from Avonmouth and at English Grounds (near Clevedon).

The macro-scale distribution of the subtidal sandbanks should be maintained, and there should be continued presence of ephemeral subtidal sandbanks in the Estuary.

[4] Subtidal sandbank communities

There are two groups of communities comprising the 'sub-features' of the subtidal sandbanks feature:

- Sublittoral Sands and Muddy Sands:

i. Infralittoral mobile sand in variable salinity (estuaries)
ii. Infralittoral mobile clean sand with sparse fauna
iii. *Nephtys cirrosa* and *Macoma balthica* in variable salinity infralittoral mobile sand
iv. *Neomysis integer* and *Gammarus* spp. in fluctuating low salinity infralittoral mobile sand

- Sublittoral cohesive mud and sandy mud communities:

i. *Capitella capitata* in enriched sublittoral muddy sediments
ii. *Nephtys hombergii* and *Tubificoides* spp. in variable salinity infralittoral soft mud
iii. *Capitella capitata* and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment*
iv. *Nephtys hombergii* and *Macoma balthica* in infralittoral sandy mud*

(* these records have a lower degree of confidence than the other communities listed, i.e. the biotope assessor was uncertain regarding precisely which biotope should be recorded).

[5] Community composition

Species typical of the subtidal sandbank communities:

Aricidea minuta
Capitella capitata
Diastylis rathkei typica
Eurydice pulchra
Gammarus salinus
Harpinia pectinata
Mediomastus fragilis
Nephtys cirrosa
Nephtys hombergii
Oligochaeta
Pygospio elegans
Pontocrates arenarius
Pseudocuma longicornis
Retusa obtusa
Tubificoides amplivasatus

4.1.3 SAC interest feature 3 : Mudflats and sandflats not covered by seawater at low tide (mudflats and sandflats)

The conservation objective for "mudflats and sandflats" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[1], each of the following conditions are met:

i. The total extent of the mudflats and sandflats feature[2] is maintained;

ii. the variety and extent of individual mudflats and sandflats communities[3] within the site is maintained;

iii. the distribution[4] of individual mudflats and sandflats communities[3] within the site is maintained;

iv. the community composition[5] of the mudflats and sandflats feature within the site is maintained;

v. the topography of the intertidal flats and the morphology (dynamic processes of sediment movement and channel migration across the flats) are maintained.

The meaning of terms [1-5] above is explained in **section 4.1.3.1.**

Appendix 4 shows the extent of the "mudflats and sandflats" feature within the Severn Estuary SAC European Marine Site.

4.1.3.1 Explanatory information for the "mudflats and sandflats" conservation objective

[1] Natural processes in respect of the SAC

The meaning of 'natural processes' is explained in **section 4.1.1.1.**

[2]Extent of the intertidal mudflats and sandflats

The extent of the feature is defined using intertidal Phase 1 survey information, which gives the seaward limit of the feature as the low water mark of spring tides (MLWS) because that is in practice the lower limit to which Phase 1 survey is possible. The feature does not include other intertidal habitats which are not mudflats and sandflats, such as intertidal reefs and rocky shores. This is the basis on which the feature is shown in the map in Figure 4, the total extent being 20,271 ha. However in addition there will be some areas of intertidal mudflat and sandflat seaward of MLWS and down to Lowest Astronomical Tide, which is the absolute seaward limit of this habitat type.

[3] Mudflat and sandflat communities

There are three groups of communities comprising the "sub-features" of the "Mudflats and sandflats not covered by seawater at low tide" feature:

• Intertidal gravel and clean sand communities

i. Barren coarse sand shores; **LGS.S.BarSnd**
ii. Burrowing amphipods and *Eurydice pulchra* in well drained clean sand shores; **LGS.S.AEur**
iii. Burrowing amphipods and polychaetes in clean sand shores. **LGS.S.AP**
iv. Talitrid amphipods in decomposing seaweed on the strandline **LGS.S.Tal**
v. Dense *Lanice conchilega* in tide-swept lower shore sand **LGS.S.Lan**
vi. Barren shingle or gravel shores **LGS.Sh.BarSh**

• Intertidal muddy sand communities :

i. Polychaetes and *Cerastoderma edule* in fine sand or muddy sand shores **LMS.MS.PCer**
ii. *Bathyporeia pilosa* and *Corophium spp.* in upper shore slightly muddy fine sand shores **LMS.MS.BatCor**
iii. *Macoma balthica* and *Arenicola marina* in muddy sand shores. **LMS.MS.MacAre**

• Intertidal mud communities:

i. *Hediste diversicolor* and *Macoma balthica* in sandy mud shores: **LMU.SMu.HedMac**
ii. *Hediste diversicolor, Macoma balthica* and *Arenicola marina* in muddy sand or sandy mud shores **LMU.SMu.HedMacAre**
iii. *Hediste diversicolor* and *Scrobicularia plana* in reduced salinity mud shores **LMU.Mu.HedScr**
iv. *Hediste diversicolor* and oligochaetes in low salinity mud shores **LMU.Mu.HedOl**
v. *Hediste diversicolor* and *Streblospio shrubsolii* in sandy mud or soft mud shores **LMU.Mu Hed Str**

Appendix 4a shows the extent of the "mudflats and sandflats" subfeatures within the Severn Estuary SAC European Marine Site.

[4] Distribution

The distribution of mudflats and sandflats communities refers to the macro spatial pattern in which these communities are distributed around the estuary. This statement does not require micro-distribution of communities e.g. the exact mapped positions of specific communities to be maintained.

[5] Community composition

Species typical of the mudflat and sandflat communities:

Aphelochaeta marioni
Arenicola marina
Bathyporeia pelagica
Corophium volutator
Enchytraeidae
Eurydice pulchra
Hediste diversicolor
Hydrobia ulvae
Macoma balthica
Nephtys cirrosa
Nephtys hombergii
Oligochaeta indet.
Pygospio elegans
Scoloplos armiger
Scrobicularia plana
Streblospio shrubsolii
Tubificoides benedii

4.1.4 SAC interest feature 4: Atlantic salt meadow

The conservation objective for the "Atlantic salt meadow" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[1], each of the following conditions are met:

i. the total extent of Atlantic salt meadow and associated transitional vegetation communities[2] within the site is maintained[3];

ii. the extent and distribution[4] of the individual Atlantic salt meadow and associated transitional vegetation communities[2] within the site is maintained;

iii. the zonation of Atlantic salt meadow vegetation communities and their associated transitions[2] to other estuary habitats is maintained;

iv. the relative abundance of the typical species[5] of the Atlantic salt meadow and associated transitional vegetation communities[2] is maintained;

v. the abundance of the notable species[6]of the Atlantic salt meadow and associated transitional vegetation communities[2] is maintained.

vi. the structural variation of the salt marsh sward (resulting from grazing) is maintained within limits sufficient to satisfy the requirements of conditions iv and v above and the requirements of the Ramsar and SPA features[7]

vii. the characteristic stepped morphology of the salt marshes and associated creeks, pills, drainage ditches and pans, and the estuarine processes that enable their development, is maintained.

viii Any areas of *Spartina anglica* salt marsh (SM6) are capable of developing naturally into other saltmarsh communities.[8]

The meaning of terms [1-8] above is explained in **section 4.1.4.1.**

Appendix 5 shows the extent of Atlantic salt meadow and its associated transitional vegetation communities within the Severn Estuary SAC European Marine Site.

4.1.4.1 Explanatory information for the "Atlantic salt meadow" conservation objective

[1] Natural processes in respect of the SAC

The meaning of 'natural processes' is explained in **section 4.1.1.1**.

[2] Atlantic salt meadow and associated transitional vegetation communities

The vegetation communities comprising the Atlantic Salt Meadow feature can be grouped into four 'sub-features', namely:

(a) low to mid marsh communities
(b) mid to upper marsh communities
(c) transitional high marsh communities
(d) pioneer saltmarsh communities

The communities in each of these sub-features are listed below.

Sub-features (a) and (b) contain the National Vegetation Classification (NVC) communities which fall within the definition of Atlantic Salt Meadow in the EU Interpretation Manual. The extent of these two sub-features within the SAC is currently estimated at 656 ha. The communities in (c) and (d) do not fall within the Atlantic Salt Meadow definition, but are considered to be important components of this feature as they represent its landward and seaward transitions to other habitat types, namely non-saline vegetation and pioneer salt marsh respectively. Atlantic salt meadow is a naturally dynamic habitat and these transitional communities are considered to be an integral part of the Atlantic Salt Meadow feature and essential elements of its structure and function. The total extent of all four of the above sub-features in the SAC is estimated to be 1400 ha, distributed in the SAC as shown in Appendix 5a.

(a) Low to mid marsh communities:

i. Transitional low saltmarsh with *Puccinellia maritima*, annual *Salicornia* sp. and *Suaeda maritima* SM10
ii. *Aster tripolium* (rayed) saltmarsh SM12
iii. *Puccinellia maritima* saltmarsh SM13
    - *Puccinellia maritima* sub-community SM13a
    - *Glaux maritima* sub-community SM13b
    - *Limonium vulgare - Armeria maritima* sub-community SM13c
    - *Plantago maritima - Armeria maritima* sub-community SM13d
    - *Plantago maritima–Triglochin maritima* sub-community SM13x (provisional)
    - *Spartina anglica* sub-community SM13y (provisional)
iv. *Atriplex portulacoides* saltmarsh SM14
    - *Atriplex portulacoides* sub-community SM14a
v. *Juncus maritimus - Triglochin maritima* saltmarsh SM15

(b) Mid to upper marsh communities:

i. *Festuca rubra* salt-marsh SM16
    - *Puccinellia maritima* sub-community SM16a
    - *Juncus gerardii* sub-community SM16b
    - *Glaux maritima* sub-community SM16c
    - *Festuca rubra* sub-community SM16d
    - *Leontondon autumnalis* sub-community SM16e
    - *Aster tripolium* sub-community SM16x (provisional)
ii. *Artemisia maritima* saltmarsh SM17
iii. *Juncus maritimus* salt-marsh SM18
    - *Festuca arundinacea* sub-community SM18c

(c) Transitional high marsh communities:

i. *Spergularia marina - Puccinellia distans* saltmarsh SM23
ii. *Elytrigia atherica* saltmarsh SM24
iii. *Elytrigia repens* saltmarsh SM28
iv. *Festuca rubra - Agrostis stolonifera - Potentilla anserina* inundation grassland MG11
v. *Festuca arundinacea* coarse grassland MG12
vi. *Agrostis stolonifera - Alopecurus geniculatus* inundation grassland MG13
vii. *Phragmites australis* reedbed S4
    - *Phragmites australis* sub-community S4a

xiii. *Bolboshoenus maritimus* swamp S21
    - *B. maritimus* sub-community S21a

Agrostis stolonifera sub-community S21c

(d) Pioneer saltmarsh communities:

i. *Spartina anglica* saltmarsh SM6
ii Annual *Salicornia* saltmarsh SM8
iii. *Suaeda maritima* saltmarsh SM9

[3] Maintained

Since the late 1990s Natural England's condition assessment has identified that parts of the saltmarsh within the Severn Estuary appear to be exhibiting the effects of coastal squeeze. For this reason NE and CCW do not consider it sufficient simply to seek to maintain the existing saltmarsh resource, rather it is our advice that measures will be required which seek to recreate the approximate extent of saltmarsh habitat present within the estuary in 1995 (the year the Severn Estuary was first identified as a proposed SAC); whilst at all times working within the framework of seeking a sustainable estuary form. N.B. This is based upon a site specific consideration of the state of habitats within the Severn Estuary, and should not be extended to other sites on the basis of this advice.

[4]Distribution

The distribution Atlantic salt meadow communities refers to the macro spatial pattern in which these are distributed around the estuary. This statement does not require micro-distribution of communities e.g. the exact mapped positions of specific communities to be maintained.

[5] Typical species of the Atlantic salt meadow

Festuca arundinacea
Festuca rubra
Juncus gerardii
Triglochin maritimum
Carex extensa
Agrostis stolonifera
Juncus maritimus
Oenanthe lachenalii
Puccinellia maritima,
Salicornia spp.
Suaeda maritima
Aster tripolium
Glaux maritima
Plantago maritima
Armeria maritima
Elytrigia atherica
Atriplex prostrata
Phragmites australis
Spartina anglica
Spergularia media
Puccinellia distans
Cochlearia anglica
Cochlearia officinalis
Limonium vulgare
Atriplex portulacoides
Seriphidium maritimum
Plantago coronopus
Beta vulgaris maritima

[6] Notable Atlantic salt meadow vegetation species

Alopecurus bulbosus
Althaea officinalis
Bupleurum tenuissimum
Hordeum marinum
Puccinellia rupestris
Trifolium squamosum
Lepidium latifolium

Allium oleraceum
Petroselinum segetum

[7] Severn Estuary SPA and Severn Estuary Ramsar Site Conservation Objectives
Refer to sections 4.2 and 4.3 of this document

[8] *Spartina anglica* SM6
Spartina in the Severn is considered to be an invasive species and these conservation objectives do not seek the maintenance of the extent or condition of this habitat type. However, SM6 is considered to be a transitional salt marsh community and the conservation objectives seek to protect the ability of areas of *Spartina* to develop into other Atlantic Salt Meadow or transitional communities.

4.1.5 SAC interest feature 5 : Reefs

The conservation objective for the "reefs" feature of the Severn Estuary SAC is to maintain the feature in a favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[1], each of the following conditions are met:

i. the total extent and distribution[2] of *Sabellaria* reef [3] is maintained;

ii. the community composition[4] of the *Sabellaria* reef is maintained;

iii. the full range of different age structures of *Sabellaria* reef are present;

iv. the physical[5]and ecological processes[6] necessary to support *Sabellaria* reef are maintained.

The meaning of terms [1 – 6] above is explained in **section 4.1.5.1** below.

Appendix 6 shows the extent of the "reef" feature within the Severn Estuary SAC European Marine Site.

4.1.5.1 Explanatory information for the "reefs" conservation objective

[1] Natural processes in respect of the SAC

The meaning of 'natural processes' is explained in section **4.1.1.1**

[2] Distribution

The distribution of reefs refers to the macro spatial pattern in which the reefs are distributed around the estuary. This statement does not require micro-distribution of the reefs e.g. the exact mapped positions of specific reefs to be maintained.

[3] *Sabellaria* reef

Little is known about the nature of the *Sabellaria alveolata* reef in the Severn Estuary, especially in the subtidal. However, at other sites *S. alveolata* is known to have a very variable recruitment and the cover in any one area may vary greatly over a number of years. *S. alveolata* reefs also cycle through different phases, from newly settled worms through vigorous fast growing reef to older hummocks. It is likely that subtidal *S. alveolata* reef in the Severn Estuary will exhibit reduced growth forms (lower elevation) in comparison to the intertidal reef habitat. The easiest of these phases to identify is the fast growing reef and for the purposes of these conservation objectives this is defined as a dense aggregation of worms (over 1000 per m^2, as a rough guide), generally forming a thick (2 cm or more) crust of tubes. The area covered by the habitat would generally exceed 25 m^2 although there could be patchiness within this area. The other phases of growth are also important and are encompassed in point iii of the objective.

The *S. alveolata* reef biotopes recorded in the Severn Estuary are SS.SBR.PoR.SalvMx *Sabellaria alveolata on variable salinity sublittoral mixed sediment* and LS.LBR.Sab.Salv *Sabellaria alveolata reefs on sand-abraded eulittoral rock.*

[4] Community composition

Species associated with dense aggregations of *Sabellaria alveolata* in the Severn estuary:

Subtidal

Sabellaria alveolata
Eulalia tripunctata

Mediomastus fragilis
Typosyllis armillaris
Ampharete grubei
Harpinia pectinata
Melinna cristata
Pygospio elegans
Scoloplos armiger
Nemertea
Nucula nitidosa
Nucula nucleus
Tubificoides amplivasatus
Golfingia vulgaris vulgaris
Gammarus salinus
Tubificoides
Arenicola marina
Sphenia binghami
Eumida sanguinea
Nephtys hombergii
Autolytus prolifera
Harmothoe impar
Nematoda
Polycirrus
Dodecaceria concharum
Harmothoe
Syllidae
Enchytraeidae

Intertidal

Sabellaria alveolata,
Actinia equina
Cancer pagurus
Elminius modestus
Littorina saxatilis
L.littorea
L.obtusata
Pholas dactylus
Pomatocerus lamarcki
Porcellana platycheles
Semibalanus balanoides
Halichondrea sp
Corallina officinalis
Enteromorpha sp.
Fucus serratus
Fucus vesiculosus
Pelvetia canaliculata
Porphyra sp
Ulva sp

[5]Physical processes

- abundance of suitable coarse sediments to support reef growth (tube building)
- the availability of suitable substrates where *Sabellaria* has been known to occur in the past

[6]Ecological Processes

- supply of *Sabellaria* larvae (within the water column)
- abundance of food (suspended detritus material) within the water column to support feeding

4.1.6 SAC interest feature 6 : River lamprey *Lampetra fluviatilis*

The conservation objective for the river lamprey *Lampetra fluviatilis* feature of the Severn Estuary SAC is to maintain the feature in a favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[1], each of the following conditions are met:

i. the migratory passage of both adult and juvenile river lamprey through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality;

ii the size of the river lamprey population in the Severn Estuary and the rivers which drain into it, is at least maintained and is at a level that is sustainable in the long term;

iii. the abundance of prey species[2] forming the river lamprey's food resource within the estuary, is maintained.

iv. Toxic contaminants in the water column[3] and sediment are below levels which would pose a risk to the ecological objectives described above.

The meaning of terms [1-3] above is explained in **section 4.1.6.1**.

Note : The river lamprey population of the Severn depends on habitat in the adjacent River Usk SAC, River Wye SAC and River Severn. The habitats in these rivers, including spawning and nursery areas, are essential for the fulfilment of the species' lifecycle and therefore the Severn Estuary river lamprey feature can only be in favourable condition if the conservation objectives pertaining to the River Usk SAC and River Wye SAC river lamprey feature are also met in full and there is a continued recorded presence of this species in the River Severn.

4.1.6.1 Explanatory information for the river lamprey *Lampetra fluviatilis* conservation objective

[1] Natural processes in respect of the SAC fish features

River lamprey population:

The size of the population is subject to non anthropogenic factors relating to natural fluctuations of external factors such as food / host availability in the Bristol Channel and more widely and breeding success in the River Severn and other rivers draining into the Severn Estuary.

Supporting habitats
The general meaning of 'natural processes' with respect to the supporting habitats of river lamprey within the estuary is explained in **section 4.1.1.1**

[2] Prey species

Sea trout *Salmo trutta*, shad *Alosa fallax/Alosa alosa*, herring *Clupea harengu*s, sprat *Sprattus sprattu*s, flounder *Platichthys flesu*s and small gadoids such as whiting *Merlangius merlangu*s and pout *Trisopterus luscu*s are all potential prey species for the river lamprey found within the Severn Estuary (Bird 2008).

[3]Water column

Water column should be read to include contributory water flows into the estuary including surface flows over mudflats and saltmarsh.

4.1.7 SAC interest feature 7: The conservation objective for sea lamprey *Petromyzon marinus*

The conservation objective for the sea lamprey *Petromyzon marinus* feature of the Severn Estuary SAC is to maintain the feature in a favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[1], each of the following conditions are met:

i. the migratory passage of both adult and juvenile sea lamprey through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality;

ii. the size of the sea lamprey population in the Severn Estuary and the rivers which drain into it, is at least maintained as is at a level that is sustainable in the long term;

iii. the abundance of prey species[2] forming the sea lamprey's food resource within the estuary, is maintained.

vi. Toxic contaminants in the water column[3] and sediment are below levels which would pose a risk to the ecological objectives described above.

The meaning of terms [1-3] above is explained in **section 4.1.7.1**.

Note : The sea lamprey population of the Severn depends on habitat in the adjacent River Usk SAC, River Wye SAC and River Severn. The habitats in these rivers, including spawning and nursery areas, are essential for the fulfilment of the species' lifecycle and therefore the Severn Estuary sea lamprey feature can only be in favourable condition if the conservation objectives pertaining to the River Usk SAC and River Wye SAC sea lamprey shad feature are also met in full and there is a continued recorded presence of this species in the River Severn.

4.1.7.1 Explanatory information for the sea lamprey *Petromyzon marinus* conservation objective

[1] Natural processes in respect of the SAC fish features

Sea lamprey population:
The size of the population is subject to non anthropogenic factors relating to natural fluctuations of external factors such as food / host availability in the Bristol Channel and more widely and breeding success in the River Severn and other rivers draining into the Severn Estuary.

Supporting habitats:
The general meaning of 'natural processes' with respect to the supporting habitats of sea lamprey within the estuary is explained in **section 4.1.1.1**.

[2]Prey species

Eel *Anguilla anguilla*, cod *Gadus morhua*, and haddock *Melanogrammus aeglefinus* are all potential prey species for the sea lamprey found within the Severn Estuary (Bird 2008)

[3]Water column

Water column should be read to include contributory water flows into the estuary including surface flows over mudflats and saltmarsh.

4.1.8 SAC interest feature 8: The conservation objective for twaite shad *Alosa fallax*

The conservation objective for the twaite Shad *Alosa fallax* feature of the Severn Estuary SAC is to maintain the feature in a favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[1], each of the following conditions are met:

i. the migratory passage of both adult and juvenile twaite shad through the Severn Estuary between the Bristol Channel and their spawning rivers is not obstructed or impeded by physical barriers, changes in flows or poor water quality;

ii. the size of the twaite shad population within the Severn Estuary and the rivers draining into it is at least maintained and is at a level that is sustainable in the long term.

iii. the abundance of prey species[2] forming the twaite shad's food resource within the estuary, in particular at the salt wedge[3], is maintained.

iv. Toxic contaminants in the water column[4] and sediment are below levels which would pose a risk to the ecological objectives described above.

The meaning of terms[1-4] above is explained in **section 4.1.8.1**.

Note : The twaite shad population of the Severn depends on habitat in the adjacent River Usk SAC, River Wye SAC and River Severn. The habitats in these rivers, including spawning and nursery areas, are essential for the fulfilment of the species' lifecycle and therefore the Severn Estuary twaite shad feature can only be in favourable condition if the conservation objectives pertaining to the River Usk SAC and River Wye SAC twaite shad feature are also met in full and there is a continued recorded presence of this species in the River Severn.

4.1.8.1 Explanatory information for the Twaite shad *Alosa fallax* conservation objective

[1] Natural processes in respect of the SAC fish features

Twaite shad population:
The size of the population is subject to non anthropogenic factors relating to natural fluctuations of external factors such as food availability in the Bristol Channel and more widely and breeding success in the River Severn and other rivers draining into the Severn Estuary.

Supporting habitats:
The general meaning of 'natural processes' with respect to the supporting habitats of twaite shad within the estuary is explained in **section 4.1.1.1**.

[2] Prey species

Small custaceans, especially mysids and copepods, small fish, especially sprats and anchovies, and fish eggs (Maitland, P.S. & Hatton-Ellis 2003).

[3] Salt wedge

This the area within the estuary where fresh and saline water meet and where the abundance of prey species is particularly important to the twaite shad population. The actual position varies according to the state of the tide and volume of freshwater input to the estuary.

[4] Water column

Water column should be read to include contributory water flows into the estuary including surface flows over mudflats and saltmarsh.

4.1.9 Favourable Condition Tables for the SAC interest features of the Severn Estuary European Marine Site

Background information on the role of favourable condition tables and the information provided in each column is provided in Section 1.8 of this document, and a concise glossary of terms used is provided in Section 7.

The favourable condition table is intended to supplement the conservation objectives, including with respect to the management of established and ongoing activities, future requirements of monitoring and reporting on the condition of the features of the site and, together with the conservation objectives, informs the scope and nature of any appropriate assessment that may be needed. The table **does not by itself** provide a comprehensive basis on which to assess plans and projects as required under the Habitats Regulations. It should be noted that appropriate assessments are a separate activity to condition monitoring, requiring consideration of issues specific to individual plans or projects.

These tables set out all the attributes that **may** be used to monitor the condition of the features of the SAC. Where possible we will seek available information from others which can inform our assessment process.

It will be possible to monitor many of the attributes at the same time or during the same survey. The frequency of sampling for many attributes may need to be greater during the first reporting cycle in order to characterise the site and establish the baseline. Where relevant, abbreviations of National Vegetation Classification (NVC) codes are used for simplicity (Rodwell, 2000).

Comprising :

Table 8 – Favourable condition table for the “estuaries” feature of the Severn Estuary SAC and (in part) for the Ramsar Site (refer to section 4.3.1)

Table 9 – Favourable condition table for the “subtidal sandbanks” feature of the Severn Estuary SAC

Table 10 – Favourable condition table for the “intertidal mudflats and sandflats” feature of the Severn Estuary SAC

Table 11 – Favourable condition table for the “Atlantic salt meadows” feature of the Severn Estuary SAC

Table 12 – Favourable condition table for the “reefs” feature of the Severn Estuary SAC

Table 13 – Favourable condition table for the “river lamprey” and “sea lamprey” features of the Severn Estuary SAC

Table 14 – Favourable condition table for the “twaite shad” feature of the Severn Estuary SAC

Table 8 – Favourable condition table for the "estuaries" feature of the Severn Estuary SAC and (in part) for the Ramsar Site (refer to section 4.3.1)

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
A1	***SAC interest feature 1:*** **Estuaries**		**Extent** *(Total extent of the estuaries feature - section 4.1.1.i of the conservation objectives)*	Total area (ha) of estuary feature	No decrease in extent due to man induced changes from the established baseline *The baseline is the extent of all areas subject to tidal influence within the boundary of the designation of the pSAC in 2000 - see also map in Appendix 2*	Extent is an attribute on which reporting is required by the Habitats Directive.
A2		All sub-features	**Morphology** *(Characteristic physical form and flow - section 4.1.1.ii of the conservation objectives)*	Intra and inter-estuarine Tidal Prism/Cross Section ratio (TP/CS ratio) measured during the reporting cycle using remote sensing (frequency to be determined).	The intra- and inter- estuarine TP/CS relationship should not deviate significantly from an established baseline subject to natural processes (* includes recognition of fixed hard geology formations) *Baseline to be established :-* *Data to be used is Hydrological Office bathymetry data (intertidal and subtidal) and Environment Agency LIDAR survey*	TP = Tidal Prism = total volume of water crossing a given cross section during the flood tide (m^3). CS = Area of a given cross section at high water springs (m^2). The relationship between TP & CS provides a measure of the way the estuary has adjusted to tidal energy. Substantial departures from this characteristic relationship (determined on a regional basis) may indicate the influence of anthropogenic factors and this would trigger more detailed evaluation of potential problems. The identification of a suitable baseline for TP/CS relationship will need to take account of the highly dynamic nature of the Severn and potential impacts of natural processes (including sea level rise) in altering the profile of the estuary – with a view to maintaining or promoting the movement of the estuary towards "dynamic equilibrium". *The hard geology formations (headlands, cliffs and rock platforms) have a major role in influencing the characteristic physical form and flow of the estuary (many are protected in their own right as geological SSSI).

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
A3	***SAC interest feature 1:*** **Estuaries**		**Tidal regime and flows** (saline water and freshwater contributions) *(characteristic physical form and flow - section 4.1.1.ii of the conservation objectives)*	Tidal range, measured from tide gauges at specified locations, and flows measured from current estuary and river meters . Locations and frequency to be determined	No decrease in tidal range subject to natural processes. Tidal currents should not deviate significantly from an established baseline subject to natural processes Riverine flows (Rivers Wye, Usk and Severn) and estuarine flows must be sufficient to ensure Water Framework Directive target of Good Ecological Status (GES) is met. *Baseline to be established :-* *Data to be used is existing tide gauge and current meter data from EA ca 2000, and agreed WFD monitoring measures.*	

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
A4			**Sediment budget** *(characteristic range and relative proportions of sediment sizes and sediment budget - section 4.1.1.iii of the conservation objectives)*	Evaluation of the sediment fluxes, sources and sinks, using a variety of measures including bathymetry, suspended sediment concentrations, fluvial and marine influx/efflux, man-made changes (e.g. navigational dredging/marine minerals extraction), cliff erosion etc)	No decrease in sediment budget from the established baseline *Baseline to be established :-* *Data to be used is Severn Estuary Coastal Habitat Management Plan (CHaMP) Part F- Sediment Budget Analysis*	A sediment budget is a balance of the sediment volume entering and exiting a particular section of the coast or an estuary. Sediment budget analysis consists of the evaluation of sediment fluxes, sources and sinks from different processes that give rise to additions and subtractions within a control volume (e.g. a section of coast or an estuary) in order to gain a better understanding of the estuary system. An estuary provides a readily defined control volume, where point sources and sinks exist in the form of rivers, other terrestrial outfalls and the open sea. Line sources and sinks may be defined in terms of erosion from cliffs and transfers to or from saltmarshes, wetlands or other intertidal areas. The subtidal beds also needs consideration as an important source/sink as does material stored in suspension within the volume of water that moves back and forth under tidal action within the estuary. Identification and quantification of all the mechanisms giving rise to sediment transfers can be difficult, and for the most part are approximate estimates of sediment exchange between sources and sinks. Reference ; ABPmer and HR Wallingford (2007).
A5	***SAC interest feature 1:*** **Estuaries**		**Sediment size, range and distribution** *(characteristic range and proportions of sediment sizes and sediment budget - section 4.1.1.iii of the conservation objectives)*	Sediment size distribution characterised and measured by particle size analysis (PSA) at a series of locations across the estuary during the reporting cycle (locations and frequency to be determined)	Sediment size distribution should not deviate from an established baseline. *Baseline to be established :-* *Data to be used is* BGS seabed sediment data and other relevant datasets ?	PSA measures parameters including percentage sand/silt/gravel, mean and median grain size and sorting co-efficient, used to characterise sediment type. Sediment character is key to the structure of the features and reflects the physical processes acting on it – it may vary across the estuary and can be used to indicate the spatial distribution of sediment types reflecting the stability of the features and the processes supporting it..
A6		Subtidal sandbanks	**Extent, variety and spatial distribution of estuarine habitat communities** *(section 4.1.1.iv of the conservation objectives)*	*For information on the attributes of the subtidal sandbank communities sub-feature see the sections of this table which relate to the subtidal sandbanks which are covered by seawater all the time feature, see Table 9*		

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
A7		Intertidal mudflat and sandflat communities	**Extent, variety and spatial distribution of estuarine habitat communities** *(section 4.1.1.iv of the conservation objectives)*	*For information on the attributes of the intertidal mudflat & sandflat communities sub-feature see the sections of this table which relate to the intertidal mudflats and sandflats not covered by seawater at low tide feature, see Table 10*		
A8		Atlantic salt meadow (and associated transition habitats)	**Extent, variety and spatial distribution of estuarine habitat communities** *(section 4.1.1.iv of the conservation objectives)*	*For information on the attributes of the Atlantic salt meadow communities sub-feature see the sections of this table which relate to Atlantic salt meadow feature, see Table 11*		
A9		Reefs of *Sabellaria alveolata*	**Extent, variety and spatial distribution of estuarine habitat communities** *(section 4.1.1.iv of the conservation objectives)*	*For information on the attributes of the Reef sub-feature see the sections of this table which relate to the Reef feature, see Table 12*		

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
A10	***SAC interest feature 1:*** **Estuaries**	Hard substrate habitats and their notable communities	**Extent & variety** *(extent, variety, spatial distribution and community composition of hard substrate habitats and their notable communities - section 4.1.1.v of the conservation objectives)*	Area (ha) and range of types of hard substrate habitats and their notable communities, measured periodically during the reporting cycle along sampling transects or grids (frequency to be determined).	No decrease in extent or range of types of hard substrate habitats and their notable communities from the established baseline subject to natural processes. *Baseline is the CCW and English Nature Intertidal Biotope Surveys 2006.*	Loss of hard substrate habitats and their notable communities is likely to be detrimental to the structure of the interest feature, e.g. associated with a change in estuary processes and may indicate long term changes in the physical conditions of the estuaries interest feature. Notable communities of the Severn Estuary comprise the following • *Sabellaria alveolata reefs on sand-abraded eulittoral rock* (MLR.Sab.Salv) • *Hydroids, ephemeral seaweeds and Littorina littorea in shallow eulittoral mixed substrata pools.* **(**LR.RkpH) • *Balanus crenatus and Tubularia indivisa on extremely tide-swept circalittoral rock.*(ECR.BS.BalTub) • *Fucus serratus* and piddocks on lower eulittoral soft rock (MLR.Fser.Pid) • *Mytilus edulis* and piddocks on eulittoral firm clay (MLR.MytPid) • *Balanus crenatus, Halichondrea panicea* and *Alcyonidium diaphanum* on extremely tide-swept sheltered circalittoral rock (ECR.BalHpan) • *Sertularia cupressina and Hydrallmania falcate* on tide-swept sublittoral cobbles or pebbles in coarse sand (IGS.ScupHyd). • *Corralina officinalis* and coralline crusts in shallow eulittoral rockpools (LR.rkp.Cor) • Eel grass (*Zostera*) beds • Any other notable hard substrata communities that may be identified.
A11			**Spatial distribution** *(extent, variety, spatial distribution and community composition of notable communities - section 4.1.1.v of the conservation objectives)*	Spatial distribution of notable communities measured periodically during the reporting cycle using a combination of remote sensing and ground truthing using GPS (frequency to be determined).	Macroscale distribution of notable communities should not deviate significantly from the established baselines, subject to natural processes. *Baseline is the CCW and English Nature Intertidal Biotope Surveys 2006.*	Changes in the variety or distribution of notable estuarine communities may indicate long term changes in the physical conditions of the estuary interest feature or individual subfeatures.

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
A12	***SAC interest feature 1:*** **Estuaries**	Hard substrate habitats and their notable communities	**Community composition** *(extent, variety, spatial distribution and community composition of notable communities - section 4.1.1.v of the conservation objectives)*	Assessment of community quality through survey of species composition (presence of typical species) within the notable communities measured periodically	No decline in community quality due to changes in species composition or loss of typical species from an established baseline *Baseline to be established :* *Data to be used : CCW and English Nature Intertidal Biotope Surveys 2006 and future surveys*	Different associations of plants, animals and their habitat are an important structural and functional aspect of the feature. Changes in the communities present within an area of a particular type may indicate long-term changes in physical conditions at the site. Typical species of the notable communities to be determined.
A13		Notable estuarine species assemblages : **Assemblage of fish species**	**Abundance** *(abundance of notable estuarine species assemblages - section 4.1.1.vi of the conservation objectives)*	Numbers of species and population estimates	No significant reduction in overall diversity of species or in individual populations against an established baseline *Baseline to be established :* *Data to be used : Environment Agency and relevant Sea Fisheries Committee data*	Loss of notable communities may indicate long term changes in the physical conditions of the estuaries interest feature or individual subfeatures. **Assemblage of fish species:** (Refer to section 4.1.1 note 7) • Migratory species (see also section of this table which relates to the river lamprey, sea lamprey and twaite shad features) • Estuarine species • Marine species • Freshwater species Refer also to section 4.3.2 in relation to the assemblage of migratory fish species of the Ramsar Site.
A14		Notable estuarine species assemblages : **Assemblage of waterfowl species**	**Abundance** *(abundance of notable estuarine species assemblages - section 4.1.1.vi of the conservation objectives)*	Numbers of species and individual population sizes	No significant reduction in overall diversity of species or in individual populations against an established baseline *Baselines are identified in the SPA section of this advice – see section 4.2*	Loss of notable communities may indicate long term changes in the physical conditions of the estuaries interest feature or individual subfeatures. Refer also to section 4.2.7 in relation to the Internationally important **assemblage of waterfowl** of the Severn Estuary SPA and section 4.3.9 in relation to the Internationally important assemblage of waterfowl of the Severn Estuary Ramsar Site
A15		Notable estuarine species assemblages : **Assemblage of vascular plant species**	**Abundance of saltmarsh species** *(abundance of notable estuarine species assemblages - section 4.1.1.vi of the conservation objectives)*	Number of species and population sizes	No significant reduction in overall diversity of species or in individual populations against an established baseline *Baselines to be established:* *Data to be used is 1998 NVC Scarce plant survey, county botanical records and CCW/NE site records*	Loss of notable communities may indicate long term changes in the physical conditions of the estuaries interest feature or individual subfeatures. **Assemblage of vascular plant species includes**: • Salt marsh species Note : maintaining the conditions necessary for these species are covered by the Atlantic salt meadows table attributes Table 11

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
A16	***SAC interest feature 1:*** **Estuaries**	Notable estuarine species assemblages : **Assemblage of vascular plant species**	**Abundance of Eel grass**	Extent and density of Eel grass species	No significant reduction in overall extent and density against as established baseline *Baseline is CCW and English Nature Intertidal Biotope Surveys 2006 plus Severn Second Crossing monitoring data 1989-95/6*	**Assemblage of vascular plant species includes**: • Eel grass *(Zostera)* species.
A17		All sub-features	**Water quality – physico-chemical parameters** (Including temperature, salinity, oxygen, nutrients, pH and turbidity etc) *(physico chemical characteristics of the water column - section 4.1.1.vii of the conservation objectives)*	Physico-chemical parameters measured periodically throughout the reporting cycle (frequency to be determined).	Physico-chemical parameters should not pose a risk to the ecology* of the habitats and species of the SAC, SPA or Ramsar Site. Levels should comply with targets established under the EA Review of Consents and the Water Framework Directive.	Changes in any of the physico-chemical parameters in the water column can impact on the quality of the estuary habitat and hence could lead to changes in the presence and distribution of species (along with recruitment processes and spawning behaviour) and those at the edge of their geographic ranges and non-natives. *ie does not compromise the quality, extent, distribution or species composition of habitats or their ability to support species features (eg feeding, breeding, resting) – the outcome sought is the healthy functioning of the estuary.
A18			**Phytoplankton** *(physico chemical characteristics of the water column - section 4.1.1.vii of the conservation objectives)*	Average **phytoplankton biomass and characteristic species** in summer, measured periodically during the reporting cycle.	Growth of phytoplankton does not cause an undesirable disturbance to the estuary habitats and species Levels should comply with targets established under the EA Review of Consents and the Water Framework Directive.	
A19			**Macroalgae**	Average **macroalgal cover and density** in summer, measured periodically during the reporting cycle.	Average macroalgal cover and density should not compromise the ecology * of the estuary habitats and species Levels should comply with targets established under the EA Review of Consents and the Water Framework Directive.	*ie does not compromise the quality, extent, distribution or species composition of habitats or their ability to support species features (eg feeding, breeding, resting) – the outcome sought is the healthy functioning of the estuary.

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
A20	***SAC interest feature 1:*** **Estuaries**		**Toxic contaminants** *(toxic contaminants in water column and sediment - section 4.1.1.viii of the conservation objectives)*	Toxic contaminants measured periodically throughout the reporting cycle (frequency to be determined).	Toxic contaminants in water column and sediment should be below levels which would pose a risk to the ecology* of the estuary habitats and species Levels should comply with targets established under the EA Review of Consents and the Water Framework Directive	Elevated concentrations of toxic contaminants in the water column and sediment have the potential to cause lethal or sub-lethal harm to any features and sub-features. *ie does not compromise the quality, extent, distribution or species composition of habitats or their ability to support species features (eg feeding, breeding, resting) – the outcome sought is the healthy functioning of the estuary.
A21			**Airborne nutrient and contaminants** *(airborne contaminants - section 4.1.1.ix of the conservation objectives)*	Airborne contamiants measured periodically throughout the reporting cycle (frequency to be determined)	No exceedence of critical loads for: Sulphur dioxide - 20µg/m³ Nitrous Oxides - 30µg/m³ Ozone - 3000 ppb Ammonia - 3µg/m³ Nutrient Nitrogen - 30-40 kg/ha/yr.	Critical loads have been defined where possible (www.apis.ac.uk) for the conservation features of the European site. Where the critical load is exceeded features are at risk. As more in depth studies are undertaken critical loads will be altered to reflect best available scientific knowledge. The impacts of air pollution on the vegetation need further investigation. If particularly damaging, point sources (or groups of point sources) can be identified, then emissions should be regulated toreduce the impacts. It will also be very important for wider measures to be taken, at Government and international levels, to reduce air pollution. There is currently insufficient knowledge to make a judgment of the impacts on specific species. Decisions should be made at a site specific level."

Table 9 – Favourable condition table for the "subtidal sandbanks" feature of the Severn Estuary SAC

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
B1	***SAC interest feature 2:*** **Subtidal Sandbanks**	All sub-features	**Extent of feature** *(total extent of subtidal sandbanks - section 4.1.2.i of the conservation objectives)*	Total extent assessed periodically against baseline map (using bathymetry data, and other geophysical techniques (e.g. sidescan sonar), and sediment grain-size data)	No decrease in extent of subtidal sandbanks features from an established baseline, subject to natural processes. *Baseline is taken from 1994 admiralty charts, BGS seabed sediment data and sediment environments defined in the Bristol Channel Marine Aggregates Study (Posford Duvivier and ABP Research Consultancy, 2000).* *Refer also to Map in Appendix 3*	Extent is an attribute on which reporting is required by the Habitats Directive. Within the Severn the subtidal sandbanks feature includes both relatively permanent and stable banks (shown in Appendix XX as subtidal sandbanks) and more ephemeral banks which contribute sediment to the sandbanks (shown in Appendix XX as associated sediments) and which are therefore considered to be an integral part of the feature In the long term loss of subtidal sandbank feature communities is likely to be detrimental to the structure of this interest feature and the intertidal mudflats and sandflats features, e.g. associated with a change in sediment budget or geomorphological regime, and may indicate long term changes in the physical conditions of the estuaries interest feature.
B2		All sub-features	**Extent of the subtidal sandbank communities** *(extent of subtidal sandbank communities -section 4.1.2.ii of the conservation objectives)*	Extent of subtidal sandbank communities within the site assessed periodically (method and frequency to be determined).	No decrease in extent of the communities from an established baseline subject to natural processes. *Baseline is data held on Marine Recorder*	The subtidal sandbanks feature comprises two sub-features **Sublittoral sands and muddy sand** : This sub-feature comprises the following four communities: • Infralittoral mobile sand in variable salinity • Infralittoral mobile clean sands with sparse fauna • Nephtys cirrosa and Macoma balthica in variable salinity infralittoral mobile sand • Neomysis integer and Gammarus spp in fluctuating low salinity infralittoral mobile sand **Sublittoral cohesive mud and sandy mud communities** This sub-feature comprises the following four communities: • Capitella capitata in enriched sublittoral muddy sediments • Nephtys hombergii and Tubificiodes spp. In variable salinity infralittoral soft mud • Capitella capitata and Tubificiodes spp. In reduced salinity infralittoral muddy sediment • Nephtys hombergii and Macoma balthica in infralittoral sandy mud

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
B3	***SAC interest feature 2:*** **Subtidal Sandbanks**		**Distribution of subtidal sandbank communities** *(extent of subtidal sandbank communities -section 4.1.2.ii of the conservation objectives)*	Spatial distribution of subtidal sandbank communities measured periodically (frequency to be determined).	No significant change in the macro scale distribution of the communities from an established baseline subject to natural processes *Baseline is data held on Marine Recorder*	Some biotopes occur in a natural cycle linked to the dynamism of the prevailing conditions, and these may naturally appear and disappear over time. The feature should not be considered in unfavourable condition due to the short-term disappearance of such ephemeral biotopes
B4			**Community composition** *(community composition of the subtidal sandbank communities -section 4.1.2.iii of the conservation objectives)*	Assessment of community quality through survey of species composition within the subtidal sandbank feature measured periodically	No decline in community quality due to changes in species composition or loss of typical species from an established baseline subject to natural processes *Baseline is data held on Marine Recorder and EA WFD benthic sampling data*	Different associations of plants, animals and their habitat are an important structural and functional aspect of the feature. Changes in the communities present within an area of a particular type of sediment may indicate long-term changes in physical conditions at the site. Typical species of the subtidal sandbanks communities include: *Aricidea minuta, Capitella capitata, Diastylis rathkei typical, Eurydice pulchra, Gammarus salinus, Harpinia pectinata, Mediomastus fragilis, Nephtys cirrosa, Nephtys hombergii, Oligochaeta, Pygospio elegans, Pontocrates arenarius, Pseudocuma longicornis, Retusa obtuse, Tubificoides amplivasatus*
B5		All sub-features	**Sediment character** *(variety & distribution of sediment types - section 4.1.2.iv of the conservation objectives)*	Distribution of sediment types/grain sizes assessed across the site	No major change in composition of sediment type across the feature against an established baseline subject to natural processes *Baseline to be established* *Data to be used is BGS seabed sediment data and other relevant datasets*	

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
B6	***SAC interest feature 2:*** **Subtidal Sandbanks**	All sub-features	**Topography** *(gross morphology – depth distribution and profile of subtidal sandbank feature - section 4.1.2.v of the conservation objectives)*	Depth distribution/profile of the sandbank feature measured across the site	No major alteration of topography of the subtidal sandbank feature against an established baseline *Baseline to be established* *Data to be used is Hydrographic Office bathymetric data and other relevant bathymetric datasets*	

Table 10 – Favourable condition table for the "intertidal mudflats and sandflats" feature of the Severn Estuary SAC

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
C1	***SAC interest feature 3:*** **Mudflats and sandflats**	All sub-features	**Extent of the feature** *(total extent of the mudflats and sandflats feature - section 4.1.3.i of the conservation objectives)*	Total area (ha) of the intertidal mudflat and sandflat feature measured periodically during the reporting cycle using a combination of remote sensing and ground truthing of boundaries between communities using GPS (frequency to be determined).	No decrease in extent of intertidal mudflats and sandflats from an established baseline, subject to natural processes. *Baseline is aerial photography dated 1999 and CCW/English Nature Intertidal Biotope Surveys 2006.* *(Note air photo coverage from 1988 gives data for assessing trends in change of this attribute.) Refer also to maps in Appendix 4*	Extent is an attribute on which reporting is required by the Habitats Directive. In the long term loss of intertidal mudflat / sandflat communities is likely to be detrimental to the structure of the interest feature, e.g. associated with a change in sediment budget or geomorphological regime, and may indicate long term changes in the physical conditions of the estuaries interest feature. Some fluctuations in extent may occur which are directly attributable to natural coastal processes. These include reduced extent following storms or due to a change to another feature habitat such as saltmarsh. Such types of change in extent would form under the umbrella of 'natural change'
C2		All sub-features	**Extent and variety of the mudflats and sandflats communities comprising each sub-feature** *(variety and extent of the mudflat and sandflats communities – section 4.1.3.ii of the conservation objectives)*	Extent and range of types of intertidal mudflat and sandflat communities assessed along a sampling transect or grid and rapid phase 1 survey techniques using GPS (frequency to be determined).	No decrease in the extent or range of types of intertidal mudflat and sandflat communities from an established baseline, subject to natural processes *Baseline is CCW/English Nature Intertidal Biotope Surveys 2006.*	Intertidal mudflat and sand flat feature comprises three sub-features: **Intertidal gravel and clean sand communities** • Barren coarse sand shores; • Burrowing amphipods and *Eurydice pulchra* in well drained clean sand shores; • Burrowing amphipods and polychaetes in clean sand shores. • Talitrid amphipods in decomposing seaweed on the strandline • Dense *Lanice conchilega* in tide-swept lower shore sand • Barren shingle or gravel shores **Intertidal muddy sand communities** • Polychaetes and *Cerastoderma edule* in fine sand or muddy sand shores • *Bathyporeia pilosa* and *Corophium* spp. in upper shore slightly muddy fine sand shores • *Macoma balthica* and *Arenicola marina* in muddy sand shores. • *Arenicola marina*, *Macoma balthica* and *Mya arenaria* in muddy sand shores. • *Echinocardium cordatum* and *Ensis* sp. in lower shore or shallow sublittoral muddy fine sand **Intertidal mud communities** • *Hediste diversicolor* and *Macoma balthica* in sandy mud shores • *Hediste diversicolor*, *Macoma balthica* and *Arenicola marina* in muddy sand or sandy mud shores • *Hediste diversicolor*, *Macoma balthica* and *Mya arenaria* in sandy mud shores • *Hediste diversicolor* and *Scrobicularia plana* in reduced salinity mud shores • *Hediste diversicolor* and oligochaetes in low salinity mud shores

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
C3	***SAC interest feature 3:*** **Mudflats and sandflats**	All subfeatures	**Distribution of mudflats and sandflats communities** *(distribution of communities - section 4.1.3.iii of the conservation objectives)*	Spatial distribution of mudflat and sandflat communities assessed along a sampling transect or grid and rapid phase 1 survey techniques using GPS (frequency to be determined).	Macro scale distribution of communities should not deviate significantly from an established baseline, subject to natural processes. *Baseline is CCW/English Nature Intertidal Biotope Surveys 2006.*	Changes in the spatial distribution of biotopes within an area of a particular type of sediment may provide the first indications of long-term changes in physical conditions at the site. Some biotopes occur in a natural cycle linked to the dynamism of the prevailing conditions, and these may naturally appear and disappear over time. The feature should not be considered in unfavourable condition due to the short-term disappearance of such ephemeral biotopes.
C4		All subfeatures	**Community composition** *(community composition of the feature - section 4.1.3.iv of the conservation objectives)*	Assessment of community quality through survey of species composition (presence of typical species) within the intertidal mudflats and sandflats feature measured periodically	No decline in community quality due to changes in species composition or loss of typical species from an established baseline, subject to natural processes. *Baseline is CCW/English Nature Intertidal Biotope Surveys 2006.*	Different associations of plants, animals and their habitat are an important structural and functional aspect of the feature. Changes in the communities present within an area of a particular type of sediment may indicate long-term changes in physical conditions at the site. Typical species of the intertidal mudflats and sandflats communities include: *Aphelochaeta marioni, Arenicola marina, Bathyporeia pelagica, Corophium volutator, Enchytraeidae, Eurydice pulchra, Hediste diversicolor, Hydrobia ulvae, Macoma balthica, Nephtys cirrosa, Nephtys hombergii, Oligochaeta indet, Pygospio elegans, Scoloplos armiger, Scrobicularia plana, Streblospio shrubsolii, Tubificoides benedii*
C5			**Topography** *(Topography and morphology of the intertidal flats -section 4.1.3v of the conservation objectives)*	Tidal elevation and intertidal slope, measured along a series of transects across the estuary periodically during the reporting cycle using remote sensing or traditional surveying techniques (transect locations and survey frequency to be determined).	Intertidal profile should not deviate significantly from an established baseline, subject to natural processes. *Baseline to be established:* *Data to be used is Environment Agency LIDAR survey*	In the intertidal zone topography reflects the energy conditions and stability of the sediment, which is key to the structure of the interest feature. Topography is a major influence on the distribution of communities throughout the intertidal flats. Assessing topography also provides information on the position of channels through the interest feature. .
C6			**Sediment character**	**Particle size analysis** (PSA). measured at a series of locations across the estuary. Locations and frequency to be determined	Average PSA parameters should not deviate significantly from an established baseline. *Baseline to be established* Data to be used *CCW/English Nature Intertidal Biotope Surveys 2006, BGS seabed sediment data and other relevant data sources*	Parameters include percentage sand / silt / gravel, mean and median grain size, and sorting coefficient, used to characterise sediment type Sediment character defined by particle size analysis is key to the structure of the feature, and reflects all of the physical processes acting on it. Particle size composition varies across the feature and can be used to indicate spatial distribution of sediment types thus reflecting the stability of the feature and the processes supporting it.

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
C7	***SAC interest feature 3:*** **Mudflats and sandflats**			**Sediment penetrability** (degree of sinking) measured at a series of locations across the estuary (methodology, locations and frequency to be determined).	Average measure should not deviate significantly from an established baseline. *Baseline to be established by future survey*	Penetrability is an indicator of sediment stability and degree of compaction; it indicates the shear strength of the sediment and thus the susceptibility of that sediment type to erosion. Compaction of the sediment influences the biological community within the sediment. Penetrability of the sediment is determined by a combination of grain size and water content, which may provide a surrogate index of the penetrability of the sediments.
C8				**Sediment organic content** (% carbon) measured at a series of locations across the estuary (sampling locations and frequency to be determined).	Average organic carbon content should not deviate significantly from an established baseline. *Baseline to be established by future survey*	Organic content critically influences the infaunal community and can cause deoxygenation of the feature, which can be detrimental to the biota. However, a balance needs to be struck as organic content provides a measure of the material available to detritivores. A reduction in organic content could lead to a reduction in detritivores, with subsequent knock on effects throughout the food chain.
C9				**Oxidation - reduction potential** (depth of black anoxic layer) measured at a series of locations across the estuary (sampling locations and frequency to be determined).	Average black layer depth should not deviate significantly from an established baseline. *Baseline to be established by future survey*	Degree of oxidation / reduction, reflecting oxygen availability within the sediment, critically influences the infaunal community and the mobility of chemical compounds. It is an indicator of the structure of the feature.

Table 11 – Favourable condition table for the "Atlantic salt meadows" feature of the Severn Estuary SAC

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
D1	***SAC interest feature 4:* Atlantic salt meadows**	All sub-features	**Extent of Atlantic salt meadow (and transitional habitats) feature** *(extent of Atlantic salt meadow (and transitional habitats) feature - section 4.1.4.i of the conservation objectives)*	Total area (ha) of the Atlantic salt meadow feature (and associated transitional habitats) within the site measured periodically during the reporting cycle using a combination of remote sensing and ground truthing of boundaries between communities using GPS (frequency to be determined).	No decrease in total extent of Atlantic salt meadow and associated transitional habitats from the established baseline. *Baseline is the CCW/English Nature Saltmarsh NVC survey by Dargie 1998* *Refer also to maps in Appendix 5*	Extent is an attribute on which reporting is required by the Habitats Directive. Monitoring will need to take account of the dynamic nature of these habitats and seasonal and periodic random variations in vegetation types. Coastal squeeze may result in the replacement of Atlantic salt meadows with pioneer saltmarsh. A reduction in extent could be further evaluated by a ground survey to assess for signs of erosion such as toppled vegetation blocks, signs of roots in intertidal mud, signs of stress/damage to plants. Extent needs to be measured at low tide.
D2		All sub-features	**Extent of the Atlantic salt meadow communities and associated transitional vegetation communities** *(extent and distribution of atlantic salt meadow and associated transitional vegetation communities - section 4.1.4.ii of the conservation objectives)*	Area (ha) of Atlantic salt meadow and associated transitional vegetation communities within the site measured periodically during the reporting cycle using a combination of remote sensing and ground truthing of boundaries between communities using GPS (frequency to be determined).	No decrease in extent of Atlantic salt meadow and associated transitional vegetation communities from the established baseline subject to natural processes *Baseline is the CCW/English Nature Saltmarsh NVC survey by Dargie 1998*	Assessment against this target will take account of the effects of the natural process of cyclical development and breakdown of saltmarshes within the Severn which results in the natural succession of saltmarsh communities over time ie the continued presence of all types in proportions reflecting the natural processes operating. Some individual salt marsh communities occur in a natural cycle linked to the dynamism of the prevailing conditions, and these may naturally appear and disappear over time. The feature should not be considered in unfavourable condition due to the short-term disappearance of transient communities. The outcome sought is the maintenance of the general character of the saltmarshes of the Severn in terms of the continued presence, abundance and variation of communities with local differences reflected – it is not to seek the retention of saltmarsh types in situ but to allow them to shift and evolve in line with natural processes The Atlantic salt meadow feature comprises four sub-features: **Low to mid marsh communities** NVC communities: SM10, SM12, SM13a, SM13b, SM13c,SM13d, SM13x, SM13y,SM14a, SM15. **Mid to upper marsh communities** NVC communities: SM16a, SM16b, SM16c, SM16d, SM16e, SM16x, SM17, SM18c. **Transitional high marsh communities** NVC communities: SM23, SM24, SM28, MG11, MG12, MG13, S4a, S21a, S21c. **Pioneer saltmarsh communities** NVC communities: SM6, SM8, SM9

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
D3	***SAC interest feature 4:*** **Atlantic salt meadows**	All sub-features	**Distribution of the Atlantic salt meadow communities and associated transitional vegetation communities** *(extent and distribution of atlantic salt meadow and associated transitional vegetation communities - section 4.1.4.ii of the conservation objectives)*	Spatial distribution of Atlantic saltmeadow and associated transitional vegetation communities measured along a series of fixed transects (or other suitable method to be agreed) periodically during the reporting cycle using GPS (transect locations and frequency of survey to be determined).	The macro scale distribution of communities should not deviate significantly from an established baseline subject to natural processes. *Baseline is the CCW/English Nature Saltmarsh NVC survey by Dargie 1998*	The distribution of the Atlantic salt meadow communities refers to the macro spatial pattern in which these are distributed around the estuary. This statement does not require micro-distribution of communities (i.e. the exact mapped positions of specific communities to be maintained) but does require the distribution of some saltmarsh types which reflect the differences in estuary structure and function (eg in outer versus inner parts of the estuary, or the influence of freshwater inputs from the rivers) be taken into account. Consideration of this attribute needs to take account of the wider scale and long-term changes and development of saltmarshes in the Severn Estuary which shows a pattern of episodic erosion and accretion evident in a series of saltmarsh terraces. This attribute is also linked with attributes covering zonation and morphology below.
D4		All sub-features	**Extent of *Spartina anglica*** *(areas of Spartina anglica - section 4.1.4.viii of the conservation objectives)*	Total extent of Spartina anglica measured along a series of transects (or other suitable method to be agreed) around the estuary, periodically during the reporting cycle, using a combination of remote sensing and ground survey (transect locations and frequency of survey to be determined).	No increase in total extent of more than 10% over monitoring period; *Baseline is the CCW/English Nature Saltmarsh NVC survey by Dargie 1998*	*Spartina anglica* acts as a pioneer species in the Severn and can undergo succession to other saltmarsh habitats over time. As a consequence, although it may be colonising new areas in one part of the estuary, in others it may be developing into more mixed saltmarsh communities. There will be differences in the density, height and cover of the vegetation depending on where it is in the succession. These changes will need to be monitored to establish a baseline and rates of any gross change. An increase in *Spartina* at the expense of other saltmarsh could indicate changes in the sediment regime and/or tidal levels both in response to natural or anthropogenic processes. Monitoring will only focus on areas of gross expansion of *Spartina* into intertidal mudflat and saltmarsh communities.
D5		All sub-features	**Zonation of vegetation** *(zonation of Atlantic salt meadow communities - section 4.1.4.iii of the conservation objectives)*	Width of pioneer, low-mid marsh, mid-upper marsh, and transitional high marsh saltmarsh zones, measured along a series of transects (or other suitable method to be agreed) around the estuary, periodically during the reporting cycle, using a combination of remote sensing and ground survey (transect locations and frequency of survey to be determined).	The range of variation of zonation of saltmarsh communities around the estuary should not deviate significantly from an established baseline, subject to natural processes. *Baseline is CCW/English Nature Saltmarsh NVC survey by Dargie 1998 (and English Nature condition assessment data collected in 2002 for Gloucestershire section of the estuary.*	Assessment against this target will take account of the effects of the natural process of cyclical development and breakdown of saltmarshes within the Severn which results in the natural succession of saltmarsh communities and changes to the zonation over time . ie the continued presence of all zones in proportions reflecting the natural processes operating. The outcome sought is the maintenance of the general character of the saltmarshes of the Severn in terms of the continued presence and variation of the saltmarsh zones with local differences reflected – it is not to seek the retention of zones in situ but to allow them to shift and evolve in line with natural processes

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
D6	***SAC interest feature 4:*** **Atlantic salt meadows**	Low to mid marsh communities	**Species composition** *(abundance of typical species - section 4.1.4.iv of the conservation objectives)*	Frequency of typical species to be measured using methodology to be agreed (e.g. transects, plots etc) once during reporting cycle	Frequency of typical species of characteristic low to mid marsh communities should not deviate significantly from an established baseline. *Baseline is CCW/English Nature Saltmarsh NVC survey by Dargie 1998*	The typical species for these communities include: *Puccinellia maritima, Salicornia spp., Suaeda maritima, Aster tripolium, Spergularia marginata, Glaux maritima, Plantago maritima, Atriplex glabriuscula, Atriplex prostrata, Triglochin maritima, Limonium vulgare, Armeria maritima and Juncus maritimus* *This target should not however prevent the enhancement of the diversity of swards where possible eg through the encouragement of a wider range of herbs through relaxation of grazing pressure in heavily grazed areas.
D7		Mid to upper marsh communities	**Species composition** *(abundance of typical species - section 4.1.4.iv of the conservation objectives)*	Frequency of typical species to be measured using methodology to be agreed (e.g. transects, plots etc) once during reporting cycle	Frequency of typical species of characteristic mid to upper marsh communities should not deviate significantly from an established baseline. *Baseline is CCW/English Nature Saltmarsh NVC survey by Dargie 1998*	The typical species for these communities include : *Puccinellia maritima, Aster tripolium, Glaux maritima, Plantago maritima, Festuca rubra, Juncus gerardii, Triglochin maritima, , Agrostis stolonifera, Juncus maritimus , Spergularia marginata, Parapholis strigosa, Elymus pycnanthus,, Hordeum secalinum, Trifolium fragiferum and Atriplex glabriuscula,* *(see note above)
D8		Transitional high marsh communities	**Species composition** *(abundance of typical species - section 4.1.4.iv of the conservation objectives)*	Frequency of typical species to be measured using methodology to be agreed (e.g. transects, plots etc) once during reporting cycle	Frequency of typical species of characteristic high marsh communities should not deviate significantly from an established baseline. *Baseline is CCW/English Nature Saltmarsh NVC survey by Dargie 1998*	The typical species for these communities include: *Puccinellia distans, Puccinellia maritima, Puccinellia rupestris, Plantago coronopus, Parapholis strigosa, Atriplex glabriuscula, Spergularia marina, Festuca rubra, Agrostis stolonifera, Aster tripolium, Hordeum secalinum, Elymus pycnanthus, Elymus repens, Potentilla anserina, Lolium perenne, Alopecurus geniculatus, Phragmites australis, Bolboschoenus maritimus, Festuca arundinacea,* *(see note above)
D9		Pioneer saltmarsh communities	**Species composition** *(abundance of typical species - section 4.1.4.iv of the conservation objectives)*	Frequency of typical species to be measured using methodology to be agreed (e.g. transects, plots etc) once during reporting cycle	Frequency of typical species of characteristic pioneer marsh communities should not deviate significantly from an established baseline. *Baseline is CCW/English Nature Saltmarsh NVC survey by Dargie 1998*	The typical species for these communities include : *Spartina anglica, Salicornia sp, Suaeda maritima*

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
D10	***SAC interest feature 4:*** **Atlantic salt meadows**		**Abundance of locally occurring scarce and notable plant species** *(abundance of notable species - section 4.1.4v of the conservation objectives)*	Number of discrete locations within the estuary where scarce and notable species are found and their abundance at each location.	No decrease in abundance of scarce and notable species from an established baseline. *Baseline : CCW/English Nature saltmarsh rare/scarce plant survey survey by Dargie 1998* *Individual county based records from plant recorders/record centres*	Nationally scarce and notable species within the Atlantic salt meadow and associated transitional vegetation communities comprise: **Nationally scarce species:** *Alopecurus bulbosus, Althaea officinalis, Bupleurum tenuissimum, Hordeum marinum, Trifolium squamosum, Puccinellia rupestris, Polygonum raii.* **Other notable species occurring*:*** *Allium oleraceum, Lepidium latifolium, Petroselinum segetum* Note that some of the nationally scarce and notable plants require levels of ground disturbance (resulting in openings in the sward) to establish. Localised tight grazing and /or poaching may provide sward openings for such species as well as the wider range of herbs and unless widespread and persistent should not necessarily regarded as a problem.
D11		All sub-features	**Sward structure** *(structural variation of the salt marsh sward - section 4.1.4 vi of the conservation objectives)*	Sward height of Atlantic salt meadow communities measured periodically during the reporting cycle in late summer using a combination of remote sensing and field visits.	The extent and distribution of vegetation communities exhibiting different sward heights should not deviate significantly from an established set of limits. The limits will be defined to ensure that the requirements of the typical and notable plants species and birds species designated within the Severn Estuary SPA and Ramsar, can be met *Baselines are to be established from Nature Conservancy Council SSSI owner/occupier consent records dating from 1988 Severn Estuary SSSI notification (and subsequent consent reviews)* *CCW and EN/NE site monitoring records*	Vegetation structure is largely affected by the impact of grazing (of wild or domesticated herbivores) interacting with different vegetation communities and ground hydrological conditions. Not all Atlantic salt meadow within the Severn Estuary is grazed, but it is a widespread and long established practice and stocking levels need to be appropriate to the interest of the site. Over grazing can lead to a loss of structural diversity of rare plant species and affect bird use of these habitats while under grazing can lead to a loss of plant diversity by competitive exclusion. Introduction of grazing to previously ungrazed sites can result in deleterious changes to plant community composition and its value for wider conservation interests such as invertebrates. Note that some of the nationally scarce and notable plants require levels of ground disturbance (resulting in openings in the sward) to establish. Localised tight grazing and /or poaching may provide sward openings for such species as well as the wider range of herbs and unless widespread and persistent should not necessarily regarded as a problem. Disturbance is also provided in areas where natural tidal debris accumulates scattered across the salt marsh and in driftlines (often at the base and on the seaward slope of the floodbank). As well as providing seed establishment points for scarce plants the debris also plays a role in creating variation in sward structure particularly in the mid/upper and transition high marsh zones and in supporting important populations of invertebrates (notable deadwood beetles). The continued presence of tidal debris and driftlines in some locations is therefore a desirable aspect of the saltmarsh management which delivers this attribute . They may also be of value for the bird populations which roost and feed on saltmarshes of the SPA and Ramsar Site. (see sections 4.2 and 4.3)

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
D12	***SAC interest feature 4:*** **Atlantic salt meadows**		**Morphology** *(characteristic stepped morphology and associated structural features - section 4.1.4.vii of the conservation objectives)*	Location and extent of established morphological features (saltmarsh terracing, creeks, pills, drainage ditches and pans) measured during the reporting cycle using remote sensing and field survey	No anthropogenic alteration of established morphological features from an established baseline. *Baselines is taken from 1999 air photos , CCW/English Nature Saltmarsh NVC survey by Dargie 1998 and English Nature condition assessment data collected in 2002 for Gloucestershire section of the estuary.*	This target relates to features which have developed naturally as a result of the evolution of the saltmarshes or the presence of freshwater drainage systems entering the estuary and which have established conservation value (eg pill sides of value botanically, pills used for shelter, feeding and roosting by birds). The baseline dataset will establish the location and extent of these features and identify man made features which do not need to meet this target.

Table 12 – Favourable condition table for the "reefs" feature of the Severn Estuary SAC

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
E1	***SAC interest feature 4:*** **Reefs**		**(Total) Extent and distribution** *(total extent and distribution of reef - section 4.1.5.i of the conservation objectives)*	Measurement of the extent and distribution of the purely subtidal part of this feature in the Severn Estuary is challenging. Remote sensing methods (such as side scan sonar) and drop down video are unreliable in these conditions. Therefore limited grab sampling may be required. Measurement of the subtidal component at the subtidal/intertidal interface may be possible by direct observation at very low tides. Extent and distribution of the intertidal *Sabellaria* reef measured using Phase 1 mapping survey techniques	No reduction in the extent and distribution of the reef from an established baseline *Baseline is comprised of grab sampling surveys by Mettam 1988 supplemented by Environment Agency data 1999 and data from Warwick et al.2001 which provide subtidal reef records.* *CCW/English Nature Intertidal Biotope Surveys 2006 identify the distribution of intertidal Sabellaria alveolata and indication of locations for further survey for subtidal Sabellaria contiguous with these intertidal areas.*	Known occurrences of subtidal and subtidal contiguous with intertidal reefs are largely limited to the outer parts of the estuary (area seaward of a line drawn between Portishead and Newport). See appendix 6. Samples show that reef formation is not continuous within this area and is in varying stages of growth. Further work is required to establish the distribution of this feature particularly with respect to the subtidal and the intertidal/subtidal interface. A further upstream zone of intertidal *Sabellaria* populations is recorded up to the old Severn Bridge (Beachley to Aust) . While not part of the reef feature the extent of solely intertidal *Sabellaria* is relevant as these areas will also contribute larvae to the estuary wide populations of this species. The populations of *Sabellaria* within the Severn (subtidal,and intertidal) should be regarded as a metapopulation. New technologies that may allow the measurement of *Sabellaria* reef in a non destructive way should be investigated if they present themselves.
E2			**Community composition** *(community composition - section 4.1.5.ii of the conservation objectives)-*	Measurement of the community composition of this feature in the Severn Estuary is challenging. Remote sensing methods (such as side scan sonar) and drop down video are difficult. Therefore limited grab sampling may be required.	New samples of reef show no significant decline in community composition from baseline records *Baseline is survey by Mettam 1988 supplemented by Environment Agency data 1999 and data from Warwick et al.2001*	The reefs feature comprise two communities : *Sabellaria alveolata* on variable salinity sublittoral mixed sediment SS.SBR.PoR.SalvMx *Sabellaria alveolata* reefs on sand-abraded eulittoral rock. LS.LBR.Sab.Salv The typical species associated with subtidal and intertidal reefs in the Severn Estuary, derived from known samples, are listed in section 4.15.1 note 4

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
E3	***SAC interest feature 4:*** **Reefs**		**Age structure** *(full range of age structures - section 4.1.5.iii of the conservation objectives)*	Measurement of the community composition of this feature in the Severn Estuary is challenging. Remote sensing methods (such as drop down video) are difficult. Therefore limited grab sampling may be required.	Different phases from newly settled worms through vigorous fast growing reef to older hummocks are present *Baseline yet to be established.*	*Sabellaria alveolata* reefs cycle through different phases from newly settled worms through vigorous fast-growing reef to older hummocks. In a stable or increasing population all age phases are likely to be present . The presence of areas of variable stages of growth is important in ensuring larval supply and also enhances the species diversity of the reef
E4			**Physical & ecological processes** *(physical and ecological processes - section 4.1.5.iv of the conservation objectives)*	**Abundance of coarse sediments** Presence of suitable sediment grades in subtidal and intertidal sediments within the defined reefs zone (see comment on extent and distribution above) measured periodically.	No change in the abundance of suitable sediment grades within the defined reefs zone against an established baseline *Baseline yet to be established.*	An abundance of suitable coarse sediments (0.5-1mm sand) are required to support reef growth (tube building)
E5				**Availability of suitable substrates** Extent of available suitable (hard or long-term consolidated) substrates within the defined reef zone measured periodically	No change in overall extent of available suitable substrates within the defined reefs zone against an established baseline *Baseline yet to be established – data from the BGS and the CCW/English Nature intertidal biotope survey 2006 may assist*	Within the Severn reefs have been recorded both on solid geology and on smaller rocks and cobbles.
E6				**Supply of larvae** Abundance of *Sabellaria* larvae within the water column measured through plankton sampling	No decrease in the abundance of *Sabellaria* larvae against an established baseline *Baseline yet to be established – data may be available from existing plankton sampling surveys*	Area of sampling for this attribute should include both the reef zone and areas where intertidal populations are known as all areas supporting *Sabellaria alveolata* formations will be supplying larvae to the water column and hence may seed the reef feature. Recruitment is likely to be variable between years.

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
E7				**Abundance of food in water column** Methods to be determined .	No decrease in the abundance of suspended detritus within the water column of the defined reef zone against an established baseline *Baseline yet to be established*	Area of sampling of the water column should include both the reef zone and intertidal populations (the estuary-wide metapopulation of *Sabellaria alveolata*)

Table 13 – Favourable condition table for the "river lamprey" and "sea lamprey" features of the Severn Estuary SAC

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
F1	***SAC interest feature 5:*** **River lamprey** ***Lampetra fluviatilis*** **and** ***SAC interest feature 6:*** **Sea lamprey** ***Petromyzon marinus***		**Migratory access (Barriers to migration)** *(migratory passage not impeded - sections 4.1.6.i and 4.1.7.i of the conservation objectives)*	**Water quality** measured regularly throughout the reporting cycle in the Bristol Channel, Severn Estuary, River Wye SAC, River Usk SAC and River Severn. *(see also Table 8, lines A17-20 relating to general water quality requirements for the estuary feature (and dependant sub features)*	Water quality is sufficient to support migratory passage. Levels (for temperature, salinity, turbidity, pH, and dissolved oxygen) should comply with targets established under the EA Review of Consents and the Water Framework Directive. *Baseline is water quality sampling data collected by the Environment Agency*	Significant variation in these physico-chemical parameters may act as barriers to migration. For example, the timing, duration and consistency of their upstream migration are believed to be closely related to temperature changes as well as pheromone triggers from the juveniles during periods of high water flow. Peak migration usually coincides with river temperatures that remain above 10^{o}C and continues until temperatures reach 18^{o}C. Dissolved oxygen can also be significantly reduced in stretches receiving significant BOD inputs, or through the re-suspension of organic rich sediments. Toxic contaminants may act as a barrier to migration. Environmental Quality Standards (EQSs) are set for dangerous substances as defined under the Dangerous Substances Directive or Government Policy for freshwater and marine environments
F2				**Water flows** measured regularly throughout the reporting cycle (frequency to be determined) in the River Wye SAC, River Usk SAC and River Severn *(see also Table 8 line A3 relating to general tidal and water flow requirements for the estuary feature (and dependant sub features)*	Flows from the river into the estuary must be sufficient to allow migration. *Baseline is water flow sampling data collected by the Environment Agency provides a baseline. Severe low flow conditions that affect these species yet to be defined*	
F3				**Physical barriers** Mapping and quantification of potential obstructions in relation to height, type and water depth below obstruction once during the reporting cycle.	No artificial barriers significantly impairing, adults from reaching existing and historical spawning grounds, or juveniles from moving downstream. *Baseline is the Environment Agency data on structures and flood defences*	Dams, navigation and other weirs may prevent lamprey from reaching their spawning grounds. In particular, sea lamprey is known to be poor at ascending obstacles.

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
F4	***SAC interest feature 5:*** **River lamprey** ***Lampetra fluviatilis*** **and** ***SAC interest feature 6:*** **Sea lamprey** ***Petromyzon marinus***		**Population size** (returning adults) *(size of populations - sections 4.1.6.ii and 4.1.7.ii of the conservation objectives)*	Number of returning adults measured using fish counters on the feeding rivers (Wye , Usk and Severn) during the migratory period.	No decline in number of returning adults from established baseline. *Baseline is yet to be established - fish counter data may be able to provide a baseline in future years.*	(Note that this attribute will not be able to be measured until the technological solutions are developed.) Fish counter technology is being developed to monitor adult lampreys but is not yet installed on the feeding rivers of the Severn Estuary. Fish counter technology should be further developed to monitor migrating adult river and sea lamprey.
F5			**Ammocoete population in tributary rivers** *(size of populations - sections 4.1.6.ii and 4.1.7.ii of the conservation objectives)*	Electrofishing surveys in $1m^2$ quadrats at a series of locations in the Rivers Usk, Wye (and Severn)	River population targets for the Usk and Wye must be met *Baseline is the survey of ammocoete abundance and distribution in the Rivers Usk and Wye commissioned by CCW in 2005 (Harvey et al. 2007).*	(Note that this attribute will not be able to be measured until the technological solutions are developed.) During the electrofishing survey all ammocoetes should be identified as *Lampetra* or *Petromyzon* and measured (mm). Surveys should be undertaken at the earliest in July but preferably between August and October. The rivers fauna CSM state three targets which must be met for the population attribute. These are; 1. Ammocoete population age structure For samples of 50 ammocoetes or less, at least 2 distinct size classes should normally be present. If more than 50 ammocoetes are collected, at least 3 size classes should be present. 2. Ammocoete distribution within catchment Lampreys should be present at not less than 2/3 of sites surveyed. 3. Ammocoete density; a. For *lampetra*; Optimal habitat $>10m^{-2}$ Overall catchment mean $>5m^{-2}$ b. For sea lamprey - Ammocoetes should be present in at least sampling sites each not less than 5km apart

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
F6			**Prey species** *(abundance of prey species - sections 4.1.6.iii and 4.1..7.iii of the conservation objectives))*	The abundance of key prey species measured periodically	No significant reduction in abundance of key prey species against an established baseline *Baseline is yet to be established Data to be used is EA monitoring of river and fish populations and future surveys*	River and sea lamprey require a variety of other fish species to act as hosts throughout their lifecycle. Their principal host species are part of the estuarine fish assemblage which has measures and targets included within the "estuaries" feature – Table 8

Table 14 – Favourable condition table for the "twaite shad" feature of the Severn Estuary SAC

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
G1	***SAC interest feature 7:*** **Twaite shad (*Alosa fallax*)**		**Migratory access (Barriers to migration)** *(migratory passage not impeded - section 4.1.8.i of the conservation objectives)*	**Water quality** measured regularly throughout the reporting cycle in the Bristol Channel, Severn Estuary, River Wye SAC, River Usk SAC and River Severn. *(see also Table 8 line A 17-20 relating to general water quality requirements for the estuary feature (and dependant sub features)*	Water quality is sufficient to support migratory passage. Levels (for temperature, salinity, turbidity, pH, and dissolved oxygen) should comply with targets established under the EA Review of Consents and the Water Framework Directive. *Baseline is water quality sampling data collected by the Environment Agency*	Significant variation in these physico-chemical parameters may act as barriers to migration. For example, the timing, duration and consistency of their upstream migration are believed to be closely related to temperature changes . Peak migration usually coincides with river temperatures that remain above 10^{o}C and continues until temperatures reach 18^{o}C. Dissolved oxygen can also be significantly reduced in stretches receiving significant BOD inputs, or through the resuspension of organic rich sediments. Toxic contaminants may act as a barrier to migration. Environmental Quality Standards (EQSs) are set for dangerous substances as defined under the Dangerous Substances Directive or Government Policy for freshwater and marine environments.
G2				**Water flows** measured regularly throughout the reporting cycle (frequency to be determined) in the River Wye SAC, River Usk SAC and River Severn *(see also Table 8 line A3 relating to general tidal and water flow requirements for the estuary feature (and dependant sub features)*	Flows from the river into the estuary must be sufficient to allow migration *Baseline is water flow sampling data collected by the Environment Agency provides a baseline. Severe low flow conditions that affect these species yet to be defined*	
G3				**Physical barriers** Mapping and quantification of potential obstructions in relation to height, type and water depth below obstruction once during the reporting cycle.	No artificial barriers significantly impairing, adults from reaching existing and historical spawning grounds, or juveniles from moving downstream. *Baseline is Environment Agency data on structures and flood defences*	Dams, navigation and other weirs may prevent shad reaching their spawning grounds. In particular, shad are known to be poor at ascending obstacles.

Ref	SAC Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
G4	***SAC interest feature 7:*** **Twaite shad (*Alosa fallax*)**		**Population size (returning adults)** *(size of populations - section 4.1.8.ii of the conservation objectives)*	Number of returning adults measured using fish counters on the Usk and Wye rivers during the migratory period.	No drop in the annual run size greater than would be expected from variations in natural mortality alone. *Baseline is yet to be established - fish counter data may be able to provide a baseline in future years. Noble et al. (2007) provides historical information on returning adults for the River Wye.*	(Note that this attribute will not be able to be measured until the technological solutions are developed.) Fish counter technology is being developed to monitor adult shad but is not yet installed on the feeding rivers of the Severn Estuary. Fish counter technology should be further developed to monitor migrating adult shad.
G5			**River population** *(size of populations - section 4.1.8.ii of the conservation objectives)*	Seine netting for juveniles in the lower rivers and upper estuaries and monitoring of shad eggs by kick sampling	River population targets for the Usk and Wye must be met *Baseline yet to be established. Noble et al. (2007) provides some information on juvenile densities.*	(Note that this attribute will not be able to be measured until the technological solutions are developed.) Seine netting should occur in lower rivers and upper estuaries. Netting should be carried out in late summer early autumn (July-October). For each river, juvenile densities should exceed a specified minimum target at least two years in six. The extent of spawning should be monitored by kick sampling for eggs at a proportion of known spawning sites. A reduction in the spawning distribution of more than 50 % compared with the baseline will indicate an adverse change. Kick sampling should occur during May and June.
G6			**Prey species** *(abundance of prey species – section 4.1.8.iii of the conservation objectives))*	The abundance of key prey species measured by EA in their routine monitoring of the rivers and estuary	No significant reduction in abundance of key prey species against an established baseline *Baseline is yet to be established through fish surveys in estuary and rivers*	Twaite shad require a variety of invertebrates including crustacean, mysids and copepods, small fish and fish eggs particularly in that section of the estuary where saline and freshwaters meet.

4.2 Conservation objectives for SPA European Marine Site interest features

The protection and management of the SPA in accordance with Article 6 of the Habitats Directive, including in particular the consideration of plans and projects under Article 6(3) and 6(4), should be carried out in view of the conservation objectives in this section.

Note : The conservation objectives for areas of the SPA which lie outside the European Marine Site boundary are provided in separate documents by CCW and Natural England which are currently in preparation and will soon be available on request.

4.2.1 SPA Interest feature 1: Internationally important population of regularly occurring Annex 1 species : Bewick's swan

The conservation objective is to maintain the Bewick's swan population and its supporting habitats[1]in **favourable condition**, as defined below

The interest feature Bewick's swan will be considered to be in favourable condition when, subject to natural processes[2], each of the following conditions are met:

(i) the 5 year peak mean population size for the Bewick's swan population is no less than 289 individuals (ie the 5 year peak mean between 1988/9 - 1992/3);

(ii) the extent of saltmarsh at the Dumbles (Appendix 8: Map 1) is maintained;

(iii) the extent of intertidal mudflats and sandflats at Frampton Sands, Waveridge Sands and the Noose (Appendix 8: Map 1) is maintained;

(iv) the extent of vegetation with an effective field size of >6 ha and with unrestricted bird sightlines > 500m at feeding, roosting and refuge sites (Appendix III) are maintained;

(v) greater than 25% cover of suitable soft leaved herbs and grasses[3] in winter season throughout the transitional saltmarsh at the Dumbles (Appendix 8: Map 1) is maintained;

(vi) aggregations of Bewick's swan at feeding, roosting and refuge sites are not subject to significant disturbance.

4.2.1.1 Explanatory information for the Bewick's swan conservation objective

[1] Key supporting habitats for the Annex I species

- **Intertidal mudflats and sandflats**
- **Saltmarsh**

[2]Natural processes in respect of the SPA

Each interest feature is subject to both natural processes and human influences. Human influence on the interest features is acceptable provided that it is compatible with the achievement of the conditions set out under the definition of favourable condition for each interest feature. A failure to meet these conditions which is entirely a result of natural processes will not constitute unfavourable condition, but will trigger a review of the definition of favourable condition. This qualification is necessary because:

(a) the bird populations themselves are subject to natural factors, many of which arise outside the SPA, such as breeding success and winter temperatures;

(b) the supporting habitats of the birds are influenced by the evolution of the estuary. Natural adjustments within estuaries can take many forms. One important example is the tendency of estuaries to accumulate sediment, thereby changing their form from their original Holocene morphology to a state where tidal energy is dissipated by subtidal and intertidal sediment banks or features. This, with other natural processes, will therefore cause the width and depth of the estuary to change over time, moving towards a state of dynamic equilibrium or 'most probable state'. As part of this process, the location and extent of saltmarshes and mudflats may change, provided there is capacity to accommodate readjustment. However, where this process is constrained, the capacity of habitats to accommodate readjustment may be affected.

[3]Key food plants of Bewick's swan

eg *Agrostis stolonifera, Alopecurus geniculatus, Glyceria geniculatus.* (This list contains examples and is not exhaustive)

4.2.2 SPA interest feature 2: Internationally important population of regularly occurring migratory species: wintering European white-fronted goose

The conservation objective is to maintain the European white-fronted goose population and its supporting habitats[1] in **favourable condition**, as defined below.

The interest feature European white-fronted goose will be considered to be in favourable condition[2] when, subject to natural processes[2], each of the following conditions are met:

(i) the 5 year peak mean population size for the wintering European white fronted goose population is no less than 3,002 individuals (ie the 5 year peak mean between 1988/9-1992/3);

(ii) the extent of saltmarsh at the Dumbles (Appendix 8: Map 1) is maintained;

(iii) the extent of intertidal mudflats and sandflats at Frampton Sands, Waveridge Sands and the Noose (Appendix 8: Map 1) is maintained;

(iv) greater than 25% cover of suitable soft-leaved herbs and grasses[3] is maintained during the winter on saltmarsh areas (Appendix 8: Map 1);

(v) unrestricted bird sightlines of >200m at feeding and roosting sites are maintained;

(vi) aggregations of European white-fronted goose at feeding or roosting sites are not subject to significant disturbance.

4.2.2.1 Explanatory information for the wintering European white-fronted goose objective

[1]Key supporting habitats for the migratory bird species

- **Intertidal mudflats and sandflats**
- **Saltmarsh**

[2]Natural processes in respect of the SPA

The meaning of 'natural processes' is explained in **section 4.2.1.1**.

[3]Key food plants of European white-fronted goose

eg *Alopecurus bulbosus, Festuca rubra, Hordeum marinum, Lolium perenne; Puccinellia maritima*. (This list contains examples and is not exhaustive)

4.2.3 SPA interest feature 3: Internationally important population of regularly occurring migratory species: wintering dunlin

The conservation objective is to maintain the dunlin population and its supporting habitats[1] in **favourable condition**, as defined below:

The interest feature dunlin will be considered to be in favourable condition when, subject to natural processes[2], each of the following conditions are met:

(i) the 5 year peak mean population size for the wintering dunlin population is no less than 41,683 individuals (ie the 5 year peak mean between 1988/9 - 1992/3);

(ii) the extent of saltmarsh (Appendix 8)and associated strandlines is maintained;

(iii) the extent of intertidal mudflats and sandflats (Appendix 8) is maintained;

(iv) the extent of hard substrate habitats (Appendix 8) is maintained;

(v) the extent of vegetation with a sward height of <10cm is maintained throughout the saltmarsh (Appendix 8);

(vi) the abundance and macro-distribution of suitable invertebrates[3] in intertidal mudflats and sandflats (Appendix 8) is maintained;

(vii) the abundance and macro-distribution of suitable invertebrates[3] in hard substrate habitats (Appendix 8) is maintained;

(viii) unrestricted bird sightlines of >200m at feeding and roosting sites are maintained;

(ix) aggregations of dunlin at feeding or roosting sites are not subject to significant disturbance.

4.2.3.1 Explanatory information for the wintering dunlin objective

[1]Key supporting habitats for the migratory bird species

- **Intertidal mudflats and sandflats**
- **Saltmarsh**
- **Hard substrate habitats (rocky shores)**

[2]Natural processes in respect of the SPA

The meaning of 'natural processes' is explained in **section 4.2.1.1**.

[3]Key intertidal invertebrate prey species of dunlin

eg *Carcinus, Crangon, Hydrobia, Macoma, Hediste,* and *Talitrus* spp.
(This list contains examples and is not exhaustive)

4.2.4 SPA interest feature 4: Internationally important population of regularly occurring migratory species: wintering redshank

The conservation objective is to maintain the redshank population and its supporting habitats[1] in **favourable condition**, as defined below

The interest feature redshank will be considered to be in favourable condition when, subject to natural processes[2] each of the following conditions are met:

(i) the 5 year peak mean population size for the wintering redshank population is no less than 2,013 individuals (ie the 5 year peak mean between 1988/9 - 1992/3);

(ii) the extent of saltmarsh (Appendix 8) and associated strandlines is maintained;

(iii) the extent of intertidal mudflats and sandflats (Appendix 8) is maintained;

(iv) the extent of hard substrate habitats (Appendix IV) is maintained;

(v) the extent of vegetation with a sward height of <10cm throughout the saltmarsh (Appendix 8) is maintained;

(vi) the abundance and macro-distribution of suitable invertebrates[3] in intertidal mudflats and sandflats (Appendix 8) is maintained;

(vii) the abundance and macro-distribution of suitable invertebrates[3] in hard substrate habitats (Appendix 8) is maintained;

(viii) unrestricted bird sightlines of >200m at feeding and roosting sites are maintained;

(ix) aggregations of redshank at feeding or roosting sites are not subject to significant disturbance.

4.2.4.1 Explanatory information for the wintering redshank objective

[1]Key supporting habitats for the migratory bird species

- **Intertidal mudflats and sandflats**
- **Saltmarsh**
- **Hard substrate habitats (rocky shores)**

[2]Natural processes in respect of the SPA

The meaning of 'natural processes' is explained in **section 4.2.1.1**.

[3]Key intertidal invertebrate prey species of redshank

eg *Carcinus, Crangon, Hydrobia, Macoma, Hediste,* and *Talitrus* spp.
(This list contains examples and is not exhaustive)

4.2.5 SPA interest feature 5: Internationally important population of regularly occurring migratory species: wintering shelduck

The conservation objective is to maintain the shelduck population and its supporting habitats[1] in **favourable condition**, as defined below:

The interest feature shelduck will be considered to be in favourable condition when, subject to natural processes[2], each of the following conditions are met:

(i) the 5 year peak mean population size for the wintering shelduck population is no less than 2,892 individuals (ie the 5 year peak mean between 1988/9 - 1992/3);

(ii) the extent of saltmarsh (Appendix 8) is maintained;

(iii) the extent of intertidal mudflats and sandflats (Appendix 8) is maintained;

(iv) the extent of hard substrate habitats (Appendix 8) is maintained;

(v) the abundance and macro-distribution of suitable invertebrates[3] in intertidal mudflats and sandflats (Appendix 8) is maintained;

(vi) unrestricted bird sightlines of >200m at feeding and roosting sites are maintained;

(vii) aggregations of shelduck at feeding or roosting sites are not subject to significant disturbance.

4.2.5.1 Explanatory information for the wintering shelduck objective

[1]Key supporting habitats for the migratory bird species

- **Intertidal mudflats and sandflats**
- **Saltmarsh**
- **Hard substrate habitats (rocky shores)**

[2]Natural processes in respect of the SPA

The meaning of 'natural processes' is explained in **section 4.2.1.1**.

[3]Key intertidal invertebrate prey species of shelduck

eg *Carcinus, Corophium* , *Hydrobia, Macoma, Mytilus,* and *Hediste* spp
(This list contains examples and is not exhaustive)

4.2.6 SPA interest feature 6: Internationally important population of regularly occurring migratory species: wintering gadwall

The conservation objective is to maintain the gadwall population and its supporting habitats[1] in **favourable condition**, as defined below:

The interest feature gadwall will be considered to be in favourable condition when, subject to natural processes[2], each of the following conditions are met:

(i) the 5 year peak mean population size for the wintering gadwall population is no less than 330 (ie the 5 year peak mean between 1988/9 - 1992/3);

(ii) the extent of intertidal mudflats and sandflats (Appendix 8) is maintained;

(iii) unrestricted bird sightlines of >200m at feeding and roosting sites are maintained;

(iv) aggregations of gadwall at feeding or roosting sites are not subject to significant disturbance.

4.2.6.1 Explanatory information for the wintering gadwall objective

[1]Key supporting habitats for the migratory bird species

- **Intertidal mudflats and sandflats**

  Note : It is currently unclear what use this species is making of the estuary – they are clearly present in intertidal areas particularly around areas freshwater streams and pills enter the estuary. Although primarily freshwater plant feeders they do also take animal material including insects, molluscs, annelids and even small fish and small amphibians – it is possible that they are feeding on such matter in the freshwater influenced mud and sands. Recent evidence indicates this species is changing it general habits as it extends its range westwards. As a result the conservation objective for this species does not include a condition in respect of the key food sources as for other species at this time.

[2]Natural processes in respect of the SPA

The meaning of 'natural processes' is explained in **section 4.2.1.1**.

4.2.7 SPA interest feature 7: Internationally important assemblage of waterfowl

The conservation objective is to maintain the waterfowl assemblage and its supporting habitats[1] in **favourable condition**, as defined below:

The interest feature waterfowl assemblage will be considered to be in favourable condition when, subject to natural processes[2] , each of the following conditions are met:

(i) the 5 year peak mean population size for the waterfowl assemblage is no less than 68,026 individuals (ie the 5 year peak mean between 1988/9 - 1992/3);

(ii) the extent of saltmarsh (Appendix 8) and their associated strandlines is maintained;

(iii) the extent of intertidal mudflats and sandflats (Appendix 8) is maintained;

(iv) the extent of hard substrate habitats (Appendix 8) is maintained;

(v) extent of vegetation of <10cm throughout the saltmarsh (Appendix 8) is maintained;

(vi) the abundance and macroscale distribution of suitable invertebrates[3] in intertidal mudflats and sandflats (Appendix 8) is maintained;

(vii) the abundance and macroscale distribution of suitable invertebrates[3] in hard substrate habitats (Appendix IV) is maintained;

(viii) greater than 25% cover of suitable soft leaved herbs and grasses[4] during the winter on saltmarsh areas (Appendix 8) is maintained;

(ix) unrestricted bird sightlines of >500m at feeding and roosting sites are maintained;

(x) waterfowl aggregations at feeding or roosting sites are not subject to significant disturbance.

4.2.7.1 Explanatory information for the internationally important assemblage of waterfowl

[1]Key supporting habitats for the waterfowl assemblage[1]

- **Intertidal mudflats and sandflats**
- **Saltmarsh**
- **Hard substrate habitats (rocky shores)**

[2]Natural processes in respect of the SPA

The meaning of 'natural processes' is explained in **section 4.1.1**.

[3]Key intertidal invertebrate prey species of the waterfowl assemblage

eg *Arenicola, Carcinus, Corophium, Crangon, Gammarus, Hydrobia, Macoma, Hediste, Notomastus and Talitrus* spp. - these lists are examples and are not exhaustive

[4]Key saltmarsh food plants

eg *Puccinellia maritima, Salicornia* spp., *Agrostis stolonifera, Atriplex* spp., *Hordeum marinum, Festuca rubra, Alopecurus bulbosus, Lolium perenne* - these lists are examples and are not exhaustive

4.2.8 Favourable Condition Tables for SPA interest features of the Severn Estuary European Marine Site

Background information on the role of favourable condition tables and the information provided in each column is provided in section 1.8 of this document, and a concise glossary of terms used is provided in Section 7.

The favourable condition table is intended to supplement the conservation objectives, including with respect to the management of established and ongoing activities, future requirements of monitoring and reporting on the condition of the features of the site and, together with the conservation objectives, informs the scope and nature of any appropriate assessment that may be needed. The table **does not by itself** provide a comprehensive basis on which to assess plans and projects as required under the Habitats Regulations. It should be noted that appropriate assessments are a separate activity to condition monitoring, requiring consideration of issues specific to individual plans or projects.

These tables set out all the attributes that **may** be used to monitor the condition of the features of the SPA. Where possible we will seek available information from others which can inform our assessment process.

It will be possible to monitor many of the attributes at the same time or during the same survey. The frequency of sampling for many attributes may need to be greater during the initial monitoring events in order to characterise the site and establish the baselines. Extreme events (such as storms reducing or increasing salinities, exceptionally cold winters or warm summers) also need to be recorded as they may be critical in influencing ecological issues in the Severn Estuary and may well be missed by routine monitoring.

Comprising :

Table 15 – Favourable condition table for the supporting habitats of the bird interest features in the Severn Estuary SPA

Table 16 – Favourable condition table for the qualifying bird features of the Severn Estuary SPA

Reference should also be made to Tables 8,10 and 11 - Favourable Condition Tables for the SAC habitat features relevant to the supporting habitats (intertidal mudflats and sandflats, saltmarsh and hard substrate habitats (rocky shores)) .

Table 15 Favourable Condition Table for the supporting habitats of the bird interest features in the Severn Estuary SPA European Marine Site (information on the populations of bird species using these habitats are given in Table 4)

SPA interest feature	Supporting Habitat	Attribute	Measure	Target	Comments
SPA interest feature 1: **Internationally important Annex 1 species: Bewick's swan**	Saltmarsh	Habitat extent	Area (ha) measured once per reporting cycle.	At The Dumbles, no decrease in extent from 76 ha.	Saltmarsh provides an important feeding and roosting habitat for Bewick's swans on The Dumbles - saltmarsh/transition wet grassland in front of sea defences.
		Vegetation characteristics	Abundance of suitable soft leaved herbs and grasses - % cover (frequency to be determined)	Greater than 25% cover during the winter season.	Bewick's swans graze on soft wet meadow grasses such as *Agrostis stolonifera, Glyceria fluitans* and *Alopecurus geniculatus* which are found in the transition of saltmarsh to grassland.
		Unimpeded sightlines at feeding and roosting sites	Openness of terrain unrestricted by obstructions	No increase in obstructions to existing bird sightlines. Areas of vegetation with an effective field size of >6ha	Bewick's swan require unrestricted views >500m to allow early detection of predators when feeding and roosting.
	Intertidal mudflats and sandflats	Habitat extent	Area (ha), measured once per reporting cycle.	At Frampton Sands, Waveridge Sands and the Noose, no decrease in extent from 980 ha.	The intertidal mudflats and sandflats at The Noose, Frampton Sand and Waveridge Sand are used as disturbance refuge for Bewick's swan. The extent and distribution of this sub-feature are important to maintain the population in favourable condition.
		Unimpeded sightlines at feeding and roosting sites	Openness of terrain unrestricted by obstructions	No increase in obstructions to existing bird sightlines.	Bewick's swan require unrestricted views >500m to allow early detection of predators when feeding and roosting.

Table 15 - continued

SPA interest feature	Supporting Habitat	Attribute	Measure	Target	Comments
SPA interest features 2 - 6: **Internationally important populations of regularly occurring migratory species** and *SPA interest feature 7:* **Internationally important assemblage of waterfowl**	Saltmarsh	Habitat extent	Area (ha), measured once per reporting cycle.	No decrease in extent from 1,400 ha. At The Dumbles, no decrease in extent from 76 ha.	Saltmarsh and their communities are important habitats as they provide both roosting and feeding areas.
		Food availability	Presence and abundance of suitable saltmarsh food plants measured periodically (frequency to be determined).	Presence and abundance of suitable saltmarsh food plants should not deviate significantly from an established baseline[1]	European white-fronted geese graze on a range of saltmarsh grasses and herbs. Wigeon feed on well-grazed saltmarsh with *Puccinella maritiae*, *Salicornia* and *Agrostis*. Teal and pintail feed on seeds from *Salicornia* and *Atriplex*.
		Vegetation characteristics	Range of vegetation heights measured periodically (frequency to be determined).	Sward height and density throughout areas used for roosting should not deviate significantly from an established baseline[1].	Vegetation of <10 cm is required throughout areas used by roosting waders. This is managed by grazing.
		Unimpeded sightlines at feeding and roosting sites	Openness of terrain unrestricted by obstructions	No increase in obstructions to existing bird sightlines.	Waterfowl require unrestricted views >500m to allow early detection of predators when feeding and roosting.

Table 15 - continued

SPA interest feature	Supporting Habitat	Attribute	Measure	Target	Comments
SPA interest features 2 - 6: **Internationally important populations of regularly occurring migratory species** and *SPA interest feature 7:* **Internationally important assemblage of waterfowl**	Intertidal mudflats and sandflats	Habitat extent	Area (ha), measured once per reporting cycle.	No decrease in extent from 15,000 ha. At Frampton Sands, Waveridge Sands and The Noose no decrease in extent from 980 ha.	Intertidal mudflats and sandflats and their communities are important habitats as they provide both roosting and feeding areas.
		Food availability	Presence and abundance of suitable prey species measured periodically (frequency to be determined).	Presence and abundance of suitable prey species should not deviate significantly from an established baseline. [1]	Most of the waders and waterfowl within the assemblage including the internationally important regularly occurring migratory birds feed on invertebrates within and on the sediments. Diet includes *Arenicola, Crangon, Hydrobia,Hediste, Corophium, Macoma, Gammarus,* small molluscs and strandline plankton and seeds.
		Unimpeded sightlines at feeding and roosting sites	Openness of terrain unrestricted by obstructions	No increase in obstructions to existing bird sightlines.	Waterfowl require unrestricted views >500m to allow early detection of predators when feeding and roosting.
	Shingle and rocky shores	Habitat extent	Area (ha), measured once per reporting cycle.	No decrease in extent from 1,500 ha.	This habitat is used for feeding and roosting, particularly by waders.
		Food availability	Presence and abundance of suitable intertidal invertebrates, measured periodically (frequency to be determined).	Presence and abundance of suitable food species should not deviate significantly from an established baseline[1]	Waders feed on worms, crustaceans and molluscs.
		Unimpeded sightlines at feeding and roosting sites	Openness of terrain unrestricted by obstructions	No increase in obstructions to existing bird sightlines.	Waterfowl require unrestricted views >500m to allow early detection of predators when feeding and roosting.

[1] Baselines to be established

Table 16 Favourable Condition Table for the qualifying bird features in the Severn Estuary European Marine Site

SPA interest feature	Supporting Habitat	Attribute	Measure	Target	Comments
SPA interest feature 1: **Internationally important Annex 1 species: Bewick's swan**		Population size	5 year peak mean number of individuals	No less than 289 individuals [ie the 5 year peak mean between 1988/9 - 1992/3]	Mainly found in the Upper Severn Estuary at Slimbridge
		Proportion of biogeographic population	% of NW European population	1 % of NW European population	WeBS counts provide this information
		Distribution	Number and location of sectors occupied at low tide	No decrease in use of the number of sectors and their distribution established as baseline[1]	WeBS low tide counts display distribution information by sector (not annual counts) Birds use certain sectors to a greater or lesser degree from year to year
		Disturbance in feeding and roosting areas	Reduction or displacement of wintering birds	No significant reduction in numbers or displacement of wintering birds attributable to disturbance from an established baseline[1]	Significant disturbance attributable to human activities can result in reduced food intake and/or increased energy expenditure. Five year peak mean information on populations will be used as the basis for assessing whether disturbance is damaging.
SPA interest features 2 - 6: **Internationally important populations of regularly occurring migratory species** and *SPA interest feature 7:* **Internationally important assemblage of waterfowl**		Population size	5 year peak mean number of individuals	No less than 68,026 individuals in the assemblage [ie the 5 year peak mean between 1988/9 - 1992/3] For individual species - no less than the 5 year peak mean between 1988/9 - 1992/3 detailed in Table 4	Figures derived from WeBS counts. The 5 year peak means for this period for each of the internationally important populations and species with nationally important populations which make up the internationally important assemblage are detailed in Table 4
		Distribution	Number and location of sectors occupied at low tide	No decrease in use of the number of sectors and their distribution established as baseline[1]	In some years birds use certain sectors to a greater or lesser degree. WeBS low tide counts display distribution information by sector (not annual counts).

SPA interest feature	Supporting Habitat	Attribute	Measure	Target	Comments
		Disturbance in feeding and roosting areas.	Reduction or displacement of wintering birds	No significant reduction in numbers or displacement of wintering birds attributable to disturbance from an established baseline[1].	Significant disturbance attributable to human activities can result in reduced food intake and/or increased energy expenditure. Five year peak mean information on populations will be used as the basis for assessing whether disturbance is damaging.

[1] Baselines to be established

4.3 Conservation objectives for the Severn Estuary / Môr Hafren Ramsar Site

The protection and management of the Ramsar in accordance with Article 6 of the Habitats Directive, including in particular the consideration of plans and projects under Article 6(3) and 6(4), should be carried out in view of the conservation objectives in this section.

4.3.1 Ramsar interest feature 1: Estuaries

The conservation objective for the "estuaries" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined by the conservation objective for the SAC "estuaries" feature" (refer to section 4.1.1 and Table 8 of this document), in so far as these objectives are applicable to the area designated as Ramsar Site and as defined below.

4.3.1.1 Explanatory information for the Ramsar Site "estuaries" conservation objective

The area of the estuarine ecosystem designated as Ramsar Site is smaller than that of the SAC as it is restricted to the terrestrial and intertidal areas and excludes all subtidal areas. There are therefore aspects of the SAC "estuaries" conservation objective that are not applicable to the Ramsar Site "estuaries" feature. The following Table 17 identifies the limits and restrictions, if any, that apply in respect of the Ramsar Site. The table layout follows the numbering of the SAC "estuaries" objective conditions given in section 4.1.1.

Table 17 - Limits of the Ramsar "estuaries" feature

SAC "estuaries" objective conditions to be met		Limits, if any, of the Ramsar
i.	the total extent of the estuary is maintained;	Limited to the lesser area of the Ramsar Site – excludes all subtidal areas - refer also to Appendix 2
ii.	the characteristic physical form (tidal prism/cross sectional area) and flow (tidal regime) of the estuary is maintained;	These requirements are related to the estuary regime, structure and function at a whole ecosystem level
iii.	the characteristic range and relative proportions of sediment sizes and sediment budget[3] within the site is maintained;	
iv.	the extent, variety and spatial distribution of estuarine habitat communities within the site is maintained;	Within the Ramsar Site this is limited to the habitats listed as Ramsar "estuarine habitats communities"[1] below
v.	the extent, variety, spatial distribution and community composition of hard substrate habitats and their notable communities is maintained;	Within the Ramsar Site this is limited to the habitats listed as Ramsar "hard substrate communities "[2] below
vi.	the abundance of the notable estuarine species assemblages is maintained or increased;	Within the Ramsar Site this is limited to the species listed as Ramsar "notable estuarine species assemblages"[3] below
vii.	the physico-chemical characteristics of the water column support the ecological objectives described above;	These requirements apply estuary wide at a whole ecosystem level
viii.	Toxic contaminants in water column and sediment are below levels which would pose a risk to the ecological objectives described above.	

[1]Ramsar "estuarine habitat communities"

a. Intertidal mudflats and sandflats (refer also to maps in Appendices 4 and 4a)
   - Intertidal gravel and clean sands
   - Intertidal muddy sands
   - Intertidal muds

b. Saltmarshes (equivalent to the Atlantic saltmeadows feature of the SAC) (refer also to maps in Appendices 5 and 5a)
   - Low – mid marsh communities
   - Mid – upper marsh communities
   - Transitional high marsh communities
   - Pioneer marsh communities

[2]Ramsar "hard substrate communities"

These include all hard substrate (rocky shore) communities within the Ramsar Site boundary shown in the map in Appendix 7 which includes the following notable communities:

- *Sabellaria alveolata reefs on sand-abraded eulittoral rock* (MLR.Sab Salv) *****
- *Hydroids, ephemeral seaweeds and Littorina littorea in shallow eulittoral mixed substrata pools.* **(**LR.RkpH)
- *Balanus crenatus and Tubularia indivisa on extremely tide-swept circalittoral rock* ECR.BS.BalTub)
- *Fucus serratus* and piddocks on lower eulittoral soft rock (MLR.Fser.Pid)
- *Mytilus edulis* and piddocks on eulittoral firm clay (MLR.MytPid)
- *Balanus crenatus, Halichondrea panicea* and *Alcyonidium diaphanum* on extremely tide-swept sheltered circalittoral rock (ECR.BalHpan) .
- *Sertularia cupressina and Hydrallmania falcate* on tide-swept sublittoral cobbles or pebbles in coarse sand (IGS.ScupHyd).
- *Corralina officinalis* and coralline crusts in shallow eulittoral rockpools (LR.Rkp.Cor)
- Eel grass (*Zostera*) beds
- Any other notable hard substrata communities that may be identified.

*****Note : where this community is contiguous with the occurrence of subtidal *Sabellaria alveolata* reefs it forms part of the SAC reefs feature. Within the Ramsar it is regarded as a component of the hard substrates subfeature of the Ramsar estuaries feature .

[3]Ramsar "notable estuarine species assemblages"

i. Assemblage of fish species:
   - Migratory species
     - River and Sea Lamprey and Twaite shad and Allis shad
     - Sea trout, salmon, eel,
   - Estuarine species
     - Species typically occurring and breeding in estuaries (Bird, 2008)
     - Marine species occurring in large numbers in estuaries (Bird, 2008)
   - Marine species
     - Predominantly marine species occurring infrequently in the Severn (Bird, 2008)
   - Freshwater species
     - Species typically occurring and breeding in freshwater and recorded within the Severn (Bird, 2008)

ii Assemblage of waterfowl species (refer also to section 4.3.9)

Internationally important populations of waterfowl comprising :
- Regularly occurring Annex 1 species - Bewicks' swan
- Regularly occurring migratory species - European white-fronted goose, dunlin, redshank, shelduck, and gadwall

Internationally important assemblage of waterfowl comprising above species plus the following :
- Nationally important bird populations - wigeon, teal, pintail, pochard, tufted duck, ringed plover, grey plover, curlew, whimbrel and spotted redshank, lesser black-backed gull

iii. Assemblage of vascular plant species:

- Salt marsh species (refer to notes 5 and 6 in section 4.1.4.1 - explanatory information on the conservation objective for the Atlantic salt meadows feature)
- Eel grass *(Zostera)* species.

4.3.2 Ramsar interest feature 2: Assemblage of migratory fish species[1]

The conservation objective for the "assemblage of migratory fish species" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined below:

The feature will be considered to be in favourable condition when, subject to natural processes[2], each of the following conditions are met:

i. the migratory passage of both adults and juveniles of the assemblage of migratory fish species through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality;

ii the size of the populations of the assemblage species in the Severn Estuary and the rivers which drain into it, is at least maintained and is at a level that is sustainable in the long term;

iii. the abundance of prey species[3] forming the principle food resources for the assemblage species within the estuary, is maintained.

iv. Toxic contaminants in the water column[4] and sediment are below levels which would pose a risk to the ecological objectives described above.

The meaning of terms [1-4] above is explained in **section 4.3.2.1**

Note : The populations of three of the assemblage species (river lamprey, sea lamprey and twaite shad) are designated as features of the SAC for which separate specific objectives have been written (refer to sections 4.1.6 to 4.1.8 of this document). The populations of these species depend on habitat in the adjacent River Usk SAC, River Wye SAC and River Severn. The habitats in these rivers, including spawning and nursery areas, are essential for the fulfilment of the species' lifecycle and therefore these features can only be in favourable condition if the conservation objectives pertaining to the River Usk SAC and River Wye SAC are also met in full and there is a continued recorded presence of these species in the River Severn.

4.3.2.1 Explanatory information for the assemblage of migratory fish species conservation objective

[1] Assemblage of migratory fish species

Species which are designated features of the SAC and for which individual conservation objectives have been written (refer to sections 4.1.6, 4.1.7 and 4.1.8)

Sea lamprey *Petromyzon marinus*
River lamprey *Lampetra fluviatilis*
Twaite shad *Alosa. fallax*

Other migratory species in the assemblage

Allis shad *Alosa alosa*
Salmon *Salmo salar*
Sea trout *S. trutta*
Eel *Anguilla anguilla*.

[2]Natural processes in respect of the Ramsar fish features

Assemblage populations :
The size of the populations is subject to non anthropogenic factors relating to natural fluctuations of external factors such as food / host availability in the Bristol Channel and more widely and breeding success in the River Severn and other rivers draining into the Severn Estuary.

Supporting habitats
The general meaning of 'natural processes' with respect to the supporting habitats of the migratory fish assemblage within the estuary is explained in **section 4.1.1.1**.

[3]Prey species

Assemblage Species	Key prey species
Sea lamprey	Eel *Anguilla anguilla*, cod *Gadus morhua*, and haddock *Melanogrammus aeglefinus* are all potential prey species for the sea lamprey found within the Severn Estuary (Bird 2008)
River lamprey	Sea trout *Salmo trutta*, shad *Alosa fallax/Alosa alosa*, herring *Clupea harengu*s, sprat *Sprattus sprattu*s, flounder *Platichthys flesu*s and small gadoids such as whiting *Merlangius merlangu*s and pout *Trisopterus luscu*s are all potential prey species for the river lamprey found within the Severn Estuary (Bird 2008).
Twaite shad	Small custaceans, especially mysids and copepods, small fish, especially sprats and anchovies, and fish eggs (Maitland, P.S. & Hatton-Ellis 2003).
Allis shad	Small custaceans, especially mysids and copepods, small fish, especially sprats and anchovies, and fish eggs (Maitland, P.S. & Hatton-Ellis 2003).
Salmon	While at sea, salmon feed on a variety of fish (e.g. herring, sprat, sand eel, mackerel, and various gadoids) and crustaceans (e.g. euphausiid shrimps, prawns, gammarid amphipods and various crabs). (Bird, 2008)
Sea trout	The diet of this species at sea has not been much studied but is believed to include a range of fish species including sprat, young herring and sand eels as well as crustaceans such amphipods (e.g. Corophium), gammarids, decapods such as Crangon and mysid shrimps. Many of these prey items also occur in estuaries where sea trout are known to feed extensively. (Bird, 2008)
Eel	A range of benthic organisms that include crustaceans and small fish. (Bird, 2008)

[4]Water column

Water column should be read to include contributory water flows into the estuary including surface flows over mudflats and saltmarsh.

4.3.3 Ramsar interest feature 3: Internationally important populations of waterfowl : Bewick's swan

The conservation objective for the "Bewick's swan" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined by the conservation objective for the SPA "Bewick's swan " feature (refer to section 4.2.1)

4.3.4 Ramsar interest feature 4 : Internationally important populations of waterfowl : European white-fronted goose

The conservation objective for the "European white-fronted goose" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined by the conservation objective for the SPA "wintering European white-fronted goose" feature (refer to section 4.2.2)

4.3.5 Ramsar interest feature 5: Internationally important populations of waterfowl : dunlin

The conservation objective for the "dunlin" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined by the conservation objective for the SPA "wintering dunlin " feature (refer to section 4.2.3)

4.3.6 Ramsar interest feature 6: Internationally important populations of waterfowl : redshank

The conservation objective for the "redshank" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined by the conservation objective for the SPA "wintering redshank" feature (refer to section sections 4.2.4)

4.3.7 Ramsar interest feature 7: Internationally important populations of waterfowl :shelduck

The conservation objective for the "shelduck" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined by the conservation objective for the SPA "wintering shelduck" feature (refer to section 4.2.5)

4.3.8 Ramsar interest feature 8: Internationally important populations of waterfowl : gadwall

The conservation objective for the "gadwall" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined by the conservation objective for the SPA "wintering gadwall" feature (refer to section sections 4.2.6)

4.3.9 Ramsar interest feature 9: Internationally important assemblage of waterfowl

The conservation objective for the "internationally important assemblage of waterfowl" feature of the Severn Estuary Ramsar Site is to maintain the feature in favourable condition, as defined by the conservation objective for the SPA "internationally important assemblage of waterfowl" feature (refer to section sections 4.2.7) – with special reference to the individual species listed and their population figures given in Table 6

Note : This Ramsar Site feature incorporates both wintering and passage populations of some birds and hence some species are included more than once in lists given in Table 6

4.3.10 Favourable Condition Tables for the Ramsar Site interest features of the Severn Estuary European Marine Site

Background information on the role of favourable condition tables and the information provided in each column is provided in section 1.8 of this document, and a concise glossary of terms used is provided in Section 7.

The favourable condition table is intended to supplement the conservation objectives, including with respect to the management of established and ongoing activities, future requirements of monitoring and reporting on the condition of the features of the site and, together with the conservation objectives, informs the scope and nature of any appropriate assessment that may be needed. The table **does not by itself** provide a comprehensive basis on which to assess plans and projects as required under the Habitats Regulations. It should be noted that appropriate assessments are a separate activity to condition monitoring, requiring consideration of issues specific to individual plans or projects.

These tables set out all the attributes that **may** be used to monitor the condition of the features of the Ramsar Site. Where possible we will seek available information from others which can inform our assessment process.

It will be possible to monitor many of the attributes at the same time or during the same survey. The frequency of sampling for many attributes may need to be greater during the initial monitoring events in order to characterise the site and establish the baselines. Extreme events (such as storms reducing or increasing salinities, exceptionally cold winters or warm summers) also need to be recorded as they may be critical in influencing ecological issues in the Severn Estuary and may well be missed by routine monitoring.

Comprising :

Table 18 – Favourable condition table for the “estuaries” feature of the Severn Estuary Ramsar Site

Table 19 – Favourable condition table for the migratory fish assemblage of the Severn Estuary Ramsar Site

Table 20 – Favourable condition table for the supporting habitats of the bird interest features (Ramsar features 3 to 9) in the Severn Estuary Ramsar Site

Table 21 – Favourable condition table for the qualifying bird interest features in the Severn Estuary Ramsar Site
Favourable condition table for the “estuaries” feature of the Severn Estuary Ramsar Site

Reference should also be made to Tables 8,10 and 11 - Favourable Condition Tables for the SAC habitat features relevant to the supporting habitats (intertidal mudflats and sandflats, saltmarsh and hard substrate habitats (rocky shores)) .

Table 18 Favourable Condition Table for the "estuaries" feature of the Severn Estuary Ramsar Site

Ramsar interest feature	**Comments**
Ramsar Interest feature 1: **Estuaries**	**The Favourable Condition Table for the "estuaries" feature of the Severn Estuary Ramsar Site is largely the same as that for the Severn Estuary SAC "estuaries" feature (see section 4.1 : Table 8).** However the area of the estuarine ecosystem designated as Ramsar Site is smaller than that of the SAC as it is restricted to the terrestrial and intertidal areas and excludes all subtidal areas. Table 17 identifies the limits and restrictions that apply in respect of the Ramsar Site Conservation Objective. **There are therefore aspects of the SAC "estuaries" Favourable Condition Table that are not applicable to the Ramsar Site "estuaries" feature as follows :** • All attributes other than those referred to below - apply only in respect of the area within the Ramsar Boundary (as shown in Appendix 2) • Line A6 - which relates to the subtidal sandbanks subfeature of the estuaries feature - this does not apply as these habitats lie outside the boundary of the Ramsar Site • Line A9 - which relates to the reefs subfeature of the estuaries feature - this only applies in respect of areas where intertidal *Sabellaria alveolota* occurs contiguously with the subtidal reefs (yet to be fully defined).

Table 19 Favourable Condition Table for the Migratory fish assemblage feature of the Severn Estuary Ramsar Site

Ramsar interest feature	Sub-feature	Attribute	Measure	Target	Comments
Ramsar Interest feature 2 : **Migratory fish assemblage**		**Migratory access (Barriers to migration)** *(migratory passage not impeded - sections 4.6.i and 4.7.i of the conservation objectives)*	**Water quality** measured regularly throughout the reporting cycle in the Bristol Channel, Severn Estuary, River Wye SAC, River Usk SAC and River Severn. *(see also lines A17- A20 of Table 8 relating to general water quality requirements for the estuary feature (and dependant sub features)*	Water quality is sufficient to support migratory passage. Levels (for temperature, salinity, turbidity and pH, and dissolved oxygen) should comply with targets established under the EA Review of Consents and the Water Framework Directive. *Baseline is water quality sampling data collected by the Environment Agency*	Significant variation in these physio-chemical parameters may act as barriers to migration. For example, the timing, duration and consistency of their upstream migration are believed to be closely related to temperature changes as well as pheromone triggers from the juveniles during periods of high water flow. Peak migration usually coincides with river temperatures that remain above 10^{o}C and continues until temperatures reach 18^{o}C. Dissolved oxygen can also be significantly reduced in stretches receiving significant BOD inputs, or through the re-suspension of organic rich sediments. Toxic contaminants may act as a barrier to migration.
			Water flows measured regularly throughout the reporting cycle (frequency to be determined) in the River Wye SAC, River Usk SAC and River Severn *(see also line A3 of Table 8 relating to general tidal and water flow requirements for the estuary feature (and dependant sub features)*	Flows from the rivers into the estuary must be sufficient to allow migration *Baseline is water flow sampling data collected by the Environment Agency provides a baseline. Severe low flow conditions that affect these species yet to be defined*	
			Physical barriers Mapping and quantification of potential obstructions in relation to height, type and water depth below obstruction once during the reporting cycle.	No artificial barriers significantly impairing, adults from reaching existing and historical spawning grounds, or juveniles from moving downstream. *Baseline is the Environment Agency data on structures and flood defences*	Dams, navigation and other weirs may prevent fish from reaching their spawning grounds. In particular, sea lamprey is known to be poor at ascending obstacles.

Ramsar interest feature	Sub-feature	Attribute	Measure	Target	Comments
		Population sizes (returning adults) *(size of populations - sections 4.6.ii and 4.7.ii of the conservation objectives)*	Number of returning adults measured using fish counters on the feeding rivers (Wye , Usk and Severn) during the migratory period.	No decline in number of returning adults from established baseline. *Baseline is yet to be established - fish counter data may be able to provide a baseline in future years.*	(Note that this attribute will not be able to be measured until the technological solutions for monitoring some species (notably lampreys and shad) are developed.)
		River populations *(size of populations - sections 4.6.ii and 4.7.ii of the conservation objectives)*	Survey through various methods (Electrofishing, seine netting , line fishing records, licencing returns) at a series of locations in the Rivers Wye, Usk and Severn	No decline in populations of the Rivers Wye and Usk *Baseline is yet to be established - fish counter data may be able to provide a baseline in future years.*	Details of methods for river and sea lamprey are outlined in section 4.1.9, Table 13 and for Twaite shad in Table 14 - the individual FCT for these species within the SAC section of this document
		Prey species *(abundance of prey species - sections 4.6.iii and 4.7.iii of the conservation objectives))*	The abundance of key prey species measured by EA in their routine monitoring of the rivers and estuary	No significant reduction in abundance of key prey species against an established baseline *Baseline is yet to be established through fish surveys in estuary and rivers*	River and sea lamprey require a variety of other fish species to act as hosts throughout their lifecycle. Their principal host species are part of the estuarine fish assemblage which has measures and targets included within Table 8. Twaite shad require a variety of invertebrates including crustacean, mysids and copepods, small fish and fish eggs particularly in that section of the estuary where saline and freshwaters meet. While at sea, salmon feed on a variety of fish (e.g. herring, sprat, sand eel, mackerel, and various gadoids) and crustaceans (e.g. euphausiid shrimps, prawns, gammarid amphipods and various crabs). (Bird, 2008) The diet of sea trout at sea is believed to include a range of fish species including sprat, young herring and sand eels as well as crustaceans such amphipods (e.g. Corophium), gammarids, decapods such as Crangon and mysid shrimps. Eeels feed on a range of benthic organisms that include crustaceans and small fish. (Bird, 2008)

Table 20 Favourable Condition Table for the supporting habitats of the bird interest features (Ramsar interest features 3 to 9) in the Severn Estuary Ramsar Site (Numbers of bird species using these habitats are given in Table 6)

Ramsar interest features	Supporting Habitat	Attribute	Measure	Target	Comments
Ramsar Interest features 3-8 : **Internationally important populations of waterfowl** and *Ramsar Interest feature 9 :* **Internationally important assemblage of waterfowl**	Saltmarsh	Habitat extent	Area (ha) measured once per reporting cycle.	No decrease in extent from 1,400 ha. At The Dumbles, no decrease in extent from 76 ha.	Saltmarsh and their communities are important habitats as they provide both roosting and feeding areas.
		Food availability	Presence and abundance of suitable saltmarsh food plants measured periodically (frequency to be determined).	Presence and abundance of suitable saltmarsh food plants should not deviate significantly from an established baseline[1].	European white-fronted geese graze on a range of saltmarsh grasses and herbs. Wigeon feed on well-grazed saltmarsh with *Puccinella maritiae*, *Salicornia* and *Agrostis*. Teal and pintail feed on seeds from *Salicornia* and *Atriplex*.
		Vegetation characteristics	Abundance of suitable soft leaved herbs and grasses - % cover (frequency to be determined)	Greater than 25% cover during the winter season.	Bewick's swans graze on soft wet meadow grasses such as *Agrostis stolonifera*, *Glyceria fluitans* and *Alopecurus geniculatus* which are found in the transition of saltmarsh to grassland.
		Vegetation characteristics	Range of vegetation heights measured periodically (frequency to be determined).	Sward height and density throughout areas used for roosting should not deviate significantly from an established baseline[1].	Vegetation of <10 cm is required throughout areas used by roosting waders. This is managed by grazing.
		Unimpeded sightlines at feeding and roosting sites	Openness of terrain unrestricted by obstructions	No increase in obstructions to existing bird sightlines. Areas of vegetation with an effective field size of >6ha at the Dumbles (Bewicks swan)	Waterfowl require unrestricted views >500m to allow early detection of predators when feeding and roosting.

Table 20 continued

Ramsar interest features	Supporting Habitat	Attribute	Measure	Target	Comments
Ramsar Interest features 3-8 : **Internationally important populations of waterfowl** and *Ramsar Interest feature 9 :* **Internationally important assemblage of waterfowl**	Intertidal mudflats and sandflats	Habitat extent	Area (ha), measured once per reporting cycle.	No decrease in extent from 15,000 ha. At Frampton Sands, Waveridge Sands and The Noose no decrease in extent from 980 ha.	Intertidal mudflats and sandflats and their communities are important habitats as they provide both roosting and feeding areas. The intertidal mudflats and sandflats at The Noose, Frampton Sand and Waveridge Sand are used as disturbance refuge for Bewick's swan. The extent and distribution of this sub-feature are important to maintain the population in favourable condition.
		Food availability	Presence and abundance of suitable prey species measured periodically (frequency to be determined).	Presence and abundance of suitable prey species should not deviate significantly from an established baseline[1]..	Most of the waders and waterfowl within the assemblage including the internationally important population of waterfowl feed on invertebrates within and on the sediments. Diet includes *Arenicola, Crangon, Hydrobia,Hediste, Corophium, Macoma, Gammarus,* small molluscs and strandline plankton and seeds.
		Unimpeded sightlines at feeding and roosting sites	Openness of terrain unrestricted by obstructions	No increase in obstructions to existing bird sightlines.	Waterfowl require unrestricted views >500m to allow early detection of predators when feeding and roosting.
	Shingle and rocky shores	Habitat extent	Area (ha), measured once per reporting cycle.	No decrease in extent from 1,500 ha.	This habitat is used for feeding and roosting, particularly by waders.
		Food availability	Presence and abundance of suitable intertidal invertebrates, measured periodically (frequency to be determined).	Presence and abundance of suitable food species should not deviate significantly from an established baseline[1].	Waders feed on worms, crustaceans and molluscs.
		Unimpeded sightlines at feeding and roosting sites	Openness of terrain unrestricted by obstructions	No increase in obstructions to existing bird sightlines.	Waterfowl require unrestricted views >500m to allow early detection of predators when feeding and roosting.

[1] Baselines to be established

Table 21 Favourable Condition Table for the qualifying bird features in the Severn Estuary Ramsar Site

Ramsar interest features	Supporting Habitat	Attribute	Measure	Target	Comments
Ramsar Interest features 3-8 : **Internationally important populations of waterfowl** and *Ramsar Interest feature 9 :* **Internationally important assemblage of waterfowl**		Population size	5 year peak mean number of individuals	No less than 68,026 individuals in the assemblage [ie the 5 year peak mean between 1988/9 - 1992/3] For individual species - no less than the 5 year peak mean between 1988/9 - 1992/3 detailed in Table 6	Figures derived from WeBS counts. The 5 year peak means for this period for each of the internationally important populations and species with nationally important populations which make up the internationally important assemblage are detailed in Table 6
		Distribution	Number and location of sectors occupied at low tide	No decrease in use of the number of sectors and their distribution established as baseline[1].	WeBS low tide counts display distribution information by sector (not annual counts) Birds use certain sectors to a greater or lesser degree from year to year
		Disturbance in feeding and roosting areas.	Reduction or displacement of wintering birds	No significant reduction in numbers or displacement of wintering birds attributable to disturbance from an established baseline[1].	Significant disturbance attributable to human activities can result in reduced food intake and/or increased energy expenditure. Five year peak mean information on populations will be used as the basis for assessing whether disturbance is damaging.

[1] Baselines to be established

5. Advice on Operations

CCW and Natural England have a duty under Regulation 33(2)(b) of The Conservation (Natural Habitats &c.) Regulations 1994 to advise other relevant authorities as to 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. Information on how CCW and Natural England have developed this advice is given in section 5.2, and on how it may be reviewed and updated in the future in section 5.3.

The Advice on Operations concerning the SAC are provided in detail in Table 22 and section 5.6. The Advice on Operations concerning the SPA is provided in Table 23 and section 5.7. These include recommendations regarding specific interest features and their supporting habitats. The Advice on Operations concerning the Ramsar Site is provided by cross reference to the subsections of the advice for the SAC and SPA which are relevant to the Ramsar Site interest features.

5.1. Purpose of advice

The aim of this advice is to provide CCW and Natural England's Advice on Operations as required by Regulation 33 (2)(b)for the Severn Estuary European Marine Site and thereby enable all relevant authorities to direct and prioritise their work on the management of activities that pose the greatest potential threat to the favourable condition of interest features on the Severn Estuary European Marine Site. The advice should be read in conjunction with the Conservation Objectives for the SAC, SPA and Ramsar Sites interest features given in sections 4.1, 4.2 and 4.3 respectively and it is intended to provide the basis for detailed discussions to formulate and agree a management scheme for the European Marine Sites.

General advice on sensitivity, exposure (and therefore vulnerability) contained within this document is presented against broad categories of operation which may cause the deterioration of natural habitats or the habitats of species, or the disturbance of species (refer to section 5.2). It reflects activities and plans and projects. Generic examples of some of the types of operation that are covered under the broad category headings are given for illustration.

The advice is based on best available information at the time of preparation of the Regulation 33 advice for the Severn Estuary in 2008/09. For a current assessment of levels of disturbance of specific types of activity across the Severn Estuary (relevant solely to the SPA interest features), reference should be made to the SPA Scheme of Management, available at the ASERA website (http://www.severnestuary.net/asera/). It should be noted, however, that the frequency, intensity, effects and level of risk to the SPA features that certain activities may have are still being investigated under the existing Severn Estuary Scheme of Management.

5.2 Methods for assessment

The advice provided here is within six broad categories of operation which may cause the deterioration of natural habitats or the habitats of species, or the disturbance of species. These categories are:

- Physical loss
- Physical damage
- Non-physical disturbance
- Toxic contamination
- Non-toxic contamination
- Biological disturbance

Within these categories are environmental impacts that may result from operations. Example sources of activities are provided in the MarLIN *Maritime and coastal activities to environmental factors matrix* (see Appendix 10), although these are by no means inclusive of all potentially damaging activities.

Given current knowledge of the nature and extent of activities taking place within the Severn Estuary European Marine Site, this approach therefore:

- enables links to be made between human activities and the ecological requirements of the habitats or species, as required under Article 6 of the Habitats Directive;
- provides a consistent framework to enable relevant authorities in England and Wales to assess the effects of activities and identify priorities for management within their areas of responsibility; and
- is appropriately robust to take into account the development of novel activities or operations which may cause deterioration or disturbance to the interest features of the site and should have sufficient stability to need only infrequent review and updating by the CCW and Natural England.

These broad categories provide a clear framework against which relevant authorities can assess activities or operations under their responsibility. The more detailed information in Tables 22 and 23 (covering both the SAC and SPA) provides competent authorities with a context against which to consider an assessment of 'significant effect' of any plans or projects which may affect the site and a basis to inform on the scope and nature of appropriate assessments required in relation to plans and projects. It is important to note that this advice is only a starting point for assessing impacts. It does not remove the need for the relevant or competent authorities to consult CCW or Natural England formally over individual plans and projects where required to do so under the Regulations.

This Advice on Operations for the site is based on a three-step process involving:

- an assessment of the **sensitivity** of the interest features or their component supporting habitats to operations;
- an assessment of the **current exposure** of each interest feature or their component supporting habitats to operations; and
- a final assessment of **current vulnerability** of interest features or their component supporting habitats to operations.

Note that in respect of the SPA, sensitivity, exposure and vulnerability have been assessed largely in relation to the use of habitats by birds, but may also take into account direct effects on the bird species themselves (such as 'shooting' or 'disturbance').

This three-step process builds up a level of information necessary to manage activities in and around the European Marine Site in an effective manner and to identify to competent and relevant authorities those operations which pose the most immediate threats to the favourable condition of the interest features of the European Marine Site.

The assessment of relative sensitivity, exposure and vulnerability is derived using best available scientific information and informed scientific interpretation and judgement. The process uses sufficiently coarse categorisation to minimise uncertainty in information, reflecting the current state of knowledge and understanding of the marine environment. Where possible, the sensitivity, exposure and vulnerability are assessed on a three-point scale of 'Low', 'Moderate' or 'High'. To assist with interpretation, these levels have been colour-coded in Tables 22 & 23.

5.2.1 Sensitivity assessment

The sensitivity assessment used is an assessment of the relative sensitivity of the interest features or the component supporting habitats of the Severn Estuary European Marine Site to the effects of six broad categories of human activities. In relation to this assessment, **sensitivity** has been defined as **'the intolerance of a habitat, community or individual (or individual colony) of a species to damage, or death, from an external factor and the time taken for its subsequent recovery'** (MarLIN, 2003). For

example, a very sensitive species or habitat is one that is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) and is expected to recover over a very long period of time, i.e. >10 or up to 25 years ('low' recoverability).

The sensitivity assessments are based on current information but may develop with improvements in scientific knowledge and understanding. The sensitivity of interest features (and scientific understanding of sensitivity) may change over time; hence an operation which is not currently considered to have a negative effect, may do so in the future.

English Nature (now Natural England) and Scottish Natural Heritage commissioned the Marine Biological Association of the UK, through its Marine Life Information Network (MarLIN) to provide detailed sensitivity information to underpin this advice. Detailed sensitivity information at a biotope or species level is available via MarLIN's website (www.marlin.ac.uk). The sensitivity assessments are indicative qualitative judgements based on the best available scientific information. They represent the most likely (probable) result of a given change in a factor. The sensitivity assessments of the interest features or their component supporting habitats of the Severn Estuary SAC, SPA and Ramsar Site are based upon MarLIN sensitivity assessments for biotopes (components of the Annex I habitats) and species supplemented by local knowledge and professional judgement to provide a site specific assessment that reflect the unusual and extreme character of the Severn Estuary.

The sensitivities of each of the SAC Annex I habitat features have been assessed on the component biotopes represented within each of the habitats (where information is available). Where information has not been available, such as for subtidal *Sabellaria alveolata* reefs or for Atlantic saltmeadow communities, a number of scientific review documents have been consulted, including reports produced for the UK Marine SAC LIFE project (see Bibliography section for a full list of these).

Assessments for the Annex II migratory fish have been based on current knowledge (best available scientific knowledge), which is limited for the life phase that shad and lamprey spend in estuarine waters. Given the paucity of information, it has not been possible to assess the level of sensitivity on a three-point scale; they have been assessed to be either 'sensitive' or 'not sensitive'.

For the SPA, the sensitivities have been assessed in relation to the use of habitats by birds and the sensitivities of the individual species themselves to certain activities. For example, wintering birds are highly sensitive to the loss of their roosting or feeding grounds; and they are highly sensitive to the noise of shooting. The sensitivity assessments of the interest features or their component supporting habitats of the Severn Estuary SPA are based on a number of scientific review documents. These include reports produced for the UK Marine SAC LIFE project (Davison & Hughes 1998; Elliott *et al.*, 1998), the Countryside Council for Wales Science Report (Holt *et al.*, 1995) and the Marine Habitats Review (Jones *et al.*, 2000.).

The magnitude or scale of the effect of an activity and the resultant change in environmental factors are site specific. For the purpose of this advice, the assessments of sensitivity have been adjusted for *changes in suspended sediments* and *turbidity* to reflect the particular conditions affecting the site. As a result of the high tidal energy of the site, the concentration of suspended sediment and turbidity are naturally very high. The marine fauna, including the migratory fish, are adapted to such high concentrations of suspended sediment and thus they are unlikely to have any significant effect. Consequently the sensitivities relating to *changes in suspended sediments* and *turbidity* have been downgraded.

Table 22 shows the sensitivity assessments for the SAC features and sensitivity assessments for the SPA can be seen in Table 23.

5.2.2 Exposure assessment

Exposure assessment has been undertaken for the Severn Estuary European Marine Site by assessing the relative exposure of the interest features or their component supporting habitats to the effects of broad categories of operations, resulting from human activities currently occurring on the site. Exposure has been assessed against a matrix which relates activities to operation pressures (see Appendix 10). The

matrix has been used as a guide and interpreted to assess the exposure to current activities known to be present within the site.

In assigning a three-point score (High, Moderate or Low) to the exposure, each activity is considered for:

- Spatial extent of the pressure
- Frequency of the pressure and
- Intensity of the pressure

For the SPA, the exposure has been assessed in relation to the use of habitats by birds and on the bird species themselves. As an example, the feeding and roosting grounds of wintering birds may be considered highly exposed to toxic contamination from synthetic compounds due to the locations and intensity of discharges into an area.

5.2.3 Vulnerability assessment

The third step in the process is to determine the vulnerability of interest features or their component supporting habitats to operations. This category results from an integration of sensitivity and exposure. Only if a feature is both sensitive and exposed to a human activity will it be considered vulnerable. In this context therefore, 'vulnerability' has been defined as **'the exposure of a habitat, community or individual (or individual colony) of a species to an external factor to which it is sensitive'** (Hiscock, 1996).

Tables 22 and 23 show the vulnerability assessments for the SAC features and the SPA features respectively.

5.3 Update and review of advice

Information as to the categories of operations which may cause the deterioration of natural habitats or the habitats or disturbance of species for which the site has been designated, is provided in light of what CCW and Natural England know about current activities and patterns of usage within the Severn Estuary European Marine Site. The general information on current activities and patterns of usage (which was used in part to derive Table 23) has been refined at the local level in producing the management scheme for the SPA and through further discussion with the relevant authorities. This management scheme is available at the ASERA website (http://www.severnestuary.net/asera/) although this will require review following this more detailed analysis of impacts on the estuarine habitats that are supporting habitats for the birds of the SPA.

The information provided in this advice on the sensitivity of interest features or their supporting habitats (Table 23) will change as a result of an improvement in our scientific knowledge, which will be a relatively long term process. It is suggested that advice for sites be kept under review and is periodically updated through discussion with relevant authorities and others to reflect significant changes in our understanding of sensitivity together with the potential effects of plans and projects on the marine environment.

5.4 Plans and Projects

Under Regulation 48(1), an appropriate assessment must be undertaken by competent authorities in respect of any plan or project which:

a. either alone or in combination with other plans or projects is likely to have a ***significant effect*** on a European site; and
b. is not directly connected with or necessary to the management of the site for nature conservation.

This legal requirement applies to all European sites (SACs and SPAs). Regulation 48 is also applied, as a matter of Government policy, to proposed SPAs and listed Ramsar sites.

Tables 22 and 23 provides competent authorities with a guide against which to initiate an assessment of the 'significance' of any plans or projects (and on-going operations or activities) proposed for the site, although this will only be a starting point for assessing impacts and does not remove the need for competent authorities to consult CCW or Natural England formally over individual plans and projects where required under the Regulations.

5.5 Review of consents

Regulation 50 of the Conservation (Natural Habitats, &c.) Regulations 1994 requires a competent authority to undertake a review of any existing consent or permission to which Regulation 48(1) would apply if it were to be reconsidered as of the date on which the site became a European site. Where a review is required under these provisions it must be carried out as soon as reasonably practicable after classification of the European Marine Site. Consents will need to be reviewed in the light of these objectives.

5.6 Specific Advice on Operations for the Severn Estuary SAC

This section provides information to help relate general advice to each of the specific interest features of the Severn Estuary SAC. Where specific examples are given they are provided to aid understanding of possible impacts and are not intended to be a comprehensive list of all relevant operations.

This advice relates to the vulnerability of the interest features and supporting habitats of the Severn Estuary SAC as set out in more detail in Table 22. A brief explanation of the sensitivity of the interest features or supporting habitats follows, with an explanation of their exposure and consequently their vulnerability to damage or disturbance from the listed categories of operations is also given. This enables links between the categories of operation and the ecological requirements of the European Marine Site and Ramsar Site interest features to be made.

The precise impact of any category of operation occurring on the site will be dependent upon the nature, scale, location and timing of events. In accordance with Government policy guidance, the Advice on Operations provided here, is feature and site specific, and provided in the light of current activities and patterns of usage at the site.

As such, it is important that future consideration of this advice by relevant authorities, and others, takes account of changes in usage patterns that have occurred at the site over the intervening period. Advice for sites should be kept under review: it is suggested that periodic discussions with relevant authorities and others be undertaken to reflect significant changes in the understanding of sensitivities, as well as the potential effects of future plans or projects on the marine environment.

5.6.1 Estuaries feature

(Note : this advice is also relevant to the "estuaries" feature of the Ramsar Site – refer also to section 5.8)

5.6.1.1 Sensitivity

The **estuary** and its associated biological communities are **moderately to highly sensitive** to:

- **physical loss**
- **physical damage**
- **toxic contamination**
- **non-toxic contamination** and
- **biological disturbance**

These result from a range of activities known to occur in the estuary. Further details are provided in points i) to xiv) below, with details of the level of sensitivity set out in Table 22.

5.6.1.2 Exposure

The **estuary** and its associated biological communities are **moderately to highly exposed** to:

- **substratum loss**
- **smothering**
- **changes in suspended sediment**
- **changes in water flow rate**
- **changes in wave exposure**
- **abrasion and physical disturbance**
- **noise and visual disturbance**
- **toxic contamination (introduction of synthetic & non synthetic compounds)**
- **changes in nutrient loading**
- **changes in thermal regime**
- **changes in turbidity**
- **changes in salinity**
- **changes in oxygenation**
- **introduction of microbial pathogens**
- **introduction of non-native species**
- **selective extraction of species**

5.6.1.3 Vulnerability

The **estuary** and its associated biological communities are **moderately to highly vulnerable** to:

i. Substratum loss

The estuary feature is considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to substratum loss.

The physical loss of areas of intertidal habitats may be caused directly through a change in land use, or indirectly as a consequence of changes to sedimentation processes (e.g. resulting from the construction of groynes or of seawalls). Subtidal sedimentary habitats will be directly affected by the removal of material during maintenance dredging and aggregate extraction in particular. These activities, coupled with strong current flows, result in material being suspended in the water column and removed away from their point of origin. Removal of the substratum will lead to partial loss of faunal diversity, exposure of the underlying sediment and changes in the topography of the area. Intertidal seagrass beds will be adversely affected by substratum loss, with recoverability depending upon recruitment from other populations.

ii. Smothering

The estuary feature is considered to have **high sensitivity** and **moderate exposure** and therefore **high vulnerability** to smothering

Smothering of organisms is likely to occur as a result of the direct deposition of material on top of them and/or on their habitat. Examples of activities causing smothering in intertidal areas include beach replenishment, port developments, archaeological activities, coastal farming, industrial effluent discharge, oil spills, land runoff including highways discharge and sewage discharge. In subtidal areas, dumping of spoil from dredging operations is responsible for most smothering events. Both intertidal and subtidal seagrass beds are considered to be highly sensitive to smothering. A seagrass bed close to the second Severn crossing is known to have been adversely affected by smothering as a result of changes to sediment movements due to temporary works associated with the bridge construction in the early 1990's.

iii. Changes in suspended sediment

The estuary feature is considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in suspended sediment

As a result of the high tidal energy of the site, the concentration of suspended sediment and turbidity are naturally very high. This high tidal energy is one of the reasons for site selection as part of the Natura 2000 series. The marine fauna, including the migratory fish, are adapted to high concentrations of suspended sediment. Increase in sediment in suspension is unlikely to cause problems unless it leads to smothering (see smothering). Of greater concern in the Severn estuary would be the decrease in suspended sediments leading to increased light penetration and changes in the habitats and their plant and animal communities.

Activities likely to result in changes in suspended sediment would include those which would affect sediment availability or the water flow rate (coastal defences, development, construction and dredging).

iv. Changes in water flow rate

The estuary feature is currently considered to have be **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in water flow rate.

The estuary is considered to have high exposure due to its highly constrained nature (by man made hard defences). Increases or decreases to the water flow rate are likely to lead to, respectively, increased sediment erosion or accretion in certain areas. Seagrass beds in particular are intolerant to any activity that changes the sediment regime. Activities/structures responsible for changing the water flow rate could include in-estuary construction; groynes, beach replenishment, sea walls/breakwaters, port developments and aggregate extraction.

v. Changes in wave exposure

The estuary feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in wave exposure.

The estuary is considered to have high exposure due to its highly constrained nature (coastal defence structures; groynes, seawalls, breakwaters and beach replenishment) and presence of significant aggregate extraction which can cause changes in wave exposure. Storms and intense wave action may move or remove substrata from shallow subtidal sandbanks. Increased wave action will disrupt feeding and burrowing, and reduce species abundance, richness and biomass. Decreased wave exposure will result in increased food availability, but suspension feeders are intolerant of sediment increases in silt/clay content and therefore the proportion of suspension feeders may decrease in favour of deposit feeders. Both intertidal and subtidal seagrass beds are highly sensitive to changes in wave exposure, with an increase leading to loss of substrata and exposure of rhizomes, and a decrease causing deposition of fine particles on leaves which may result in smothering.

vi. Abrasion and physical disturbance

The estuary feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to physical disturbance and abrasion.

This factor includes mechanical interference, crushing, trampling, rubbing or erosion of the organism or habitat of interest. The activities most likely to cause abrasion include beach replenishment, development of port facilities, maintenance dredging, aggregate extraction, fixed netting, benthic trawls, sea-based recreation (including anchoring, power boat and jet ski wash), archaeology, coastal farming, educational visits, shipping, litter and debris. Habitats/communities that are moderately sensitive to abrasion include saltmarsh - see section 4.4 (at risk from overgrazing, erosion from moored boats or from trampling or vehicles), intertidal mudflats and sandflats (see section 4.3), and seagrass beds in particular.

vii. Toxic contamination

The estuary feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to toxic contamination. (Note that there is currently insufficient scientific information on the sensitivities of the estuarine habitats to radionuclides to determine any vulnerability).

This category includes contamination from synthetic compounds (including pesticides and herbicides), non-synthetic compounds (including heavy metals) and hydrocarbons (oil related products). As a result of the predominance of physical conditions within the Estuary, for the majority of biological communities there is little unequivocal evidence of additional impact due to contaminants across the Estuary as a whole. Individual populations may have been impacted close to major discharges however.

A number of synthetic compounds may be present locally in elevated concentrations. Riverine inputs are probably responsible for the majority of these compounds entering the Estuary. The concentration of metals in sediments (cadmium, arsenic, chromium, silver, copper, zinc and nickel in particular) are commonly above interim sediment quality guidelines over much of the Estuary, but only occasionally exceed probable effects levels (Langston et al., 2003). Bioaccumulation of metals occurs widely in invertebrates, though the ecological significance is still uncertain. Hydrocarbon compounds may also be present locally in elevated concentrations. Sources include a combination of fossil fuel combustion, shipping, urban run-off, sewage treatment works and various point-source and diffuse discharges from industrialised areas. Moderately high levels of poly-aromatic hydrocarbons (PAHs) are present in sediments across much of the Estuary. Overall vulnerability to all toxic contamination is considered 'high' (due to the exposure from sewage inputs being classed as 'high' and also with 'moderate' levels from industrial inputs etc.).

Note that there is currently insufficient scientific information on the sensitivities of the estuarine habitats to radionuclides to determine any vulnerability. However despite the presence of several potential sources of radionuclides (Berkeley, Oldbury and Hinkley Nuclear Power Plants, a manufacturer of radiopharmaceuticals in Cardiff and a number of other smaller sources) the accumulation of radionuclides in the Severn Estuary is generally low compared with samples from the Irish Sea. The exceptions to this are Tritium and Carbon 14, which have been found locally at significant levels. This is thought to be related to discharges from the radiopharmaceutical company in Cardiff, for which remedial action is being taken. (Langston et al, 2003).

viii. Changes in nutrient loading

The estuary feature is considered to have **high sensitivity** and **high exposure** to changes in nutrient loading but **is *not* considered vulnerable to changes in nutrient loading due to the high natural turbidity.**

Whilst nutrient levels and loadings within the Estuary are considered significant in UK terms (and thus have been scored as high for sensitivity and high for exposure), the high natural turbidity of the system negates these high levels, with algal productivity being generally low except in localised hotspots. Where these do occur, nutrient enrichment may lead to significant shifts in community composition on/in subtidal sandbanks (see section 5.2) and on/in intertidal mudflats and sandflats (see section 5.3), but recoverability is likely to be high. Should there be a decrease in natural turbidity levels, then the overall associated 'masking effect' would be lessened and there would be a higher risk of nutrient enrichment.

At the present time, despite the high sensitivity and high exposure scores discussed above, the high natural turbidity levels across most of the estuary lead to a conclusion that the estuary is not considered vulnerable to changes in nutrient loading.

ix. Changes in thermal regime

The estuary feature is considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in thermal regime

Temperature can affect many biological, physical and chemical geochemical processes within the water column including stratification, mixing and turbidity, nutrients, oxygenation, salinity and pH. For example, activities which can cause short or longterm changes in temperature can include thermal discharges (eg from power station cooling waters and other discharges). Thermal discharges are likely to be between 2 and 10 degrees above ambient temperature and a long term duration of changes may impact on the larval forms and breeding cycles of marine organisms.

x. Changes in salinity

The estuary feature is considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in salinity.

Decreases in salinity within the Estuary are likely to result from heavy rain events and associated land/waterfront run-off and riverine inputs. The vast floodplain and catchment area of the Severn Estuary results in annual extreme flooding events and prolonged periods of freshwater input the estuary so the exposure is considered to be high. Localised salinity changes may also result around discharges. Certain biotopes associated with subtidal sandbanks occur in conditions of reduced salinity and these biotopes are considered to be moderately vulnerable to any long-term increases in salinity levels.

xi. Changes in oxygenation

The estuary feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in oxygenation.

A cycle of changes in oxygenation occurs within the Severn as a result of both seasonal and tidal cycles and is linked to fluctuating sediment regimes. In addition occasional, intermittent oxygen sags occur in low salinity regions of the Severn and in some of the principal rivers feeding the Estuary. These probably originate from high densities of suspended solids and associated particulate organic matter, perhaps enhanced by discharge outfalls. Other causes include maintenance dredging, aggregate extraction, spoil dumping, coastal farming and shipping.

Oxygen-deficient marine areas are characterized by a decline in the number and diversity of species. Certain communities occurring within the Estuary's intertidal mudflats and sandflats are moderately sensitive to decreases in dissolved oxygen levels . However, recoverability of these areas should be rapid upon return to normal conditions. The fish assemblage is also likely to be sensitive to decreases in dissolved oxygen levels, although it is unclear what the level of sensitivity is at the present time.

xii. Introduction of microbial pathogens

The estuary feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in microbial pathogens.

Microbial pathogens are most likely to enter the Severn's ecosystem by means of sewage discharges, be these from port facilities, recreational boating, shipping or the outfalls from sewage treatment works. For the majority of biological communities there is insufficient information available to be able to make an assessment of their sensitivity to microbial pathogens. Of the few known impacts, subtidal seagrass beds of *Zostera marina* are known to be highly sensitive to the marine fungus *Labyrinthula macrocystis* which causes 'wasting disease'. The disease causes the death of leaves and, after 2-3 seasons, can lead to the death of regenerative shoots, rhizomes and the loss of up to 90% of the population and its associated

biotope. However, no information has been found which confirms the presence of the wasting disease in the Estuary.

While no infomation has been found which confirms the presence of the wasting disease in the estuary, the potential significant consequences for one of this notable estuarine community in particular has lead to the conclusion that estuary is highly sensitive to microbial pathogens. The exposure is considered to be high due to the high number of sewage discharges.

xiii. Introduction of non-native species

The estuary feature is currently considered to have **high sensitivity** and **moderate exposure** and therefore **high vulnerability** to the introduction of non-native species.

The saltmarsh cordgrass *Spartina anglica* is an invasive pioneer species whose rapid growth consolidates sediment, raises mudflats and reduces sediment availability elsewhere. It is regarded as being a potential threat to intertidal beds of *Zostera noltei* in particular. However, whilst recognising *S. anglica* as an invasive species, it also has a role in saltmarsh formation and the community SM6 in which it features should be allowed to develop into other Atlantic Salt Meadow or transitional communities. The Japanese seaweed *Sargassum muticum* is another non-native species which is thought to compete for space with the subtidal seagrass *Zostera marina*, though evidence for actual competition is conflicting. The presence of another non-native, the slipper limpet *Crepidula fornicata*, in large numbers may alter the species composition within certain soft mud habitats leading to a decline in overall species richness. However, *C. fornicata* has yet to penetrate the Estuary, possibly due to the strong water flows. The exposure to introduction of non-natives to the estuary is considered to be moderate because of the considerable volume of ship traffic, including transport to and from the major ports at Cardiff, Newport and Bristol.

xiv. Selective extraction of species

The estuary feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to the selective extraction of species.

This category refers to the removal of key species within a biotope or of a prey species. Activities which occur within the Estuary which are likely to be implicated bait digging, fixed netting, commercial fishing, recreational angling, wildfowling and educational visits. Whilst the majority of biotopes have a low sensitivity to such activities, intertidal *Zostera noltei* beds are highly sensitive to grazing by species of wildfowl. Significant amounts of dwarf eelgrass can be consumed by wildfowl, particularly during the autumn and winter months. However as these grazers are also part of the natural estuarine ecosystem and designated features in their own right their impact is not judged to be detrimental.

5.6.2 Subtidal sandbanks feature

5.6.2.1 Sensitivity

The **sandbanks** and their associated biological communities are **moderately to highly sensitive** to:

- **physical loss**
- **physical damage**
- **toxic contamination**
- **non-toxic contamination**
- **biological disturbance**

These result from a range of activities known to occur in the vicinity of the sandbanks. Further details are provided in points i) to vii) below, with details of the level of sensitivity set out in Table 22.

5.6.2.2 Exposure

The **sandbanks** and their associated biological communities are **moderately to highly exposed** to:

- **substratum loss**
- **smothering**
- **changes in suspended sediment**
- **abrasion and physical disturbance**
- **noise** and **visual disturbance**
- **toxic contamination (introduction of synthetic & non synthetic compounds)**
- **changes in nutrient loading**
- **changes in turbidity**
- **changes in salinity**
- **changes in oxygenation**
- **introduction of microbial pathogens**

5.6.2.3 Vulnerability

The **s**ubtidal sandbanks communities are **moderately to highly vulnerable** to:

i. Substratum loss

The subtidal sandbanks feature is currently considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to substratum loss.

The physical loss of subtidal sandbanks will occur through the removal of material during maintenance dredging and aggregate extraction in particular. These activities, coupled with strong current flows, result in material being suspended in the water column and removed away from their point of origin. Removal of the substratum will lead to partial loss of faunal diversity, exposure of the underlying sediment and changes in the topography of the area. Recolonisation of the biotope might occur within a few months, but the biotope would be unlikely to be recognized until after six months. Cohesive mud and sandy mud communities are considered to be moderately sensitive to substratum loss.

ii. Changes in suspended sediment

The subtidal sandbanks feature is currently considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in suspended sediment.

Increase in sediment in suspension are unlikely to cause problems unless it leads to smothering (see smothering). A decrease in suspended sediments may lead to increased light penetration and changes in the sandbank communities.

Activities likely to result in changes in suspended sediment would include those which would affect sediment availability or the water flow rate (coastal defences, development, construction and dredging).

iii. Toxic contamination

The subtidal sandbanks feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to toxic contamination. (Note that there is currently insufficient scientific information on the sensitivities of subtidal sandbank communities to radionuclides to determine their vulnerability).

This category includes contamination from synthetic compounds (including pesticides and herbicides), non-synthetic compounds (including heavy metals) and hydrocarbons (oil related products). As a result of the domination of physical conditions within the Estuary, for the majority of biological communities there is little unequivocal evidence of additional impact due to contaminants across the Estuary as a whole. Individual populations may have been impacted close to major discharges however.

Moderately high levels of poly-aromatic hydrocarbons (PAHs) are present in sediments across much of the Estuary (Langston et al., 2003). Generally speaking however, subtidal sediments are less likely to be at risk from oil spills than intertidal sediments unless oil dispersants are used or if wave action causes dispersion of oil into the water column and sediment mobility drives oil into the sediment. Certain species such as amphipods which occur within the Estuary's infralittoral mobile clean sand community have been found to be moderately sensitive to oil pollution. (See also section 5.1).
Despite the presence of several potential sources of radionuclides (Berkeley, Oldbury and Hinkley Nuclear Power Plants, a manufacturer of radiopharmaceuticals in Cardiff and a number of other smaller sources) the accumulation of radionuclides in the Severn Estuary is generally low compared with samples from the Irish Sea. The exceptions to this are Tritium and Carbon 14, which have been found at locally at significant levels. This is thought to be related to discharges from the radiopharmaceutical company in Cardiff, for which remedial action is being taken. The exposure for subtidal sandbanks is therfore thought to be low.

iv. Changes in nutrient loading

The subtidal sandbanks feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in nutrient loading

Whilst nutrient levels and loadings within the Estuary are considered significant in UK terms the high natural turbidity of the system negates these high levels, with algal productivity being generally low except in localised hotspots. Where these do occur, nutrient enrichment may lead to significant shifts in community composition on/in subtidal sandbanks but recoverability is likely to be high.

v. Changes in salinity

The subtidal sandbanks feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in salinity.

Aphelochaeta marioni, a polychaete worm which characterizes the shallow sandbanks' biotope of variable salinity infralittoral mobile sand, is very tolerant of low salinity conditions but would be moderately vulnerable to any long-term increases in salinity levels. This species has a wide distribution throughout the Estuary, being present on subtidal and intertidal sand habitats on both sides of the Estuary.

vi. Changes in oxygenation

The subtidal sandbanks feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in oxygenation.

A cycle of changes in oxygenation occurs within the Severn as a result of both seasonal and tidal cycles and is linked to fluctuating sediment regimes. In addition occasional, intermittent oxygen sags occur in low salinity regions of the Severn and in some of the principal rivers feeding the Estuary.

Decreases in oxygenation levels can result from maintenance dredging, aggregate extraction, industrial effluent discharge, land/waterfront runoff and sewage discharge (Langston et al., 2003). Oxygen-deficient

marine areas are characterized by a decline in the number and diversity of species. Certain communities occurring within the Estuary's subtidal sandbanks are moderately sensitive to decreases in dissolved oxygen levels. However, recoverability of these areas should be rapid upon return to normal conditions.

vii. Introduction of microbial pathogens

The subtidal sandbanks feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to the introduction of microbial pathogens.

Microbial pathogens are most likely to enter the Severn's ecosystem by means of sewage discharges. For the majority of biological communities there is insufficient information available to be able to make an assessment of their sensitivity to microbial pathogens. However, some research has been undertaken on marine bivalves, several species of which occur within the Estuary's sandbanks. Mass mortalities of bivalves can result from diseases caused by bacteria, viruses (over 20 have been described for marine bivalves) or protozoans. There is a greater likelihood of such events occurring in areas adjacent to outfalls than elsewhere. Recovery of populations is probable.

5.6.3 Mudflats and sandflats feature

(Note : this advice is also relevant to the Ramsar Site as the mudflats and sandflats are both a subfeature of the estuaries feature and a supporting habitat of the birds species, for which the Ramsar Site has been designated – refer also to section 5.8)

5.6.3.1 Sensitivity

The **mudflats and sandflats** and their associated biological communities are **moderately to highly sensitive** to:

- **physical loss**
- **physical damage**
- **toxic contamination**
- **non-toxic contamination**
- **biological disturbance**

These result from a range of activities known to occur in the vicinity of the mudflats and sandflats. Further details are provided in points i) to xiii) below, with details of the level of sensitivity set out in Table 22.

5.6.3.2 Exposure

The **mudflats and sandflats** and their associated biological communities are **moderately to highly exposed** to:

- **substratum loss**
- **smothering**
- **changes in suspended sediment**
- **changes in water flow rate**
- **changes in wave exposure**
- **abrasion and physical disturbance**
- **toxic contamination(introduction of synthetic & non synthetic compounds)**
- **changes in nutrient loading**
- **changes in thermal regime**
- **changes in turbidity**
- **changes in salinity**
- **changes in oxygenation**
- **introduction of microbial pathogens**

5.6.3.3 Vulnerability

The **intertidal mudflats and sandflats** communities are **moderately to highly vulnerable** to:

i. Substratum loss

The intertidal mudflats and sandflats feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to substratum loss.

Areas of intertidal habitats will be lost as a direct result of land claim or developments, or indirectly as a consequence of changes to sedimentation processes (e.g. resulting from the construction of groynes or of seawalls). Consequently, there is moderate to high exposure of mudflats and sandflats to substratum loss. The sediment infauna reside in the uppermost layers of the substratum and the removal of this layer would cause a major decline in species richness as they would have been removed with it. Thus the sensitivity of the biotopes in question is high. Fortunately, recovery of the community is also regarded as being high as recolonisation is likely following deposition of suitable substrata.

ii. Smothering

The intertidal mudflats and sandflats feature is considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to smothering

Smothering of organisms is likely to occur as a result of the direct deposition of material on top of them and/or on their habitat. Examples of activities causing smothering in intertidal areas include beach replenishment, port developments, archaeological activities, coastal farming, industrial effluent discharge, oil spills, land runoff including highways discharge and sewage discharge.

iii. Changes in suspended sediment

The intertidal mudflats and sandflats feature feature is considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in suspended sediment

Changes in suspended sediments could change the extent and nature of intertidal habitats including affecting estuary-wide erosion and accretion patterns. Increase in sediment in suspension are unlikely to cause problems unless it leads to smothering (see smothering) and in some cases the invertebrate communities associated with the sediment may provide additional food resources for feeding birds. A decrease in suspended sediments may lead to increased light penetration and changes in the intertidal mud and sandflat communities.

Activities likely to result in changes in suspended sediment would include those which would affect sediment availability or the water flow rate (coastal defences, development, construction and dredging).

iv. Changes in water flow rate

The intertidal mudflats and sandflats feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in water flow rate.

Increases or decreases to the water flow rate are likely to lead to, respectively, increased sediment erosion or accretion in certain areas. Activities/structures responsible for changing the water flow rate include construction activities, groynes, beach replenishment, sea walls/breakwaters, port developments and aggregate extraction.

v. Changes in wave exposure

The intertidal mudflats and sandflats feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in wave exposure.

Changes in wave exposure result from coastal defence structures (groynes, seawalls, breakwaters and beach replenishment), shipping and possibly aggregate extraction. Increased wave action will disrupt feeding and burrowing, and reduce species abundance, richness and biomass. The strength of wave action determines the topography, steepness and shore width of the intertidal zone.

vi. Abrasion and physical disturbance

The intertidal mudflats and sandflats feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to physical disturbance and abrasion.

The activities most likely to cause abrasion to mudflats and sandflats include beach replenishment, bait digging, maintenance dredging, aggregate extraction, land-based recreation and archaeology. Boating, anchoring, trampling or the use of vehicles are also likely to cause physical disturbance, with compaction of the substratum being of particular concern. For example, the use of vehicles on mudflats or sandflats appears to have a potentially severe impact on gaper clams *Mya arenaria*. Large clams live in permanent burrows and are therefore susceptible to burrow collapse and sediment compaction through trampling and especially vehicle use. Another two key species found in muddy sand, the heart urchin *Echinocardium cordatum* and the razor shell *Ensis ensis*, are probably highly sensitive to physical disturbance. Recovery is likely to be moderate because, although the individual key species may recolonize an area within five years, several of the species are very long-lived and so the biotope may take longer to return to its original age structure and species diversity.

vii. Toxic contamination

The intertidal mudflats and sandflats feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to toxic contamination by synthetic and non-synthetic compounds. (Note that there is currently insufficient scientific information on the sensitivities of communities present on/in intertidal mudflats and sandflats to radionuclides to determine their vulnerability).

This category includes contamination from synthetic compounds (including pesticides and herbicides), non-synthetic compounds (including heavy metals) and hydrocarbons (oil related products). Infaunal populations present within intertidal sediments are likely to have been impacted close to major discharges, with a number of synthetic compounds known to have elevated concentrations locally (Langston et al.,2003). However, because of the energetic hydrodynamic regime in the Severn, and the resultant high turbidity, there is considerable mixing and redistribution of fines and their associated contamination burden, resulting in a fairly homogenous distribution.

Whilst the concentration of metals within the Estuary's sediments (cadmium, arsenic, chromium, silver, copper, zinc and nickel in particular) are commonly above interim sediment quality guidelines, these only occasionally exceed probable effects levels (Langston et al.,2003).. Contamination loadings of metals will be highest where fine particulates predominate (for example between Avonmouth and Severn Beach, Caldicot Flats, the River Parrett and outer Bridgewater Bay, and between the mouths of the Usk and Taff), and lowest on sands (for example the Middle to Welsh Grounds, and Culver Sands). Bioaccumulation of metals is known to occur widely in invertebrates, though the ecological significance is still uncertain. Note also that the toxicity of metals to many invertebrates increases with decreased salinity and elevated temperature (Langston et al.,2003). Thus many benthic invertebrates living within their normal salinity range may be less susceptible to heavy metal pollution than those living in salinities near the lower limit of their salinity tolerance.

Hydrocarbon compounds are present locally in elevated concentrations (Langston et al.,2003).. Sources include a combination of fossil fuel combustion, shipping, urban run-off, sewage treatment works and various point-source and diffuse discharges from industrialised areas. Moderately high levels of poly-aromatic hydrocarbons (PAHs) are present in sediments across much of the Estuary (Langston et al.,2003).

Overall vulnerability to all toxic contamination is considered 'high' (due to the exposure from sewage inputs being classed as 'high' and also with 'moderate' levels from industrial inputs etc.).
Despite the presence of several potential sources of radionuclides (Berkeley, Oldbury and Hinkley Nuclear Power Plants, a manufacturer of radiopharmaceuticals in Cardiff and a number of other smaller sources) the accumulation of radionuclides in the Severn Estuary is generally low compared with samples from the Irish Sea. The exceptions to this are Tritium and Carbon 14, which have been found at locally at significant levels. This is thought to be related to discharges from the radiopharmaceutical company in Cardiff, for which remedial action is being taken. The intertidal mudlfats and sandflats are therefore thought to be moderately exposed to radionuclides (Langston et al, 2003).

viii. Changes in nutrient loading

The intertidal mudflats and sandflats feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in nutrient loading.

The most obvious sign of an increase in nutrient loading (or organic enrichment) on mudflats is the lush growth of green seaweeds on the surface. Such increases coupled with reduced oxygenation typically lead to anaerobic conditions predominating within the sediment. Moderate organic enrichment does provide food which can enhance species diversity but with greater enrichment, the diversity declines and the community becomes increasingly dominated by a few, pollution tolerant, opportunistic species such as the polychaete *Capitella capitata*. In sandier sediments where particle size is greater, the effects of an increase in organic enrichment are less dramatic. However, the structure of the community is still likely to change from one dominated by suspension feeders to one favouring deposit feeders, accompanied by an increase in the abundance of opportunistic species and a decrease in species richness. Note, however,

that the high natural turbidity of the system negates many of these effects, and algal productivity is generally low except in localised hotspots.

ix. Changes in thermal regime

The intertidal mudflats and sandflats feature is currently considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in thermal regime

Temperature can affect many biological, physical and chemical geochemical processes within the water column including stratification, mixing and turbidity, nutrients, oxygenation, salinity and pH. For example, activities which can cause short or longterm changes in temperature can include thermal discharges (eg from power station cooling waters and other discharges). Thermal discharges are likely to be between 2 and 10 degrees above ambient temperature and a long term duration of changes may impact on the larval forms and breeding cycles of marine organisms.

x. Changes in salinity

The intertidal mudflats and sandflats feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in salinity

Decreases in salinity are likely to result from heavy rain events and associated land/waterfront run-off and riverine inputs. Localised salinity changes may also result around discharges. The vast floodplain and catchment area of the Severn Estuary results in annual extreme flooding events and prolonged periods of freshwater input to the intertidal areas so the exposure is considered to be high. However the metabolism of intertidal communities cope with vast extremes of conditions which result from the dynamic nature of the estuary's tidal regime and so are considered to have low sensitivity.

xi. Changes in oxygenation

The intertidal mudflats and sandflats feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in oxygenation.

A cycle of changes in oxygenation occurs within the Severn as a result of both seasonal and tidal cycles and is linked to fluctuating sediment regimes. In addition occasional, intermittent oxygen sags occur in low salinity regions of the Severn and in some of the principal rivers feeding the Estuary.

Decreases in oxygenation levels will result from maintenance dredging, aggregate extraction, industrial effluent discharge, land/waterfront runoff and sewage discharge. Oxygen-deficient marine areas are characterized by a decline in the number and diversity of species. Certain communities occurring within the Estuary's intertidal mudflats and sandflats are moderately sensitive to decreases in dissolved oxygen levels. However, recoverability of these areas should be rapid upon return to normal conditions.

xii. Introduction of microbial pathogens

The intertidal mudflats and sandflats feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to the introduction of microbial pathogens.

Microbial pathogens are most likely to enter the Severn's ecosystem by means of sewage discharges. For the majority of biological communities there is insufficient information available to be able to make an assessment of their sensitivity to microbial pathogens. However, some research has been undertaken on marine bivalves, several species of which occur within the Estuary's intertidal sandbanks. Mass mortalities of bivalves can result from diseases caused by bacteria, viruses (over 20 have been described for marine bivalves) or protozoans. There is a greater likelihood of such events occurring in areas adjacent to outfalls than elsewhere. Recovery of populations is probable.

xiii. Introduction of non-native species

The intertidal mudflats and sandflats feature is currently considered to have **high sensitivity** and **low exposure** and therefore **moderate vulnerability** to the introduction of non-native species.

The saltmarsh cordgrass *Spartina anglica* is an invasive pioneer species whose rapid growth consolidates sediment, raises mudflats and reduces sediment availability elsewhere. It is regarded as being a potential threat to intertidal beds of *Zostera noltei* in particular. However, whilst recognising *S. anglica* as an invasive species, it also has a role in saltmarsh formation and the community SM6 in which it features should be allowed to develop into other Atlantic Salt Meadow or transitional communities. The presence of another non-native, the slipper limpet *Crepidula fornicata*, in large numbers may alter the species composition within certain soft mud habitats leading to a decline in overall species richness. However, *C. fornicata* has yet to penetrate the Estuary, possibly due to the strong water flows.

*Note, in relation to '**noise and visual disturbance'**, that while mudflats and sandflats communities have **moderate exposure** to both noise and visual disturbance, these habitats are **not sensitive** to these factors but they do provide a vitally important role as supporting habitats for waterfowl that use these areas for roosting and feeding and these are considered **highly sensitive to** both noise and visual disturbance – see sections 5.7.1 & 5.7.2). So while the habitats themselves have **low vulnerability** their dependant bird species have high vulnerability.*

5.6.4 Atlantic salt meadow feature

(Note : this advice is also relevant to the Ramsar Site as the Atlantic saltmeadows are both a subfeature of the estuaries feature and a supporting habitat of the birds species, for which the Ramsar Site has been designated – refer also to section 5.8)

5.6.4.1 Sensitivity

The **Atlantic salt meadow** and its associated biological communities are **moderately or highly sensitive** to:

- **physical loss**
- **physical damage**
- **toxic contamination**
- **non-toxic contamination**

These result from a range of activities known to occur on or in the vicinity of the salt meadows. Further details are provided in points i) to xiii) below, with details of the level of sensitivity set out in Table 22.

5.6.4.2 Exposure

The **Atlantic salt meadow** and its associated biological communities are **moderately to highly exposed** to:

- **substratum loss**
- **smothering**
- **changes in suspended sediment**
- **changes in water flow rate**
- **changes in wave exposure**
- **abrasion and physical disturbance**
- **changes in grazing management**
- **noise and visual disturbance**
- **toxic contamination(introduction of synthetic & non synthetic compounds)**
- **changes in nutrient loading**
- **changes in salinity**
- **changes in oxygenation**
- **introduction of microbial pathogens**

5.6.4.3 Vulnerability

The **saltmarsh** communities are **moderately to highly vulnerable** to:

i. Substratum loss

The Atlantic salt meadows and their associated communities feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to substratum loss

Saltmarshes, cordgrass and *Salicornia* are highly sensitive to physical loss. This can occur mostly through one-off developments such as infrastructure construction and modification involving land claim and changes in land management and coastal farming, and also as a result of coastal squeeze. This is a process by which coastal features such as saltmarshes and *Salicornia* are eroded as they become trapped between man-made structures such as sea walls and rising sea levels. Where this occurs on saltmarshes, it may result in the replacement of mid-marsh communities by pioneer saltmarsh communities or through erosion changing saltmarsh to intertidal mud and sand. Changes to coastal processes may also affect the sediment budget of estuaries and reduce the supply of sediment to saltmarsh, *Salicornia* and cordgrass areas. Whilst some areas of the Estuary are subject to these pressures, others are not, yet it remains a real

threat as is reflected in the moderate to high exposure score. When combined with high sensitivity this leads to a high vulnerability.

ii. Smothering

The Atlantic salt meadows feature is considered to have **high sensitivity** and **moderate exposure** and therefore **high vulnerability** to smothering.

Smothering of saltmarsh is likely to occur as a result of the direct deposition of material on the surface. This can happen by either direct deposition of materials on land or through silt-laden tides. The saltmarshes of the Severn are subject to spring tides each year which can in some locations deposit a thick layer of sediment on the surface which can persist for some months. Normally the level of this natural deposition is compatible with the speed of vertical accretion and growth of the saltmarsh. Higher levels of sediment deposition which may be associated with development activities (increasing sediment suspension) can cause smothering to occur resulting in loss of vegetation or shifts in community composition and zonation. Examples of activities likely to cause smothering from tidal deposition include coastal defence works, dredging, construction and archaeological works. Examples of direct deposition are fly tipping and accumulation of tidal debris.

iii. Changes in suspended sediment

The Atlantic salt meadows and their associated communities feature is currently considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in suspended sediment

Changes in suspended sediments could change the extent and nature of saltmarsh communities and other intertidal habitats including affecting estuary-wide erosion and accretion patterns. Increases in suspended sediment are unlikely to cause problems unless it leads to smothering (see smothering).

Activities likely to result in changes in suspended sediment would include those which would affect sediment availability or the water flow rate (coastal defences, development, construction and dredging).

iv. Desiccation and changes in emergence regime

The Atlantic salt meadows and their associated communities feature is currently considered to have **high sensitivity** and **low exposure** and therefore **moderate vulnerability** to desiccation and changes in emergence regime

Changes in the emergence regime will result in changes in the time habitats or species spend either covered in water or exposed to the air, one consequence of which is the desiccation (drying) of habitats and species. Examples of activities which may induce these changes are the construction of coastal and flood defences and other developments which change the tidal regime and water flow characteristics of the estuary.

The morphology, zonation and composition of saltmarshes are determined by their position within the tidal frame. They therefore considered highly sensitive to changes in the emergence regime and desiccation in particular.

These changes occurring in saltmarshes may result in either the stranding and exposure of communities or lengthened periods of inundation and lack of drying out with consequent impacts on species composition of swards (through dieback and shifts in community types) and affecting their suitability for species dependant on them. These changes may also cause the expansion of *Spartina* into both saltmarsh habitats and across adjacent mudflats.

The size of the estuary means that most small scale activities will have limited impacts with only large scale or estuary-wide activities likely to be of concern and exposure to this operation is therefore currently considered as low.

v. Changes in water flow rate

The Atlantic salt meadows and their associated communities feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in water flow rate.

A reduction in the rate of water flow over the saltmarsh will result in an increase in the deposition of sediment. The rate at which this occurs will depend on the sediment supply, the duration of the tidal cover and the extent to which the tidal flow is impeded by the vegetation itself to facilitate deposition. Saltmarsh communities actually require a degree of sediment deposition in order to survive and flourish and they have been assessed as having a low to moderate sensitivity. Exposure to changes in water flow rate on saltmarsh communities will vary throughout the Estuary.

vi. Changes in wave exposure

The Atlantic salt meadows and their associated communities feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in wave exposure.

Changes in wave exposure result from the presence of coastal defence structures (groynes, seawalls, breakwaters), beach replenishment and possibly aggregate extraction. Increased wave action can have two opposing effects. On the one hand it is likely to lead to a greater amount of suspended sediment being carried to the saltmarsh, while on the other hand the greater energy regime is likely to prevent the settlement of this material and may even remove material from the saltmarsh through erosion at the saltmarsh edge. A decrease in wave action will lead to greater sediment deposition with the possibility of smothering.

vii. Abrasion and physical disturbance

The Atlantic salt meadows and their associated communities feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to physical disturbance and abrasion.

Physical disturbance or abrasion to saltmarsh communities may result from a wide range of activities including recreational usage (both land-based and water-based), any of which may damage individual saltmarsh plants or areas of saltmarsh. Trampling by foot, and particularly by off-road vehicles, causes localised damage which may impact upon the ecological structure and function of larger areas, and requiring long-term recovery. Saltmarshes are also sensitive to erosion as a result of trampling or overgrazing, with communities that support succulents such as *Limonium* spp. being very susceptible to any form of grazing. In addition, it is widely recognised that shipping and boating can increase saltmarsh erosion from their wash.

viii. Changes in grazing management

The Atlantic salt meadows and their associated communities feature is currently considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in grazing management.

The presence, duration and intensity of grazing management can alter the vegetation composition and structure of saltmarsh habitats. Abandonment or introduction of grazing can result in changes in the saltmarsh plant and animal communities which are important in their own right and which also provide food resources for passage and wintering birds. Grazing changes may also affect the suitability of saltmarsh areas as resting and roosting sites for birds where open terrain with low vegetation is an important factor. Changes may also affect the presence of specific niches for scarce and notable plants.

ix. Toxic contamination

The Atlantic salt meadows and their associated communities feature is currently considered to have **moderate to high sensitivity** and **high exposure** and therefore **high vulnerability** to toxic contamination from both synthetic and non-synthetic compounds.

Atlantic salt meadows, cordgrass swards and *Salicornia* within the Estuary are considered to have a moderate sensitivity to toxic contamination by synthetic compounds (which includes domestic/industrial effluent, pesticides, anti-foulant paints and PCBs) and a high sensitivity to non-synthetic compounds

(which includes domestic/industrial effluent, heavy metals and hydrocarbons). Although saltmarsh plants may be reasonably tolerant of certain synthetic substances, they can bioaccumulate toxic compounds and act as sinks for them. This could have implications for wildfowl which feed on saltmarsh plants.
Saltmarsh communities are also highly sensitive to oil and oil products, even at relatively low levels. This is mainly by virtue of their ability to trap sediments. Acute events, such as oil spills, can be particularly damaging to saltmarsh plants. Dispersants used to treat oil spills can also have a toxic effect on saltmarsh plants, sometimes to a greater degree that the spilled oil itself. Saltmarshes have been reported to recover from chronic oil pollution, where denuded of vegetation, within ten years, although recovery depends largely on the degree to which oil is retained in the sediment and the clean up procedures used.

x. Changes in nutrient loading

The Atlantic salt meadows and their associated communities feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in nutrient loading.

The Estuary's saltmarshes and associated communities are thought to be more susceptible to nutrient enrichment than was previously realised (Deegan, L. A. et al. 2007), so they have been assessed as being of high sensitivity to increases in nutrient loading and/or organic enrichment. However, increased growth of certain seaweed species may result from elevated levels of nitrates and phosphates and cause local smothering which is known to have a detrimental effect on glasswort (*Salicornia* spp.) in low marsh communities. In addition, the species composition of the plants on the saltmarsh may be altered by changes in nutrient loading leading to a change in the structure of the sward.

xi. Changes in salinity

The Atlantic salt meadows and their associated communities feature is currently considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in salinity.

Changes to the salinity of water flowing across the saltmarshes as a result of the tides are likely to occur following heavy rain events and associated land/waterfront run-off and riverine inputs. The vast floodplain and catchment area of the Severn Estuary results in annual extreme flooding events and prolonged periods of freshwater input to the intertidal areas so the exposure is considered to be high. The botanical composition of the saltmarshes reflects salinity. The saltmarshes, while capable of tolerating a wide range of salinities, are considered moderately sensitive to changes in salinity particularly prolonged periods of change which can cause shifts in composition and zonation.

xii. Changes in oxygenation

The Atlantic salt meadows and their associated communities feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in oxygenation.

A cycle of changes in oxygenation occurs within the Severn as a result of both seasonal and tidal cycles and is linked to fluctuating sediment regimes. In addition occasional, intermittent oxygen sags occur in low salinity regions of the Severn and in some of the principal rivers feeding the Estuary.

xiii. Introduction of microbial pathogens

The Atlantic salt meadows and their associated communities feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to the introduction of microbial pathogens

For the majority of saltmarsh communities there is insufficient information available to be able to make an assessment of their sensitivity to microbial pathogens.

*Note, in relation to '**noise and visual disturbance'**, that while Atlantic salt meadows and their associated plant communities have **high exposure** to both noise and visual disturbance, these habitats are **not sensitive** to these factors but they do provide a vitally important role as supporting habitats for waterfowl that use these areas for roosting and feeding and these are considered **highly sensitive** to both noise and*

visual disturbance – see sections 5.7.1 & 5.7.2). So while the habitats themselves have ***low vulnerability*** *their dependant bird species have high vulnerability.*

5.6.5 Reefs feature

5.6.5.1 Sensitivity

The **reefs** and their associated biological communities are **moderately to highly sensitive** to:

- **physical loss**
- **physical damage**

These result from a range of activities. Note that there is currently insufficient scientific information to assess the degree of sensitivity of reefs to **toxic** & **non-toxic contamination** and also to **biological disturbance**. In these cases, the precautionary principle has been applied with a **moderate level of sensitivity** being assumed until proven otherwise**.** Further details are provided in points i) to vii) below, with details of the level of sensitivity set out in Table 22.

5.6.5.2 Exposure

The **reefs** and associated biological communities are **moderately to highly exposed** to:

- **changes in suspended sediment**
- **toxic contamination(introduction of synthetic & non synthetic compounds)**
- **changes in nutrient loading**
- **changes in turbidity**
- **changes in salinity**
- **changes in oxygenation**
- **introduction of microbial pathogens**

The reefs of the Severn Estuary are biogenic in origin, that is, they are built by a concretion-forming organism creating elevated structures. The organism in this case is the honeycomb worm *Sabellaria alveolata.* These reefs occur both in the intertidal (where one might expect to find them) and, most unusually, in the subtidal. Indeed, the Severn Estuary has the only extensive subtidal *Sabellaria alveolata* reef in Britain. There has been little research undertaken on these subtidal *Sabellaria alveolata* reefs, so the scientific information on their sensitivities is extremely limited. In the advice given here, much has been drawn on the information known about subtidal reefs of the closely related *Sabellaria spinulosa*.

5.6.5.3 Vulnerability

The **reef** communities are **moderately to highly vulnerable** to:

i. Changes in suspended sediment

The reefs feature is currently considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in suspended sediment

The reduced availability of sand, essential for *S. alveolata* tube building, may lead to the reduced development of *S. alveolata* reefs and the decline of colonies. Increase in suspended sediment is unlikely to cause problems unless it leads to smothering of the reef. Activities likely to result in changes in suspended sediment would include those which would affect sediment availability or the water flow rate (coastal defences, development, construction and dredging).

ii. Toxic contamination

The **sensitivity** of *Sabellaria alveolata* to toxic contaminants (domestic effluent, industrial effluent, heavy metals, hydrocarbons) entering the water is **not known**. The precautionary principle should therefore be applied.

The reefs are considered to have **high exposure** to both synthetic compounds and non-synthetic compounds (industrial effluents, heavy metals, hydrocarbons etc.),

The reefs are therefore **moderately vulnerable** to the introduction of synthetic compounds and non-synthetic compounds .

iii. Changes in nutrient loading

The reefs feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in nutrients.

iv. Changes in salinity

The reefs feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in salinity.

Decreases in salinity within the Estuary are likely to result from heavy rain events and associated land/waterfront run-off and riverine inputs. The vast floodplain and catchment area of the Severn Estuary results in annual extreme flooding events and prolonged periods of freshwater input the estuary so the exposure is considered to be high.

v. Changes in oxygenation

The reefs feature is currently considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in oxygenation.

A cycle of changes in oxygenation occurs within the Severn as a result of both seasonal and tidal cycles and is linked to fluctuating sediment regimes. In addition occasional, intermittent oxygen sags occur in low salinity regions of the Severn and in some of the principal rivers feeding the Estuary.

vi. Introduction of microbial pathogens

Microbial pathogens are most likely to enter the Severn's ecosystem by means of sewage discharges. There is considered to be **high exposure** to microbial pathogens due to the high number of sewage discharges within the estuary.

For the majority of biological communities there is insufficient information available to be able to make an assessment of their sensitivity to microbial pathogens and there is currently no information on the sensitivity of *Sabellaria* reefs to the introduction of microbial pathogens. The vulnerability of the *Sabellaria* reefs therefore remains unknown and the precautionary principle should be applied.

vii. Introduction of non-native species

There is insufficient information on the sensitivity of reefs to introduction of non native species therefore the vulnerability is unknown.

5.6.6 Shad and lamprey features

(Note : this advice is also relevant to the Ramsar Site as these features are also part of the "assemblage of migratory fish species" for which the Ramsar Site has been designated – refer also to section 5.8)

Note that in the explanatory text that follows, the term 'shad and lamprey' refer to three species of migratory fish: twaite shad *Alosa fallax*, river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*.

As the populations of these migratory fish depend upon the freshwater habitats of the Rivers Usk, Wye and Severn as well as the estuarine habitats of the Severn Estuary during their lifetime, the advice presented here should be read in conjunction with the advice given for the River Usk SAC and the River Wye SAC (Management Plans and Conservation Objectives) available from CCW and Natural England on request.

5.6.6.1 Sensitivity

The **shad and lamprey** are considered **sensitive** to:

- **physical damage** of their supporting habitats
- **non-physical disturbance**
- **toxic contamination**
- **non-toxic contamination**
- **biological disturbance**

These result from a range of activities known to occur within the Estuary on which further details are provided in points i) to xi) below.

5.6.6.2 Exposure

The **shad and lamprey** and their supporting habitats (whilst within the Estuary) are **moderately to highly exposed** to:

- **noise** (part of 'noise and visual presence' but latter not applicable)
- **toxic contamination(introduction of synthetic & non synthetic compounds)**
- **changes in nutrient loading**
- **changes in thermal regime**
- **changes in turbidity**
- **changes in salinity**
- **changes in oxygenation**
- **introduction of microbial pathogens**

The Estuary provides an important migration route for these three rare species, to and from their spawning and nursery grounds. Shad and lamprey are known to be present in coastal and estuarine waters throughout the year, though there remains a lack of information on these migratory species during the time they actually spend in the Estuary. More information exists for the rivers where they migrate to spawn and for the subsequent development of juveniles. Little is known of their biology and distribution during the marine part of their life cycle.
In the assessments given below, it is assumed that these species would be capable of avoiding unsuitable areas, that is, given the size of the Estuary, localized activities are unlikely to adversely affect the population.

5.6.6.3 Vulnerability

Assessment of vulnerability of these features is particularly difficult given that there is little or no information to enable the level of sensitivity to be established. In line with the "precautionary principle" **where there is moderate to high exposure the feature is considered vulnerable.**

Therefore the **shad and lamprey** are considered **vulnerable** to:

i. Noise (part of 'noise and visual presence' but latter not applicable)
Research has shown that shad are sensitive to vibration which can arise from noisy activities. High frequency vibration (70 – 300Khtz) can be barrier to migration affecting movement both up and downstream and preventing fish reaching spawning areas. In some circumstances high frequency vibrations can be fatal. Vibration sources need to be assessed at the planning and consent stage and their potential impacts mitigated for, particularly during the key upstream migration phase.

ii. Toxic contamination
A decrease in water quality within the Estuary may impede the migration of these fish to their spawning grounds in the rivers. Poor water quality may also affect their supply of food. Shad require a good supply of small crustacean prey species, especially mysids and small fish (particularly clupeids). At sea, river lamprey feed on a variety of small fish such as clupeids, whilst sea lamprey feed on larger fish including salmon. Pollution tolerance levels of shad and lamprey are unknown, but EA water quality policy is that levels should comply with targets established under the EA Review of Consents and the Water Framework Directive.

iii. Changes in nutrient loading
It is possible that changes in nutrient levels may affect the food supply of the shad and lamprey. However, due to the natural high turbidity of the system and the volumes of water involved, it is thought that any effects would be minimal.
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iv. Changes in thermal regime
Water temperature is believed to act as a trigger for the shad to migrate upstream to spawn in the rivers. There could be changes in water temperature in the vicinity of the power stations (eg Hinkley Point and Oldbury) and from other discharges

v. Changes in turbidity
It is not known whether the migratory fish are sensitive to changes in turbidity within the Estuary. Given the extremely high background levels of turbidity, it is unlikely that any changes in turbidity will have any significant impact on the shad and lamprey whilst in the estuarine waters.

vi. Changes in salinity
Decreases in salinity within the Estuary are likely to result from heavy rain events and associated land/waterfront run-off and riverine inputs. The vast floodplain and catchment area of the Severn Estuary results in annual extreme flooding events and prolonged periods of freshwater input the estuary so the exposure is considered to be high. Within the Estuary, juvenile twaite shad prey on mysids feeding at the salt wedge near the head of the tide. It must be assumed that any activities affecting the salinity regime of the estuary would in turn affect the distribution of these prey species, which may have consequences for the shad.

vii. Changes in oxygenation
A cycle of changes in oxygenation occurs within the Severn as a result of both seasonal and tidal cycles and is linked to fluctuating sediment regimes. In addition occasional, intermittent oxygen sags occur in low salinity regions of the Severn and in some of the principal rivers feeding the Estuary. Shad and lamprey may therefore be vulnerable to changes in oxygenation given the high exposure to changes resulting from operations within the Estuary.

viii. Introduction of microbial pathogens

There is insufficient information available to make any meaningful assessment on the introduction of microbial pathogens to these species of fish, but there is potential for high exposure.

Note regarding 'changes in water flow rate'

It is thought unlikely that changes in water flow rate within the Estuary will affect these fish but they are likely to be affected (and therefore vulnerable) once in the rivers where water abstraction and freshwater flows may have more of a bearing.

Note regarding 'selective estraction of species'

After hatching in the rivers, young shad gradually move downstream into the upper estuary where they feed and mature until the end of their second summer before moving into coastal waters. Young shad feed on estuarine invertebrates while adult shad feed on mysids and other fish (particularly other clupeids such as sprat and herring). Both river and sea lamprey spend several years of development in riverine mud and then, after a relatively rapid metamorphosis, migrate downstream to the estuary. River lamprey feed on a variety of estuarine fish, particularly herring, sprat and flounder. At sea, sea lamprey feed on larger fish including large salmon.

Extraction of target species - it is reported that twaite shad are vulnerable to capture on cooling water intakes, particularly those associated with power stations, where the numbers killed can be considerable.

Extraction on non target species - the shad and lamprey may be vulnerable to the extraction of their prey species (levels unknown) affecting their feeding behavior and patterns and long-term survival.

Table 22 Sensitivity, exposure and vulnerability of the Severn Estuary SAC to physical, chemical and biological pressures

Sensitivity		Exposure		Vulnerability	
High sensitivity	OOO O	High Exposure	××××	High vulnerability	⊗⊗⊗⊗ ⊗⊗⊗O ⊗⊗⊗×
Moderate sensitivity	OOO	Medium Exposure	×××	Moderate vulnerability	⊗⊗OO ⊗⊗×× ⊗⊗⊗
Low sensitivity	OO	Low Exposure	××	Low vulnerability	⊗⊗O ⊗⊗× ⊗⊗ ⊗××× ⊗×× ⊗×
No detectable sensitivity	O	No exposure	×	No vulnerability	⊗O
?S =Insufficient information on sensitivity; ✓ = migratory fish considered to be sensitive, but insufficient information to assess level of sensitivity				Unknown vulnerability	

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Categories of operations which may cause deterioration or disturbance[25]	**Annex I features**					**Annex II species**
	Estuaries	**Subtidal Sandbanks**	**Mudflats & sandflats**	**Atlantic saltmeadow**	**Reefs**	**Fish**[26]
Physical loss						
Removal / substratum loss	⊗⊗⊗⊗	⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗O	⊗×
Smothering	⊗⊗⊗O	⊗⊗×	⊗⊗⊗	⊗⊗⊗O	⊗⊗	⊗×
Physical damage						
Changes in suspended sediment	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗	⊗×
Desiccation & changes in emergence regime	⊗⊗O	⊗O	⊗⊗O	⊗⊗OO	⊗O	✓××
Changes in water flow rate	⊗⊗⊗×	⊗⊗O	⊗⊗⊗×	⊗⊗⊗×	⊗⊗O	✓××
Changes in wave exposure	⊗⊗⊗⊗	⊗⊗O	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗O	⊗×
Abrasion / physical disturbance (of habitats)	⊗⊗⊗×	⊗⊗×	⊗⊗⊗×	⊗⊗⊗×	⊗⊗O	✓××
Changes in grazing management	⊗⊗	Not relevant	Not relevant	⊗⊗⊗⊗	Not relevant	Not relevant
Non-physical disturbance						
Noise & visual presence	⊗××	⊗××	⊗⊗×	⊗×××	⊗×	✓×××
Toxic contamination						
Introduction of synthetic compounds	⊗⊗⊗×	⊗⊗⊗×	⊗⊗⊗⊗	⊗⊗⊗×	⊗⊗××	✓××××
Introduction of non-synthetic compounds	⊗⊗⊗×	⊗⊗⊗×	⊗⊗⊗⊗	⊗⊗⊗⊗	?S××××	✓××××
Introduction of radionuclides	?S××	?S××	?S××	?S××	?S××	✓××
Non-toxic contamination[27]						
Changes in nutrient loading	⊗⊗⊗⊗[28]	⊗⊗××	⊗⊗⊗×	⊗⊗⊗×	⊗⊗××	✓××××
Changes in thermal regime	⊗⊗⊗	⊗⊗	⊗⊗⊗	⊗⊗	⊗⊗	✓××××
Changes in turbidity[29] (light penetration)	⊗⊗×	⊗⊗×	⊗⊗×	⊗×	⊗××	✓×××
Changes in salinity	⊗⊗⊗×	⊗⊗⊗×	⊗⊗××	⊗⊗⊗×	⊗⊗××	✓××××
Changes in oxygenation	⊗⊗⊗×	⊗⊗××	⊗⊗××	⊗⊗××	⊗⊗××	✓××××
Biological disturbance						
Introduction of microbial pathogens	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗××	?S××××	✓××××
Introduction of non-native species	⊗⊗⊗O	⊗⊗O	⊗⊗OO	⊗⊗	?S××	✓××
Selective extraction of species	⊗⊗⊗×	⊗⊗	⊗⊗	⊗⊗	⊗⊗	✓××

[25] For a further explanation of each category see http://www.marlin.ac.uk/sah/baskitemplate.php?benchmarks
[26] River lamprey, sea lamprey & twaite shad
[27] All elements of non toxic contamination are interrelated and also link closely with changes in suspended sediment (physical damage)
[28] The high natural turbidity of the estuary negates these high levels with algal productivity being generally low – the estuary feature is therefore not considered vulnerable – see section 5.6.1.3.(viii)
[29] Turbidity here incorporates light penetration; suspended sediment under 'changes in suspended sediment' and its deposition under 'smothering'

5.7 Specific Advice on Operations for the Severn Estuary SPA

This section provides information to help relate general advice to each of the specific interest features of the Severn Estuary SPA. Where specific examples are given they are provided to aid understanding of possible impacts and are not intended to be a comprehensive list of all relevant operations.

This advice relates to the vulnerability of the interest features and supporting habitats of the Severn Estuary SPA as set out in Table 23. An explanation of the sensitivity of the interest features or supporting habitats follows with an explanation of their exposure and therefore their vulnerability to damage or disturbance from the listed categories of operations. This enables links between the categories of operation and the ecological requirements of the SPA's interest features (as set out in Section 2.2) to be made. It should be noted that sensitivity scorings are a combination of whether the habitat itself is likely to be affected by a particular operation (which is drawn from the SAC scores in Table 22), in combination with an assessment as to whether the outcome is likely to affect the bird's use of that habitat.

Note that this advice for the SPA supercedes that issued to ASERA in February 2005 following reassessment of exposure, sensitivity and vulnerability to take account of availability of new information in the Severn Estuary CHaMP and MarLIN sensitivities and following the more detailed analysis of impacts on the SAC estuarine habitats that are supporting habitats for the birds of the SPA.

5.7.1 Internationally important populations of regularly occurring Annex 1 species (Bewick's swan)

(Note : this advice is also relevant to the Ramsar Site's internationally important population of waterfowl "Bewick's swan" feature and as part of the "internationally important assemblage of waterfowl" feature for which the Ramsar Site has been designated – refer also to section 5.8)

5.7.1.1 Sensitivity

The Annex 1 species is **moderately to highly sensitive** to :

- **Physical loss**
- **Physical damage**
- **Non-physical disturbance**
- **Toxic contamination**
- **Non- toxic contamination**
- **Biological disturbance**

These result from a range of activities known to occur within the Estuary. Further details are provided in points i) to xii) below, with details of the level of sensitivity set out in Table 23.

5.7.1.2 Exposure

The Annex 1 species is **moderately to highly exposed** to:

- **Substratum loss and smothering**
- **Changes in suspended sediment**
- **Desiccation and changes in emergence regime**
- **Changes in water flow**
- **Changes in wave exposure**
- **Changes in grazing regime**
- **Noise and visual disturbance**
- **Toxic contamination**
- **Changes in nutrient loading**
- **Changes in salinity**
- **Changes in oxygenation**
- **Introduction of microbial pathogens**

5.7.1.3 Vulnerability

The Annex 1 species is **moderately to highly vulnerable** to:

i. Substratum loss and smothering

The intertidal habitats and therefore the Bewick's Swan feature which these habitats support are considered to have **moderate to high sensitivity** and **moderate to high exposure** and therefore **moderate to high vulnerability** to physical loss (removal and smothering).

The physical loss of areas of intertidal habitats may be caused directly through change of land use or indirectly as a consequence of changes to sedimentation processes (e.g. coastal defences) as well as via the effects of smothering by artificial structures (e.g. jetties) or the disposal of spoils. Activities or developments resulting in physical loss of the intertidal supporting habitats are likely to reduce the availability of food and roosting habitat and thus be detrimental to the favourable condition of the SPA interest features including the Annex 1 species, Bewick's swan. The intertidal mudflats and sandflats and the saltmarsh are highly sensitive to removal by land reclamation and major construction activities.

ii. Changes in suspended sediment

It is thought unlikely that changes in the suspended sediment within the Estuary will affect the Bewick's Swan directly but such changes may have marked effects on the supporting habitats on which they are dependant for roosting and feeding. The saltmarshes and intertidal mudflats and sandflats are currently considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in suspended sediments . (Refer also to sections 5.6.3 and 5.6.4). Impacts on the suitability of these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

iii. Desiccation and changes in emergence regime

It is thought unlikely that changes in the emergence regime within the Estuary will affect the Bewick's Swan directly but such changes may have marked effects on the supporting habitats on which they are dependant for roosting and feeding. The saltmarshes are currently considered to have **high sensitivity** and **low exposure** and therefore **moderate vulnerability** to desiccation and changes in emergence regime. (Refer also to section 5.6.4.) Impacts on the suitability of these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

iv. Changes in water flow rate

It is thought unlikely that changes in water flow rate within the Estuary will affect the Bewick's Swan directly but such changes may have marked effects on the supporting habitats on which they are dependant for roosting and feeding. The saltmarshes and intertidal mudflats and sandflats of the estuary are considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in water flow rate . (Refer also to sections 5.6.3 and 5.6.4). Impacts on the suitability of these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

v. Changes in wave exposure

It is thought unlikely that changes in wave exposure within the Estuary will affect the Bewick's Swan directly but such changes may have marked effects on the supporting habitats on which they are dependant for roosting and feeding. The saltmarshes and intertidal mudflats and sandflats of the estuary are considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in water flow rate . (Refer also to sections 5.6.3 and 5.6.4). . Impacts on the extent and suitability of these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

vi. Changes in grazing management

The Bewicks Swan feature, which is dependent on the saltmarsh habitats, is considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in grazing management.

The vegetation composition of saltmarsh habitats can be altered by changes in grazing management. This can affect the palatability of the sward for grazing Bewick's swans and therefore affect the availability of adequate preferred feeding areas within the SPA. There are critical areas for this species located at the Dumbles in the uppermost part of the estuary all of which are grazed.

vii. Noise and visual presence

Overwintering birds are disturbed by sudden movements and sudden noises. This can displace the birds from their feeding grounds. Disturbance can prevent the birds from feeding and in response they either a) decrease their energy intake at their present (disturbed) feeding site through displacement activity, or b) move to an alternative less favoured feeding site. Such a response affects energy budgets and thus survival. There is intermittent disturbance from both the landward and seaward side of the site. Bewick's swans are mainly affected by disturbance from the landward side and any increase in disturbance should be avoided. At present the Annex 1 species are **moderately vulnerable** to noise and visual disturbance on the intertidal mudflats and sandflats and have a **high vulnerability** to this category of operation on the saltmarsh.

viii. Toxic contamination through the introduction of synthetic and/or non-synthetic compounds

Waterfowl are subject to the accumulation of toxins through the food chain or through direct contact with toxic substances when roosting or feeding. Their ability to feed can also be affected by the abundance or change in palatability of their prey caused by toxic contamination. At the moment there is no evidence to show that this is the case, but the estuary is vulnerable to oil spills and there is a continuous discharge of toxins into the estuary,

some of which bind to the sediments. This is an area which requires further assessment and is likely to be addressed by work arising from both the Water Framework Directive and ongoing Review of Consents by the Environment Agency. The Bewick's swans has a **moderate vulnerability** to toxic contamination.

ix. **Changes in nutrient loading**

Changes in organic or nutrient loading can change the species composition of the plants on the saltmarsh and thus the structure of the sward. This could affect the palatability of the sward for grazing Bewick's swans and therefore affect the availability of adequate preferred feeding areas within the SPA. There are critical areas for this species located at the Dumbles in the uppermost part of the estuary all of which are grazed.

x. Changes in salinity

It is thought unlikely that changes in salinity within the Estuary will affect the Bewicks Swan feature directly but such changes may have marked effects on the supporting saltmarsh habitats on which this species are dependant for feeding. The saltmarshes of the estuary are considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in salinity. Impacts on these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

xi. Changes in oxygenation

It is thought unlikely that changes in oxygenation within the Estuary will affect the Bewicks Swan feature directly but such changes may have an effect on the community composition of supporting saltmarsh habitats on which this species are dependant for feeding. The saltmarshes of the estuary are considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in oxygenation. Impacts on these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

xii. Introduction of microbial pathogens

Bewicks swan is considered to have **low sensitivity** and **high exposure** (due to the high number of sewage discharges) and therefore **moderate vulnerability** to the introduction of microbial pathogens.

Microbial pathogens are most likely to enter the Severn's ecosystem by means of sewage discharges. Bewicks swans on their feeding or roosting grounds may be affected by direct infection by pathogens (bacteria or viruses) present in the water or river sediments and through the release of endo or exotoxins bacterial toxins. Infection may cause mortality, loss of condition and behavioural changes in individuals and within the population using the site through onward contamination.

5.7.2 Internationally important waterfowl assemblage including populations of regularly occurring migratory species

(Note : this advice is also relevant to the Ramsar Site's "internationally important populations of waterfowl" features and the "internationally important assemblage of waterfowl" feature for which the Ramsar Site has been designated – refer also to section 5.8)

5.7.2.1 Sensitivity

The Internationally important waterfowl assemblage including populations of regularly occurring migratory species is **moderately to highly sensitive** to:

- **Physical loss**
- **Physical damage**
- **Non-physical disturbance**
- **Toxic contamination**
- **Non-Toxic contamination**
- **Biological disturbance**

These result from a range of activities known to occur within the Estuary. Further details are provided in points i) to xvi) below, with details of the level of sensitivity set out in Table 23.

5.7.2.2 Exposure

The Internationally important waterfowl assemblage including populations of regularly occurring migratory species is **moderately to highly exposed** to:

- **Substratum loss and smothering**
- **Changes in suspended sediment**
- **Desiccation and changes in emergence regime**
- **Changes in water flow**
- **Changes in wave exposure**
- **Abrasion and physical disturbance**
- **Grazing management**
- **Noise and visual disturbance**
- **Toxic contamination**
- **Changes in nutrient loading**
- **Changes in thermal regime**
- **Changes in salinity**
- **Changes in oxygenation**
- **Introduction of microbial pathogens**
- **Introduction of non-native species**
- **Selective extraction of species**

5.7.2.3 Vulnerability

The Internationally important waterfowl assemblage including populations of regularly occurring migratory species has **moderate to high vulnerability** to:

i. Substratum loss and smothering

The intertidal habitats and therefore the waterfowl assemblage feature which these habitats support are considered to have **moderate to high sensitivity** and **moderate to high exposure** and therefore **moderate to high vulnerability** to physical loss (substratum loss and smothering).

The physical loss of areas of intertidal habitats may be caused directly through change of land use or indirectly as a consequence of changes to sedimentation processes (e.g. coastal defences) as well as via the effects of smothering by artificial structures (e.g. jetties) or the disposal of spoils. Activities or developments resulting in

physical loss of the intertidal supporting habitats are likely to reduce the availability of food and roosting habitat and thus be detrimental to the favourable condition of the SPA interest features including all the migratory species and waterfowl assemblage. The intertidal mudflats and sandflats and the saltmarsh are highly sensitive to removal by land reclamation and major construction activities.

Eelgrass beds (which are a food source for some species of the assemblage) are being affected by siltation due to changes in sediment movement after construction of the Second Severn Crossing which has resulted in smothering.

ii. Changes in suspended sediment

It is thought unlikely that changes in the suspended sediment within the Estuary will affect the waterfowl assemblage directly but such changes may have marked effects on the supporting habitats on which they are dependant for roosting and feeding.. (Refer also to sections 5.6.1, 5.6.3 and 5.6.4). The supporting habitats are all are currently considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to desiccation and changes in emergence regime. Impacts on the suitability of these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

iii. Desiccation and changes in emergence regime

It is thought unlikely that changes in the emergence regime within the Estuary will affect the waterfowl assemblage directly but such changes may have marked effects on the supporting habitats on which they are dependant for roosting and feeding.. (Refer also to sections 5.6.1, 5.6.3 and 5.6.4). The saltmarshes are currently considered to have **high sensitivity** and **low exposure** and therefore **moderate vulnerability** to desiccation and changes in emergence regime. Impacts on the suitability of these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

iv. Changes in water flow rate

It is thought unlikely that changes in water flow rate within the Estuary will affect the designated bird species of the assemblage directly but such changes may have marked effects on the supporting habitats on which these species are dependant for roosting and feeding. All the supporting habitats are considered to have **moderate sensitivity** and **high exposure** and therefore **high vulnerability** to changes in water flow rate . (Refer also to sections 5.6.1, 5.6.3 and 5.6.4). Impacts on the suitability of these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

v. Changes in wave exposure

It is thought unlikely that changes in wave exposure within the Estuary will affect the designated bird species of the assemblage directly but such changes may have marked effects on the supporting habitats on which these species are dependant for roosting and feeding. All the supporting habitats are considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in water flow rate . (Refer also to sections 5.6.1, 5.6.3 and 5.6.4). Impacts on the extent and suitability of these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

vi. Abrasion and physical disturbance

Saltmarsh may be physically damaged from overgrazing or eroded when boats are moored on it and when paths are worn through it to reach moored boats on foot or via vehicles. Currently all supporting habitats are considered to be moderately vulnerable to abrasion. Intertidal habitats are **highly sensitive** to damage by direct and indirect effects of aggregate dredging. The intertidal mudflats and sandflats and the shingle and rocky shore are therefore considered **highly vulnerable** to selective extraction.

vii. Changes in grazing management

The waterfowl assemblage which is in part dependant on the saltmarsh habitats is considered to have **high sensitivity** and **high exposure** and therefore **high vulnerability** to changes in grazing management.

The vegetation composition of saltmarsh habitats can be altered by changes in grazing management. This can affect the palatability of the sward for grazing wildfowl and availability of invertebrate food sources and therefore affect the availability of adequate preferred feeding areas within the SPA. Grazing changes may also

affect the suitability saltmarsh areas as resting and roosting sites for birds where open terrain with low vegetation is an important factor.

viii. Noise or visual disturbance

Overwintering birds are disturbed by sudden movements and sudden noises. This can have the effect of displacing the birds from their feeding grounds. Disturbance can prevent the birds from feeding and in response they either a) decrease their energy intake at their present (disturbed) feeding site through displacement activity, or b) move to an alternative less favoured feeding site. Such a response affects energy budgets and thus survival. There is intermittent disturbance to the internationally important migratory species and the waterfowl assemblage from both the landward and seaward side of the site which has increased in recent years, due to the estuary becoming more populated and the development of all weather recreational pursuits. All supporting habitats are currently **highly vulnerable** to noise and visual disturbance.

ix. Toxic contamination through the introduction of synthetic and/or non-synthetic compounds

Waterfowl are subject to the accumulation of toxins through the food chain or through direct contact with toxic substances when roosting or feeding. Their ability to feed can also be affected by the abundance or change in palatability of their prey caused by toxic contamination. At the moment there is no evidence to show that this is the case on the Severn Estuary, but the estuary is vulnerable to oil spills and there is a continuous discharge of toxins into the estuary, some of which bind to the sediments. This is an area that requires further assessment. The intertidal mudflats and sandflats and the saltmarsh are currently **highly vulnerable** to the introduction of synthetic and non-synthetic compounds.

x. Changes in nutrient loading

Changes in organic or nutrient loading can change the species composition of the plants on the saltmarsh and thus the structure of the sward. Increases in nutrients can cause excessive algal growth on the mudflats, denying the birds access to their invertebrate prey and changing the invertebrate species composition in the sediment. However, high nutrient loads can also be beneficial to some species of birds by increasing the density and size of prey items. Though the water quality has been improved in recent years there are still local areas of concern. On balance, any increase in nutrient loading should be avoided. At present the intertidal mudflats and sandflats are **moderately vulnerable** to this category of operation.

xi. Changes in thermal regime

It is thought unlikely that changes in the thermal regime within the Estuary will affect the designated bird species of the assemblage directly but such changes may have marked effects on the community composition of supporting habitats on which these species are dependant for feeding. The intertidal mudflats and sandflats of the estuary are considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to changes in thermal regime. Impacts on these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

xii. Changes in salinity

It is thought unlikely that changes in salinity within the Estuary will affect the waterfowl assemblage feature directly but such changes may have marked effects on the supporting habitats on which these species are dependant for feeding. The saltmarshes, intertidal mudfalts and sand flats and hard substrate habitats (rocky shores) of the estuary are considered to have **low to moderate sensitivity** and **high exposure** and therefore **moderate to high vulnerability** to changes in salinity. Impacts on these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

xiii. Changes in oxygenation

It is thought unlikely that changes in oxygenation within the Estuary will affect the waterfowl assemblage feature directly but such changes may have marked effects on the community composition of supporting habitats on which these species are dependant for feeding. The saltmarshes, intertidal mudfalts and sand flats and hard substrate habitats (rocky shores) of the estuary are considered to have **low sensitivity** and **high exposure** and therefore **moderate vulnerability** to changes in oxygenation. Impacts on these habitats may affect the long term survival of individuals (in terms of energy and competition) or alter behavior and patterns of use or distribution.

xiv. Introduction of microbial pathogens

The bird assemblage is considered to have **low to high sensitivity** and **high exposure** (due to the high number of sewage discharges) and therefore **moderate vulnerability** to the introduction of microbial pathogens.

Microbial pathogens are most likely to enter the Severn's ecosystem by means of sewage discharges. Waterfowl may be affected by microbial pathogens (bacteria or viruses) on their feeding or roosting grounds and are considered to be particularly highly exposed when feeding and roosting on the intertidal mudflats and sandflats and hard substrate habitats where there may be bioaccumulation of pathogens within food sources (filter feeding organisms). Birds may also be affected by direct infection by pathogens present in the water or river sediments and through the release of endo or exotoxins bacterial toxins. Infection may cause mortality, loss of condition and behavioural changes in individuals and within the population using the site through onward contamination.

xv. Introduction of non-native species

The birds assemblage is considered to have **high sensitivity** and **low exposure** and therefore **moderate vulnerability** to the introduction of non native species.

The saltmarsh cordgrass *Spartina anglica* is an invasive pioneer species whose rapid growth consolidates sediment, raises mudflats and reduces sediment availability elsewhere. This expansion can affect areas of intertidal habitats (mud and sandflats and hard substrate habitats) which are key habitats for roosting and feeding birds. Such expansion is regarded as being a potential threat to intertidal beds of eelgrass *Zostera noltei* in particular which are a food source for some species within the assemblage (Wigeon and European white-fronted goose). However, whilst recognising *S. anglica* as an invasive species, it also has a role in saltmarsh formation and the community SM6 in which it features should be allowed to develop into other Atlantic Salt Meadow or transitional communities which are also of value as feeding and roosting habitats for birds within the assemblage.

The presence of another non-native, the slipper limpet *Crepidula fornicata*, in large numbers may alter the species composition within certain soft mud habitats leading to a decline in overall species richness and consequent implications on food availability for feeding birds. However, *C. fornicata* has yet to penetrate the Estuary, possibly due to the strong water flows.

xvi. Selective extraction of species

The birds assemblage is considered to have **moderate sensitivity** and **moderate exposure** and therefore **moderate vulnerability** to the selective extraction of species.

Wildfowling is carried out all around the estuary. It is believed that there is currently no direct detrimental effect on the overall bird populations but wildfowling is one of many activities that may be contributing (through disturbance) to the decline in some species on the Severn. Continuing monitoring and regulation of wildfowling is achieved by the countyside agencies and through the management of wildfowling by a British Association of Shooting and Conservation (BASC) affiliated associations, applying the BASC wildfowlers code of conduct.

Bait digging is also carried out in localised areas of the mid and outer estuary. Extensive areas of digging can change the availability of prey in the sediment as the area needs a period of recovery and recolonisation. There is currently no evidence that existing levels of activity is detrimental to the birds on the European Marine Site.

The removal of strandline vegetation by beach cleaning removes an important habitat for invertebrates, as well as many of the invertebrates themselves, reducing the quantity and variety of prey available to the birds. Much of the saltmarsh is managed by grazing and changes in management can alter the availability of prey and suitability of roosting sites.

Table 23 Sensitivity, exposure and vulnerability of the Severn Estuary SPA to physical, chemical and biological pressures *(See note in section 5.7 on changes to this table since version issued in1995.)*

Sensitivity		Exposure		Vulnerability	
High sensitivity	OOOO	High Exposure	××××	High vulnerability	⊗⊗⊗⊗ ⊗⊗⊗O ⊗⊗⊗×
Moderate sensitivity	OOO	Medium Exposure	×××	Moderate vulnerability	⊗⊗OO ⊗⊗× × ⊗⊗⊗
Low sensitivity	OO	Low Exposure	××	Low vulnerability	⊗⊗O ⊗××× ⊗⊗× ⊗×× ⊗⊗ ⊗×
No detectable sensitivity	O	No exposure	×	No vulnerability	⊗O
?S =Insufficient information on sensitivity				Unknown vulnerability	

Categories of operations which may cause deterioration or disturbance	Internationally important populations of regularly occurring Annex 1 species		Internationally important migratory species and waterfowl assemblage		
	Intertidal mudflats and sandflats	Saltmarsh	Intertidal mudflats and sandflats	Saltmarsh	Hard substrates
Physical Loss					
Removal/substratum loss	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗
Smothering	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗
Physical Damage					
Changes in suspended sediment	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗
Desiccation and changes in emergence regime	⊗⊗O	⊗⊗OO	⊗⊗O	⊗⊗OO	⊗⊗O
Changes in water flow	⊗⊗⊗×	⊗⊗⊗×	⊗⊗⊗×	⊗⊗⊗×	⊗⊗⊗×
Changes in wave exposure	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗
Abrasion / physical disturbance (of habitats)	⊗⊗	⊗⊗O	⊗⊗⊗⊗	⊗⊗⊗×	⊗⊗⊗×
Grazing management	Not relevant	⊗⊗⊗⊗	Not relevant	⊗⊗⊗⊗	Not relevant
Non-physical disturbance					
Noise & visual presence	⊗⊗OO	⊗⊗⊗O	⊗⊗⊗O	⊗⊗⊗⊗	⊗⊗⊗O
Toxic contamination					
Introduction of synthetic compounds	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗×	⊗⊗⊗×
Introduction of non-synthetic compounds	⊗⊗⊗	⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗×
Introduction of radionuclides	**?S××**	**?S××**	**?S××**	**?S××**	**?S××**
Non-toxic contamination					
Changes in nutrient loading	⊗×××	⊗⊗⊗×	⊗⊗⊗×	⊗⊗⊗×	⊗⊗××
Changes in thermal regime	⊗×	⊗⊗	⊗⊗⊗	⊗⊗	⊗⊗
Changes in turbidity (light penetration)	⊗××	⊗×	⊗⊗×	⊗×	⊗⊗×
Changes in salinity	⊗×××	⊗⊗⊗×	⊗⊗××	⊗⊗⊗×	⊗⊗××
Changes in oxygenation	⊗×××	⊗⊗××	⊗⊗××	⊗⊗××	⊗⊗××
Biological disturbance					
Introduction of microbial pathogens	⊗⊗××	⊗⊗××	⊗⊗⊗⊗	⊗⊗××	⊗⊗⊗⊗
Introduction of non-native species	⊗×	⊗⊗	⊗⊗OO	⊗⊗	⊗⊗OO
Selective extraction of species	⊗⊗O	⊗⊗O	⊗⊗⊗	⊗⊗⊗	⊗××

5.8 Specific Advice on Operations for the Severn Estuary Ramsar Site

Separate advice for the Ramsar Site features has not been produced here as it repeats the advice given in the previous sections (5.6 and 5.7) for the SAC and SPA respectively due to the overlapping nature of the Ramsar features. The following table therefore cross references the features of these designations and provides a direct reference to the section where advice relevant to the Ramsar features can be found.

Table 24 Cross reference table relating features of the Ramsar Site to the advice on operations for the SAC and SPA

Ramsar interest features	**Relevant SAC and SPA features and supporting habitats**	**Reference section for advice on operations relevant to the Ramsar features**
Ramsar Interest feature 1 : **Estuaries**	**SAC: Annex I habitats** Estuaries Intertidal mudflats and sandflats Atlantic Salt Meadows	 Section 5.6..1 & Table 22 Section 5.6.3 & Table 22 Section 5.6.4 & Table 22
Ramsar Interest feature 2 : **Migratory fish assemblage**	**SAC : Annex II species** River lamprey *Lampetra fluviatilis*; Sea lamprey *Petromyzon marinus*; Twaite shad *Alosa fallax*	 Section 5.6.6 & Table 22 Section 5.6.6 & Table 22 Section 5.6.6 & Table 22
Internationally important populations of waterfowl *Ramsar Interest feature 3:* **Bewick's swan** *Ramsar Interest feature 4:* **European white-fronted goose** *Ramsar Interest feature 5:* **Dunlin** *Ramsar Interest feature 6:* **Redshank** *Ramsar Interest feature 7:* **Shelduck** *Ramsar Interest feature 8:***Gadwall**	**SPA : Internationally important populations of regularly occurring Annex 1 species (Bewick's swan)** SPA: **Internationally important populations of regularly occurring migratory species (same species as column to left)** **Supporting habitats** Intertidal mudflats and sandflats Saltmarsh Hard substrates .	Section 5.7.1 & Table 23 Section 5.7.2 & Table 23 Section 5.6.3 & Table 22 Section 5.6.4 & Table 22
Ramsar Interest feature 9 **Internationally important assemblage of waterfowl**	SPA: **Internationally important assemblage of waterfowl** **Supporting habitats** Intertidal mudflats and sandflats Saltmarsh Hard substrates	Section 5.7.2 & Table 23 Section 5.6.3 & Table 22 Section 5.6.4 & Table 22

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7. Glossary

Advisory Group	The body of the representatives from local interests, user groups and conservation groups, formed to advise the management group
Annex 1 Bird species	The species listed in Annex 1 of the Birds Directive are the subject of special conservation measures concerning their habitat. These measures ensure the survival and reproduction of the birds in their area of distribution. Species listed on Annex 1 are in danger of extinction, rare or vulnerable
Annex I habitat type(s)	A natural habitat(s) listed in Annex I of the Habitats Directive for which Special Areas of Conservation can be selected.
Annex II species	A species listed in Annex II of the Habitats Directive for which Special Areas of Conservation can be selected.
Annex V	The listing, in the Habitats Directive, of the animal and plant species whose taking in the wild and exploitation may be subject to management measures.
Assemblage	A collection of plants and/or animals characteristically associated with a particular environment.
Attribute	Characteristic of an interest feature or supporting habitat which provides an indication of the condition of the feature or supporting habitat to which it applies.
BASC	British Association of Shooting and Conservation
Benthos	Those organisms attached to, or living on, in or near, the seabed, including that part which is exposed by tides.
Birds Directive	The abbreviated term of *Council Directive* 79/409/*EEC of 1979 on the conservation of wild birds.*
Biodiversity	The total variety of life on earth. This includes diversity within species, between species and ecosystems.
Biotope	The physical habitat with its biological community; a term which refers to the combination of physical environment and its distinctive assemblage of conspicuous species.
BTO	British Trust for Ornithology
CCW	Countryside Council for Wales
Characteristic	Special to, or especially abundant in, a particular situation or biotope. Characteristic species should be immediately conspicuous and easily identified.
Community	A group or organisms occurring in a particular environment, presumably interacting with each other and with the environment, and identifiable by means of ecological survey from other groups.
Competent authority	Any Minister, government department, public or statutory undertaker, public body or person holding a public office that exercises legislative powers.
Conservation objective	A statement of the nature conservation aspirations for a site, expressed in terms of the favourable condition that we wish to see the species and/or habitats for which the site has been selected to attain. Conservation objectives for European Marine Sites relate to the aims of the Habitats Directive.
DEFRA	Department for Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions
Epifauna	Benthic animals living on the seabed.
EN	English Nature (now incorporated into Natural England).
Eulittoral	The main part of the intertidal zone characterised by limpets, barnacles, mussels, fucoid algae and with red algae often abundant on the lower part.

European Marine Site	A European site which consists of, or in so far as it consists of, areas covered intermittently or continuously by seawater.
European Site	A classified SPA, designated SAC, site of Community importance (a site selected as a candidate SAC, adopted by the European Commission but not yet designated), a candidate SAC (in England only) or a site hosting a priority species in respect of which Article 5 of the Habitats directive applies.
Favourable condition	The condition represented by the achievement of the conservation objectives, in other words the desired condition for a designated habitat or a species on an individual site.
Favourable conservation status (FCS)	A range of conditions for a natural habitat or species at which the sum of the influences acting upon that habitat or species are not adversely affecting its distribution, abundance, structure or function throughout the EC in the long term. The condition in which the habitat or species is capable of sustaining itself on a long-term basis.
Habitat	The place in which a plant or animal lives.
Habitats Directive	The abbreviated term of *Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora.* It is the aim of this Directive to promote the conservation of certain habitats and species within the European Union.
Habs Regs	The Conservation (Natural Habitats &c.) Regulations 1994.
HAT	Highest Astronomical Tide.
Infauna	Benthic animals which live within the sediment.
Infralittoral	The subtidal zone in which upward facing rocks are dominated by erect algae, typically kelps.
Interest feature	A natural or semi-natural feature for which a European site has been selected. This includes any Habitats Directive Annex I habitat, or any Annex II species and any population of a bird species for which an SPA has been designated under the Birds Directive.
JNCC	Joint Nature Conservation Committee.
Maintain	The action required for an interest feature when it is considered to be in favourable condition.
Management group	The body of relevant authorities formed to manage the European Marine Site.
Management scheme	The framework established by the relevant authorities at a European Marine Site under which their functions are exercised to secure, in relation to that site, compliance with the requirements of the Habitats Directive.
MNR	Marine Nature Reserve.
Nationally scarce/rare	For marine purposes, these are regarded as species of limited national occurrence.
Natura 2000	The European network of protected sites established under the Birds Directive and the Habitats Directive.
NNR	National Nature Reserve.
Notable species	A species that is considered to be notable due to its importance as an indicator, and may also be of nature conservation importance, and which is unlikely to be a 'characteristic species.'
Operations which may cause deterioration or disturbance	Any activity or operation taking place within, adjacent to, or remote from a European Marine Site that has the potential to cause deterioration to the natural habitats for which the site was designated, or disturbance to the species and its habitats for which the site was designated.
PCB	Polychlorinated Biphenyls.

Peak mean counts (5 yr)	The Severn Estuary is broken down into count sectors. Over the winter months WeBS volunteers count all the birds which are visible within each sector. The yearly figures for each species in the Severn Estuary are then averaged over a five year period to give the 5 yr peak mean count.
Plan or project	Any operation that is within a competent authority's (including relevant authorities) function to control, or over which a competent authority (including relevant authorities) has a statutory function to decide on applications for consents, authorisations, licences or permissions. There is no generally accepted definition of the term "plan or project". This definition may be subject to review and may require further discussion in the context of developing a management scheme for the Severn Estuary SPA.
Ramsar	Site designated under the 1971 Ramsar Convention as a wetland of international importance.
Relevant authority	The specific competent authority which has powers or functions which have, or could have, an impact on the marine environment, or adjacent to, a European Marine Site.
Reporting period	The cycle within which a definitive report on the condition of features protected within the site series will be produced, set as once in every 6 years.
Restore	The action required for an interest feature when it is not considered to be in a favourable condition.
SAC	Special Area of Conservation.
Sensitivity	The intolerance of a habitat, community or individual species to damage from an external force.
SPA	Special Protection Area for birds.
SSSI	Site of Special Scientific Interest.
Strandline	The organic matter particularly rotting seaweed deposited by the tide anywhere along the intertidal.
Supporting Habitats	The key habitats within the European Marine Site necessary to support the interest feature.
TAN 5	Planning Guidance (Wales) Technical Advice Note (TAN)5: Nature Conservation and Planning (Welsh Assembly Government)
TBT	Tri-butyl tin
Vulnerability	The exposure of a habitat, community or individual of a species to an external factor to which it is sensitive.
WeBS	Wetland Bird Survey: a collaborative national surveillance scheme of the UK's waterfowl based on counts undertaken once per month outside of the breeding season.
WWT	Wildfowl & Wetlands Trust