ENGLISH NATURE

Morecambe Bay
European marine site

English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994

Issued 14 January 2000

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Acknowledgments

English Nature would like to acknowledge the assistance from the following people who have provided advice at various times to help prepare parts of this package:

John Hetherington (Cumbria County Council)
Jim Andrews (North Western & North Wales Sea Fisheries Committee)
Captain John Green (Associated British Ports)
Richard Greenwood (South Lakeland District Council)
Judy Palmer (Cumbria County Council)
Joyce Holden (Lancashire County Council)
Mike Parker (MAFF)
Susannah Bleakley (Morecambe Bay Partnership)
Colin Hurst (Wyre Borough Council)
Phil Huck (Barrow Borough Council)
Julian Inman (Lancaster City Council)
Steve Garner (Environment Agency)
Ed Mycock (Environment Agency)
Andrew Withers (Environment Agency)
Alan Chester (North West Water)
Bill Cook (North Western and North Wales Sea Fisheries Committee)
Richard Scott (Institute of Terrestrial Ecology)
Trevor Harwood (Morecambe Bay Saltmarsh Expert)
Mark Woombs (Lancashire Area Marine Conservation Society)
John Wilson (RSPB Leighton Moss)
Jack Sheldon (Morecambe Bay Wader Group)
Pat Lowe (Grange & District Wildfowlers Group)
Steve Manning (Flookburgh & Morecambe Bay Fishermens Association)
Len Blacow (Wyre Ecology Centre)
Professor John Jeffers (South Lakeland Environmental Forum)
Dave Harpley (Cumbria Wildlife Trust)

Preface

This formal consultation draft provides English Nature's advice to other relevant authorities as to (a) the conservation objectives and (b) any operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species for the Morecambe Bay European marine site. This advice is being prepared to fulfill our obligations under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994.

The Morecambe Bay European marine site is part of a candidate Special Area of Conservation. It is Government policy that such sites should be protected as if they were already designated and, where appropriate, it is desirable to establish voluntary management schemes at an early stage, before the formal statutory obligations apply, and to act in the spirit of the Directive in the meantime (DETR & The Welsh Office, 1998). In light of this policy, we have worked with many of you to develop this advice in advance of statutory obligations applying.

European marine sites are defined in the Conservation (Natural Habitats &c.) Regulations 1994 as any part of a European site covered (continuously or intermittently) by tidal waters or any part of the sea in or adjacent to Great Britain up to the seaward limit of territorial waters. European sites include Special Areas of Conservation under the Habitats Directive, which support certain natural habitats and species of European importance, and Special Protection Areas under the Birds Directive which support significant numbers of internationally important wild birds. In many instances, as in the case of Morecambe Bay European marine site, these designations may coincide and our advice is being prepared to cover both the SAC and SPA interests.

This 'Regulation 33 package' is designed to help relevant and competent authorities, who have responsibilities to implement the Habitats Directive, to:

- understand the international importance of the site, the underlying physical processes and the ecological requirements of the habitats and species involved;

- develop a management scheme to ensure that the ecological requirements of the site's interest features are met; and

- set the standards against which the condition of the site's interest features can be determined and undertake monitoring to establish whether they are in favourable condition.

In addition, the Regulation 33 package will provide a basis to inform the scope and nature of 'appropriate assessment' required in relation to plans and projects (Regulations 48 & 50 and by English Nature under Regulation 20). English Nature will keep this advice under review and may update it every six years or sooner, depending on the changing circumstances of the European marine site. In addition, we will be providing 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. If during the European Union's moderation process, qualifying interest features are added to this European marine site, English Nature will add to this advice, as appropriate.

Tim Bines
English Nature
14th January 2000

English Nature's advice for Morecambe Bay European marine site given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994

1. Introduction

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. 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[3]. The Birds Directive protects all wild birds and their habitats within the European Union, especially migratory birds and those that are considered rare or vulnerable.

The Habitats and Birds Directives include requirements for the designation of conservation areas. In the case of the Habitats Directive these are Special Areas of Conservation (SACs) which support certain natural habitats or species, and in the Birds Directive, Special Protection Areas (SPAs) which support wild birds of European Union interest. These sites will form a network of conservation areas to be known as "Natura 2000". Where SACs or SPAs consist of 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, they are referred to as European marine sites.

Further guidance on European marine sites is contained in the Department of the Environment Transport and Regions/Welsh Office document: *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.*

1.2 English Nature's role

The Conservation (Natural Habitats &c.) Regulations 1994 translate the Habitats Directive into law in Great Britain. It gives English Nature a statutory responsibility to advise relevant authorities as to the conservation objectives for European marine sites in England and to advise relevant authorities as to any operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of

[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] 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.

species for which the sites have been designated. This information will be a key component of the management schemes which may be developed for these sites. This document is English Nature's advice for Morecambe Bay European marine site issued in fulfilment of Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994 (the 'Regulation 33 package"). Copies of key references quoted in this document are held at the English Nature local office.

In addition to providing such advice, the Regulation 33 package will inform the scope and nature of 'appropriate assessment' which the Directive requires to be undertaken for plans and projects (Regulations 48 & 50 and by English Nature under Regulation 20). In the future, English Nature may also provide more detailed advice to competent and relevant authorities to assess the implications of any such plans or projects.

1.3 The role of relevant authorities

The Conservation (Natural Habitats &c.) Regulations 1994 require relevant authorities to exercise their functions so as to secure compliance with the Habitats Directive. The management scheme which the relevant authorities are drawing up under Regulation 34 for Morecambe Bay European marine site will provide the framework through which this will be done and it should be based on the advice in this package. In this respect, 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.

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, local Environment Agency plans, SSSI management plans, local BAP 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 SAC and SPA 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.

Under certain circumstances, where another relevant authority is unable to act for legal reasons, or where there is no other relevant authority, English Nature is empowered to use its byelaw-making powers for Marine Nature Reserves (MNR) for use in European marine sites.

1.4 Activity outside the control of relevant authorities

Nothing within this Regulation 33 package will require relevant authorities to undertake any actions or ameliorate changes in the condition of interest features if it is shown that the changes result wholly from natural causes[4]. This also applies if the changes, although causing deterioration or disturbance to the

[4]Determination of what constitutes natural change will be based on the best available information and scientific opinion at the time.

interest features, are the result of human or natural events outside their control. Having issued Regulation 33 advice for European marine sites, English Nature will work with relevant authorities and others to agree, within a defined time frame, a protocol for evaluating all observed changes to baselines and to develop an understanding of natural change and provide further guidance as appropriate and possible.

On Morecambe Bay European marine site a Management Group has already been set up and should be used to alert English Nature to such issues so that they may be assessed and any appropriate measures taken. This does not, however, preclude relevant authorities from taking action to prevent deterioration to the interest features, for example by introducing or promoting codes of practice through the advisory group of the Morecambe Bay Partnership.

1.5 Responsibilities under other conservation designations

In addition to its candidate SAC and SPA status, Morecambe Bay is also designated and subject to agreements under other conservation legislation (e.g. SSSIs notified under the Wildlife and Countryside Act 1981). The obligations of relevant authorities and other organisations under such designations are not affected by the advice contained in this document.

1.6 Role of conservation objectives

Section 5 of this document sets out the conservation objectives for the Morecambe Bay European marine site. They are the starting point from which management schemes and monitoring programmes are to be developed as they provide the basis for determining what is likely to cause a significant effect, and for informing on the scope of appropriate assessments of plans or projects. The conservation objectives set out what needs to be achieved and thus deliver the aims of the Habitats Directive**.**

1.7 Role of advice on operations

The advice on operations set out in Section 7 provides the basis for discussion about the nature and extent of the operations taking place within or close to the site and which may have an impact on its interest features. It is given on the basis of the working assumption that sites have been generally presumed to be in favourable condition at the time they were identified. This assumption will be tested during the 2000 - 2006 reporting period. The advice should also be used to identify the extent to which existing measures of control, management and use are, or can be made, consistent with the conservation objectives and thereby focus the attention of relevant authorities and surveillance to areas that may need management measures.

This operations advice, will need to be supplemented through further detailed discussions with the management and advisory groups in formulating and agreeing a management scheme, where required, to agreed timescales for the European marine site.

2. Identification of interest features under the EU Habitats and Birds Directives

2.1 Introduction

Morecambe Bay is the second largest embayment in Britain after the Wash and, at over 310km^2, it contains the largest continuous area of intertidal mudflats and sandflats in the UK, Within the sediments are a wide range of communities with particularly high numbers of various polychaete worms, bivalve molluscs and crustaceans. Every autumn internationally important numbers of migratory birds fly to overwinter in Morecambe Bay where they feed on this rich resource. The site is also important for the nationally important population of breeding sandwich terns as well as the total numbers of waterfowl and seabirds which, during the summer, feed and breed around the Bay. Other habitats include large areas of saltmarsh and pioneer saltmarsh and rare transitional zones between saltmarsh and freshwater and terrestrial habitats. Around the Bay, scattered areas of boulders and cobbles provide a hard substrate for dense beds of mussels and other species such as honeycomb worms. In the north of the Bay, the sheltered waters of the Walney Channel create yet another important habitat for a community of sponges and sea squirts which is highly restricted in the UK. Further up the shore the only eelgrass beds in northwest England colonise the sheltered mudflats.

Morecambe Bay is a candidate Special Area of Conservation (SAC) and is classified as a Special Protection Area (SPA), the boundaries of which are illustrated in Appendix 2. The marine components of both sites qualify as European marine sites but for simplicity, and for the purposes of this advice, both the SAC and SPA components are treated as a single European marine site - the Morecambe Bay European marine site. Accordingly, the advice in this document covers both the SAC habitat interests and the SPA bird interests.

Where these habitats occur within the European marine site they are referred to as interest features. Sub-features have also been identified to highlight the ecologically important components of each interest feature. The interest features of the Morecambe Bay European marine site are outlined below and discussed in more detail in section 3. The boundary of the European marine site and the distribution and extent of these interest features and the more detailed sub-features are mapped in Figure 1.

2.2 Interest features under the EU Habitats Directive

Morecambe Bay qualifies as a Special Area of Conservation for the following Annex I habitats as listed in the EU Habitats Directive:

- **Large shallow inlets and bays.**
- **Mudflats and sandflats not covered by seawater at low tide** (*Referred to in this document as* Intertidal mudflats and sandflats).
- **Glasswort *Salicornia* spp. and other annuals colonising mud and sand** *(Referred to in this document as* Pioneer saltmarsh).
- **Atlantic salt meadows *Glauco-Puccinellietalia*** *(Referred to in this document as* Saltmarsh).

The Morecambe Bay SAC also qualifies for the Annex I habitat **coastal vegetated shingle**. This does not however, occur within the European marine site, and therefore within this document, as it occurs above Highest Astronomical Tide. Objectives to maintain coastal vegetated shingle in favourable condition are found within English Nature's conservation objectives for the relevant SSSI within the SAC boundary and will be dealt with through procedures outlined in the Conservation (Natural Habitats &c.) Regulations 1994. Relevant authorities need to have regard to such adjacent European interests, as they might be affected by activities taking place within, or adjacent to the European marine site.

2.3 Interest features under the EU Birds Directive

Morecambe Bay also qualifies as a Special Protection Area for the following bird assemblages, as listed under the Birds Directive:

- Internationally important populations of regularly occurring Annex 1 species.
- An internationally important assemblage of waterfowl and seabirds.
- Internationally important populations of regularly occurring migratory species.

The Morecambe Bay SPA was classified in October 1996, the citation for which was updated in 1997 and it is upon this citation which this advice is based.

3. SAC interest features

This section describes and explains the importance of the SAC interest features of Morecambe Bay European marine site.

3.1 Large shallow inlets and bays

3.1.1 General description

Large shallow inlets and bays are large indentations of the coast, which are generally more sheltered from wave action than the open coast. They are relatively shallow and usually average less than 20m in water depth. They are complex systems linking the aquatic and terrestrial environments and are composed of a mosaic of marine and surrounding transitions to terrestrial habitats. The selection of European marine sites favoured larger areas, which tended to encompass the greatest variety of habitat and community types (Brown *et al.*, 1997).

3.1.2 Importance of Morecambe Bay

Morecambe Bay is the second largest embayment in the UK, after the Wash in Norfolk. At low water, large areas of intertidal sandflats are exposed, with small areas of mudflat, particularly in the upper reaches of the adjoining estuaries. The sediments of the Bay are mobile and support a range of habitat and community types, from those typical of open coasts, where the sand is constantly on the move, to more sheltered areas where the sediment is less disturbed allowing more stable communities to develop. The diversity and composition of biological communities that occur in or on the sediments of Morecambe Bay are influenced by a number of key ecological factors. These include the hydrophysical regime (tides, waves and currents), the nutrient levels, temperature, oxygen levels, salinity and the composition of the substrate (Elliot *et al.,* 1998).The Bay is also important as a fish nursery area and is an important habitat for migratory fish species such as salmon *Salmo salar*, sea trout *Salmo trutta* and eels *Anguilla anguilla* (Potts & Swaby, 1993).

3.1.3 Key sub-features

Intertidal boulder and cobble skear communities

Although the Bay is principally a region of soft sediments there are important areas of exposed boulder and cobble skears which provide an important habitat for a range of marine organisms and thus contribute to the structure of the Bay. The boulder and cobble areas are mainly colonised by mussel beds *Mytilus edulis* and associated species (Woombs, 1997) and there are also extensive reefs of the nationally scarce honeycomb worm *Sabellaria alveolata* colonising the boulder and cobble skears off Morecambe (Woombs, 1997).

Subtidal boulder and cobble skear communities

The wave sheltered subtidal boulder and cobble skear sites in the Walney Channel are particularly important as they provide a habitat for a nationally scarce assemblage of cushion sponges, hydroids and sea squirts which thrive in these tide-swept waters (George, 1992; Cook, 1998). The subtidal boulder and cobble areas are also densely colonised by mussel beds *Mytilus edulis* and associated species (Woombs, 1997).

Brittlestar bed communities
The tideswept waters of the Walney Channel are inhabited by a dense bed of brittlestars *Ophiothrix fragilis* (George, 1992) which are a key structural component of the area and may play an important role in local carbon and nutrient cycles. Brittlestar beds are a major concentration of biomass and provide food for a range of fish species.

Intertidal boulder clay communities
Exposed lower shore outcrops of boulder clay around the Bay provide a habitat for colonies of piddocks *Barnea candida* which are a nationally rare species of bivalve (Woombs, 1997). These communities are fragile and contribute to the diversity of the Bay and the European marine site.

Coastal lagoon communities
Coastal lagoons are bodies of water, natural or artificial, partially separated from the adjacent sea. The coastal lagoons at south Walney contain soft sediments which support the macrophyte *Potamogetin pectinatus* and a range of other plant and animal species. These communities are fragile and contribute to the diversity of Morecambe Bay European marine site.

Intertidal mudflat and sandflat communities
Intertidal mudflat and sandflat communities form a large proportion and an important part of the site. They are classified in the Habitats Directive as an interest feature in their own right and are therefore described separately below. **See section 3.2**

Pioneer saltmarsh communities
Pioneer saltmarsh communities play an important role in the functioning of the site. They are classified in the Habitats Directive as an interest feature in their own right and are therefore described separately below. **See section 3.3**

Saltmarsh communities
Saltmarsh communities provide an important habitat within Morecambe Bay. They are also classified in the Habitats Directive as an interest feature in their own right and are therefore described separately below. **See section 3.4**

3.2 Intertidal mudflats and sandflats

3.2.1 General description

Intertidal mudflats and sandflats are submerged at high tide and exposed at low tide. Their physical structure can range from the mobile, coarse sand beaches of wave exposed coasts to the stable, fine sediment mudflats of estuaries and embayments. This is a widespread habitat type which occurs throughout the UK. European marine sites were selected to encompass the ecological variation across the geographical range of this habitat type in the UK (Brown *et al.,* 1997).

3.2.2 Importance of Morecambe Bay

Morecambe Bay represents the largest single area of continuous intertidal mudflats and sandflats in the UK and includes the best example of muddy sandflats on the west coast (Brown *et al.,* 1997). At low water, large areas of sandflats are exposed and these range from the mobile fine sands of the outer Bay to more sheltered sands in the inner areas. With increasing shelter in the Bay's five adjoining estuaries, finer sediments settle out and these form extensive mudflats, supporting a particularly rich and diverse range of infaunal species.

3.2.3 Key sub-features

Sand communities
Animal communities living within the sandy sediments over the central part of the Bay include high numbers of polychaete worms such as lugworm *Arenicola marina* and molluscs such as the Baltic tellin *Macoma balthica* and the edible cockle *Cerastoderma edule*. In more exposed areas with more mobile sand the communities are less diverse and include amphipods *Bathyporeia* spp. and the isopod *Eurydice pulchra* (Anderson, 1972; Adams, 1987; Rostron, 1992). The sand communities provide a rich feeding ground for internationally important populations of waterfowl which overwinter in the Bay.

Mud communities
Towards the mouths of the estuaries feeding into the Bay, the salinity decreases and the sediment is finer. Muddy sediments support a high biomass of ragworm *Hediste diversicolor* and peppery furrow shell *Scrobicularia plana* and higher up the estuaries in lower salinity, ragworms and the burrowing amphipod *Corophium volutator* (Anderson, 1972; Adams, 1987; Rostron, 1992). The mud communities provide a rich feeding ground for internationally important populations of waterfowl which feed in the Bay.

Eelgrass bed communities
An important feature of the intertidal mudflats and sandflats are the eelgrass beds *Zostera angustifolia* and *Zostera noltii* in the Walney Channel (see Figure 1). Eelgrass beds are nationally rare (Stewart *et al.,* 1994) and this is the only example of this habitat in north west England. Eelgrass beds are an important habitat as they provide important spawning, nursery and refuge areas for fish. They also help to stabilise the sediment, contribute to primary productivity and are also an important food source for overwintering wildfowl (Davison & Hughes, 1998).

3.3 Pioneer saltmarsh

3.3.1 General description

Glasswort *Salicornia* spp and other annuals, referred to in this document as pioneer saltmarsh, vegetation comprises a small number of species which are dominated by glasswort *Salicornia* spp. This vegetation occurs in a large number of saltmarshes in the UK and European marine sites were chosen to represent the geographical range of the habitat type. Generally the largest areas of pioneer saltmarsh have been selected, and since it occurs as an integral part of a sequence of habitats, from sand/mudflats to more stable saltmarsh vegetation, preference has been given to sites where it forms part of well developed successional sequences (Brown *et al.,* 1997).

Pioneer saltmarsh develops at the lower reaches of saltmarshes where the vegetation is frequently flooded by the tide. Wave exposure is particularly important in determining whether pioneer saltmarsh will colonise an area as it is only able to do so in sheltered sites where it is protected from strong wave action. Pioneer saltmarsh is an important precursor to the development of more stable saltmarsh vegetation.

3.3.2 Importance of Morecambe Bay and key sub-feature

Glasswort *Salicornia* spp. communities
Pioneer saltmarsh covers extensive areas in Morecambe Bay and is dominated by glasswort *Salicornia* spp. Glasswort marsh occurs along the coastline of the Bay, forming a key stage in the transition from the extensive intertidal sand and mudflats to the distinctive saltmarsh of the site.

3.4 Saltmarsh

3.4.1 General description

Atlantic salt meadows *Glauco-Puccinellietalia* community, referred to in this document as saltmarsh, occur on North Sea, English Channel and Atlantic shores. There are more than 30,000 ha of saltmarsh in the UK and European marine sites were selected to represent the geographical range and ecological variation of the habitat. The European marine sites chosen are for the most part the largest examples of this habitat type, which support a well developed zonation of plant communities (Brown *et al.,* 1997).

Saltmarshes play a fundamental role in the life of an estuary, bringing stability to its margins and also operating as a source of primary productivity. They are a rare and specialised habitat in their own right and many of the plants which occur there survive nowhere else. Saltmarsh develops when vegetation colonises soft intertidal sediments of mud and sand in areas protected from strong wave action. Saltmarshes exhibit a zonation of vegetation which is influenced by the degree of tidal innundation, in turn related to the level, or height of the deposited sediment on which the saltmarsh has developed. This zonation is generally displayed as bands of characteristic vegetation communities. The lower levels of the saltmarsh, landward of the pioneer zone of glasswort, experience the greatest number of tidal innundations and are generally species poor. In the mid marsh zone, as the number of tidal innundations decreases the vegetation becomes more diverse with a more complex structure and a greater proportion of herbs. At the upper levels of the marsh, which the tide only reaches on the highest spring tides, the vegetation is diverse and includes some species which are restricted to this zone.

3.4.2 Importance of Morecambe Bay

Morecambe Bay was chosen as being characteristic of saltmarshes in north-west England demonstrating large areas of closely grazed upper marsh (Brown *et al.*, 1997). Grazing by domestic stock has been particularly significant in determining the structure and species composition of the habitat type and in determining its relative value for plants, invertebrates and wintering or breeding waterfowl. A wide range of saltmarsh community types is represented in Morecambe Bay and the saltmarsh covers large areas, especially where there has been little or no enclosure on the landward side. In the upper levels of the saltmarsh there are also important transitional habitats from saltmarsh to freshwater and grassland vegetation.

This habitat makes a vital contribution to the structure and function of the Morecambe Bay system. Saltmarshes and mudflats form two elements of an interconnected and dynamic system which is able to interact with the physical processes operating within the Bay.

3.4.3 Key sub-features

Low marsh communities
The lower levels of the saltmarsh, landward of the pioneer zone of glasswort *Salicornia,* experience a great number of tidal innundations, usually more than 360 a year. Because of this, the vegetation communities of the low marsh and low-mid marsh are often species poor, composed of plant species which can withstand such conditions. Characterising species of this zone include extensive areas of saltmarsh grass *Puccinellia maritima* with smaller areas of sea purslane *Halimione portulacoides* in ungrazed areas.

Mid marsh communities
The mid marsh zone comprises a transition between low and upper marsh. As the number of tidal innundations becomes less frequent, the vegetation becomes more diverse with a more complex structure and a greater proportion of herbs. This zone is characteristically dominated by the saltmarsh grass/fescue

Puccinellia/Festuca communities, of which over 1,000 ha occur in the Bay, and by smaller areas of saltmarsh rush *Juncus gerardii* community.

High marsh communities

At the upper levels of the marsh, tidal innundation only occurs on the highest spring tides and the vegetation reflects this with some species being restricted to this zone. The sea rush *Juncus maritimus* community is found in this zone and is more strongly represented in Morecambe Bay than elsewhere in England. Other important features of the higher saltmarsh communities include the saltmarsh flat-sedge *Blysmus rufus* and a few-flowered spike-rush *Eleocharis uniglumis* communities which are rare in Morecambe Bay (Burd,1989).

Transitional high marsh communities

The higher marsh communities will grade into transitional communities at around extreme high water spring tide. Transitional communities are an important structural aspect of the upper saltmarsh. They may be freshwater transitional communities, such as the common reedbed *Phragmites australis*, common-club rush *Schoenoplectus tabernaemontanii* and sea club rush *Scirpus maritimus* communities, or grassland transitions include creeping bent *Agrostis stolonifera,* red fescue *Festuca rubra* and tall fescue *Festuca arundinacea* communities. Historically, where the upper saltmarshes have been truncated by sea walls, these habitats have been lost.

4. SPA interest features

Background and context

A major aim of the Birds Directive is to take special measures to conserve the habitats of qualifying birds in order to ensure their survival and reproduction within the European Union. A key mechanism in achieving this is the classification by Member States of the most suitable sites as SPAs.

English Nature's conservation objectives at a site level focus on maintaining the condition of the habitats used by the qualifying species. Habitat condition will be delivered through appropriate site management including the avoidance of damaging disturbance. In reporting on Favourable Conservation Status, account will need to be taken both of habitat condition and the status of the birds on the SPA.

Accordingly, English Nature 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 Commission

English Nature's advice focuses on the qualifying species for which the SPA was originally classified despite the fact that numbers and species composition may have changed on this site since that time. Such population and species composition changes are being documented through the UK SPA Network Review, led by JNCC, which will provide advice to Ministers on any changes in SPA citations required. Depending on the review and decisions from DETR, English Nature may reissue this advice on SPAs with updated bird information.

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

Attention is, however, also directed to the inclusion of disturbance in the advice on operations provided in section 6. Where disturbance is highlighted in such advice, Relevant authorities need to avoid damaging disturbance to qualifying species when exercising their functions under the Directive.

Reductions in organic inputs

Under the Urban Waste Water Treatment (UWWT) Directive all coastal discharges above a certain size must have secondary treatment installed by the end of 2000. Secondary treatment of sewage will significantly reduce organic loading and to a lesser extent reduce concentrations of dissolved nutrients. The effects of these reductions on coastal birds in Morecambe Bay are difficult to predict. On a local scale cleaner sewage discharges may cause a redistribution of feeding birds or they may have a much greater effect causing a reduction in the overall capacity of a coastal area to support bird populations.

English Nature supports the cleaning up of coastal discharges. The overall ecological benefits of cleaner discharges will, in general, outweigh any subsequent local decline in bird numbers. However, coastal clean ups may have the potential to significantly effect the features of the SPA. Under the Birds and Habitats

Directives, the competent authority (in this case Environment Agency) will therefore be required to undertake an appropriate assessment and establish a monitoring baseline. If adverse effects are anticipated then compensatory measures, such as habitat creation or mitigation in the form of reducing disturbance through the use of refuges at critical times of the year, may be an option.

4.1 General description

Morecambe Bay SPA qualifies under Article 4.1 of the EU Birds Directive by supporting:

- internationally important populations of a regularly occurring Annex 1 species (Sandwich terns *Sterna sandvicensis*).

It also qualifies under Article 4.2 of the EU Birds Directive in that it supports:

- an internationally important assemblage of waterfowl and seabirds; and

- internationally important populations of regularly occurring migratory species.

In recognition that bird populations may change as a reflection of national or international trends or events, this advice on the bird interests of the European marine site focuses on the condition of the habitats necessary to support the bird populations. As with SAC interest features, sub-features are identified which describe the key habitats within the European marine site necessary to support the birds that qualify within the SPA. Detailed information and targets for habitat condition are listed in the favourable condition table in Section 6. Bird usage of the site varies seasonally, with different areas being favoured over others at certain times of the year.

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 an intertidal area and different prey species. Changes in the habitat may therefore affect their prey availability. The important bird populations therefore require a functional embayment which is capable of supporting intertidal habitat for feeding and roosting. The most important factors related to this are:

- Current extent and distribution of suitable feeding and roosting habitat (e.g. saltmarsh, mudflats);
- Sufficient prey availability (e.g. small fish, crustaceans and worms);
- Minimal levels of disturbance;
- Water quality necessary to maintain intertidal plant and animal communities; and
- Water quantity and salinity gradients necessary to maintain saltmarsh conditions suitable for bird feeding and roosting.

4.2 Importance of internationally important populations of the regularly occurring Annex 1 species

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. Morecambe Bay is of importance for an internationally important population of breeding sandwich tern *Sterna sandvicensis*, a species listed on Annex 1.

4.2.1 Key sub-feature

Shingle areas.
Sparsely vegetated shingle areas are an important nesting area for sandwich terns in the Bay. The main nesting areas are on Foulney and Walney Islands.

4.3 Importance of the internationally important assemblage of waterfowl and seabirds

The large areas of intertidal mudflats and sandflats in Morecambe Bay support dense populations of marine invertebrate species, which in turn provide a food source for large populations of waterfowl (wildfowl and waders). Morecambe Bay is one of the most important estuaries in the UK for wintering waterfowl regularly supporting over 20,000 birds (Cranswick *et al.,* 1995). During severe winter weather Morecambe Bay assumes even greater national and international importance as waterfowl arrive from other areas further inland, as they are attracted by the mild conditions and the abundant food resource. The Bay also supports an internationally important assemblage of breeding seabirds.

4.3.1 Key sub-features

Intertidal mudflat and sandflat communities
Intertidal mudflats on the site support high densities of invertebrates which are important as food for waterfowl. The high biomass of invertebrates includes species such as the Baltic tellin *Macoma balthica* (56,000 m^2 max. recorded density*),* cockles *Cerastoderma edule,* mud snails *Hydrobia ulvae* (10,000m^2 max. density)*,* marine worms such as lugworms *Arenicola marina* and crustaceans such as *Corophium volutator* (9000 m^2 max record density) . In general more sheltered areas with a relatively high silt content support a richer biomass than more exposed areas.

Intertidal and subtidal boulder and cobble skear communities
Boulder and cobble skears provide a hard substrate for a different range of prey species including dense beds of mussels. These areas are very important bird feeding habitats. Small mussels are eaten by knot, dunlin and turnstone and larger specimens are taken by oystercatchers and eider. The skear areas are also used as important mid-tide roosting areas.

Saltmarsh communities
Saltmarsh on the site provides important feeding, roosting and breeding areas for the Bay's bird life. The characteristic short sward height resulting from grazing pressure makes the saltmarsh an ideal habitat for roosting and feeding birds. On high spring tides thousands of wading birds concentrate on roost sites on the upper levels of the saltmarsh.

Coastal lagoon communities
Coastal lagoons contain soft sediments which can support tasselweeds and charophytes as well as filamentous green and brown algae. They provide an important feeding and roosting habitat for waterfowl, marshland birds and seabirds. Cavendish Dock in the Walney Channel is of regional importance as the largest coastal lagoon in north west England. The dock contains slightly brackish water which is relatively warm because it receives cooling water discharges from the nearby power station. It supports a rich growth of plants including beaked tasselweed *Ruppia maritima* and is an important site for feeding and roosting wildfowl and roosting waders.

4.4 Importance of internationally important populations of regularly occurring migratory bird species

Several of the species included in the wintering waterfowl assemblage also occur in internationally important numbers, and thus qualify for SPA status in their own right. These species are listed in Table 1. As all these internationally important populations are included within the wintering waterfowl assemblage,

and as they depend on the same marine habitats, they have been included in the conservation objective for the assemblage.

4.4.1 Key sub-features

The key sub-features for the internationally important populations of regularly occurring migratory bird species are as for the wintering waterfowl and seabird assemblage (given above at 4.3.1).

5. Conservation objectives for all interest features

Under Regulation 33(2)(a) of The Conservation (Natural Habitats &c.) Regulations 1994, English Nature has a duty to advise other relevant authorities as to the conservation objectives for the European marine site. The conservation objectives for the Morecambe Bay European marine site are provided below and should be read in the context of other advice given in this package, particularly:

- the attached map (Figure 1) showing the extent of the various interest features and sub-features;
- summary information on the interest of each of the features; and
- the favourable condition table, providing information on how to recognise favourable condition for each of the features and which will act as a basis from which the monitoring programme will be developed.

5.1 The conservation objective for the large shallow inlets and bays

Subject to natural change, maintain the **large shallow inlets and bays** in favourable condition[5], in particular:

- Intertidal boulder and cobble skear communities
- Subtidal boulder and cobble skear communities
- Brittlestar bed communities
- Intertidal boulder clay communities
- Coastal lagoon communities
- Intertidal mudflat and sandflat communities
- Pioneer saltmarsh communities
- Saltmarsh communities

5.2 The conservation objective for mudflats and sandflats not covered by seawater at low tide (intertidal mudflats and sandflats)

Subject to natural change, maintain the **mudflats and sandflats not covered by seawater at low tide (intertidal mudflats and sandflats)** in favourable condition[5], in particular:

- Mud communities
- Sand communities
- Eelgrass bed communities

[5] For a detailed definition of how to recognise favourable condition see table 2 (Section 6)

5.3 The conservation objective for Glasswort *Salicornia* spp and other annuals colonising mud and sand (pioneer saltmarsh)

Subject to natural change, maintain the **Glasswort *Salicornia* spp and other annuals colonising mud and sand (pioneer saltmarsh)** in favourable condition[5], in particular:

- The glasswort *Salicornia* spp communities.

5.4 The conservation objective for the Atlantic salt meadows *Glauco-Puccinellietalia* (saltmarsh)

Subject to natural change, maintain the **Atlantic salt meadows *Glauco-Puccinellietalia* (saltmarsh)** in favourable condition[5], in particular:

- Low marsh communities
- Mid marsh communities
- High marsh communities
- Transitional high marsh communities

5.5 The conservation objectives for the SPA features are:-

Subject to natural change, to maintain in favourable condition[5] the habitats of the **internationally important populations of regularly occurring bird species listed on Annex 1 of the Birds Directive,** in particular:

- Shingle areas

(Numbers of birds using these habitats are given in Table 1)

Subject to natural change, to maintain in favourable condition[5] the habitats of the **internationally important assemblage of waterfowl and seabirds and the internationally important populations of regularly occurring migratory species,** in particular:

- Intertidal mudflat and sandflat communities
- Intertidal and subtidal boulder and cobble skear communities
- Saltmarsh communities
- Coastal lagoon communities

(Numbers of birds using these habitats are given in Table 1)

Note: These SPA conservation objectives focus on habitat condition in recognition that bird populations may change as a reflection of national or international trends or events. Annual counts for qualifying species will be used by English Nature, in the context of five year peak means, together with available information on UK population and distribution trends, to assess whether this SPA is

continuing to make an appropriate contribution to the Favourable Conservation Status of the species across Europe.

Table 1 Information on the populations of internationally important species of birds under the EU Birds Directive using the Morecambe Bay European marine site at the time the SPA was classified

Internationally important populations of regularly occurring Annex 1 species.

Species	Population (5yr peak mean 1990/91 -1994/5)*
Sandwich Terns *Sterna sandivensis*	934 birds

Internationally important populations of regularly occurring migratory bird species.[6]

Species	Population (5yr peak mean 1989/90 -1993/4)*
Pink-footed Goose (*Anser brachyrhynchus*)	7,718 birds
Shelduck (*Tadorna tadorna*)	5,847 birds
Pintail (*Anas acuta*)	2,655 birds
Oystercatcher (*Haematopus ostralegus*)	54,439 birds
Grey Plover (*Pluvialis squatarola*)	1,600 birds
Knot (*Calidris canutus*)	29,036 birds
Dunlin (*Calidris alpina*)	59,629 birds
Bar-tailed Godwit (*Limosa lapponica*)	1,794 birds
Curlew (*Numenius arquata*)	12,465 birds
Redshank (*Tringa totanus*)	6,501 birds
Turnstone *(Arenaria interpres)*	1,739 birds
Ringed plover *Charadrius hiaticula*	934 birds

An internationally important assemblage of waterfowl and seabirds.

Importance	Population (5yr peak mean 1990/91 -1994/5)*
Morecambe Bay supports large populations of wintering waterfowl.	224,726 individual birds.
Morecambe Bay supports large populations of breeding seabirds.	20,336 individual birds.

* SPA citation held on Register of European marine sites for GB.

[6] Morecambe Bay is regularly used by 1% or more of the biogeographical population of a regularly occurring species (other than those listed on annex 1) in any season (Cranswick et al 1995).

6. Favourable condition table

The favourable condition table is supplied as an integral part of English Nature's Regulation 33 advice package. It is intended to supplement the conservation objectives only in relation to management of established and ongoing activities and future reporting requirements on monitoring the condition of the site and its features. The table **does not by itself** provide a comprehensive basis on which to assess plans and projects as required under Regulations 20 and 48-50, but it does provide a basis to inform the scope and nature of any 'appropriate assessment' that may be needed. It should be noted that appropriate assessments are, by contrast, a separate activity to condition monitoring, requiring consideration of issues specific to individual plans or projects. English Nature 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 is the principle source of information that English Nature will use to assess the condition of an interest feature and as such comprises indicators of condition. On many terrestrial European sites, we know sufficient about the preferred or target condition of qualifying habitats to be able to define measures and associated targets for all attributes to be assessed in condition monitoring. Assessments as to whether individual interest features are in favourable condition will be made against these targets. In European marine sites we know far less about habitat condition and find it difficult to predict what favourable condition may look like. Individual sites within a single marine habitat category are also all very different, further hampering the identification of generic indicators of condition. Accordingly, in the absence of such information, condition of interest features in European marine sites will be assessed against targets based on the existing conditions, which may need to be established through baseline surveys in many cases.

The assumption that existing interest features on European marine sites are in favourable condition will be tested in the 2000 - 2006 reporting period and the results subsequently fed back into our advice and site management. Where there is more than one year's observations on the condition of marine habitats, all available information will need to be used to set the site within long-term trends in order to form a view on favourable condition. Where it may become clear that certain attributes are a cause for concern, and if detailed studies prove this correct, restorative management actions will need to be taken to return the interest feature from unfavourable to favourable condition. It is the intention of English Nature to provide quantification of targets in the favourable condition table during the 2000 - 2006 reporting period.

This advice also provides the basis for discussions with management and advisory groups, and as such the attributes and associated measures and targets may be modified over time. The aim is to produce a single agreed set of attributes that will then be monitored in order to report on the condition of features. Monitoring of the attributes may be of fairly coarse methodology, underpinned by more rigorous methods on specific areas within the site. To meet UK agreed common standards, English Nature will be committed to reporting on each of the attributes subsequently listed in the final version of the table, although the information to be used may be collected by other organisations through agreements.

The 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. The monitoring programme will be developed as part of the management scheme process through discussion with the relevant authorities and other interested parties. English Nature will be responsible for collating the information required to assess condition and will form a judgement on the condition of each feature within the site, taking into account all available information and using the favourable condition table as a guide.

Box 1	**Glossary of terms used in the favourable condition table**
Feature	The habitat or species for which the site has been selected.
Sub-feature	An ecologically important sub-division of the feature.
Attribute	Selected characteristic of an interest feature/sub-feature which provides an indication of the condition of the feature to which it applies.
Measure	What will be measured in terms of the units of measurement, arithmetic nature and frequency at which the measurement is taken. This measure will be attained using a range of methods from broad scale to more specific across the site.
Target	This defines the desired condition of an attribute, taking into account fluctuations due to natural change. Changes that are significantly different from the target will serve as a trigger mechanism through which some further investigation or remedial action is taken.
Comments	The rationale for selection of the attribute.

Table 2 Favourable Condition Table for Morecambe Bay European marine site NB - Many of the attributes will be able to be monitored 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.

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
Large shallow inlet & Bay		Extent	Overall area (ha) of Morecambe Bay, measured periodically (frequency to be determined).	No decrease in extent from an established baseline, subject to natural change.	Extent is an attribute on which reporting is required by the Habitats Directive. The extent of the large shallow inlet and bay is unlikely to change significantly over time, but still needs to be measured periodically.
		Morphological equilibrium of the Bay's component estuaries.	Intra- and inter-estuarine tidal prism/cross section ratio (TP/CS ratio) measured every second reporting cycle.	Intra- and inter estuarine TP/CS ration should not deviate significantly from an established baseline, subject to natural change.	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.
		Morphological equilibrium	Long-term trend in the horizontal boundary of the saltmarsh/mudflat interface, measured annually.	The horizontal boundary of the mudflat/saltmarsh interface should not deviate significantly from the long-term trend, subject to natural change.	Monitoring the saltmarsh boundary is a practical means of securing data which indicate changes in the TP/CS relationship. Deviation from long-term trends would act as a trigger for a second tier response involving detailed bathymetric survey and evaluation of changes in the TP/CS relationship (determined on a regional basis. In the absence of saltmarsh, vertical change in mudflat position can act as a surrogate for, or in addition to, the saltmarsh boundary.
		Water clarity	Average light attenuation measured on a monthly basis from March to September, annually.	Average seasonal light attenuation should not deviate significantly from the baseline, subject to natural change. Initial baseline setup in first	Water clarity is a key process maintaining the extent and diversity of plant and algal communities. Clarity is reduced through increases in the suspension of organic or inorganic material in the water column.

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
			September, annually.	year in Spring and Autumn over a neap and spring tide in full flow and low flow states.	
Large shallow inlet & Bay		Water density - salinity & water temperature.	Average salinity and average water temperature. Measured on a monthly basis, annually.	Average seasonal temperature & salinity maxima and minima should not deviate significantly from the long-term average, subject to natural change.	Temperature and salinity are characteristics of the overall hydrography of the area, thus the overall functioning of the Bay. Seasonal averages collected at monitoring sites as part of EA routine water quality monitoring programme
	Intertidal boulder clay	Extent of piddocks and mussels in clay biotope.	Area (ha) of intertidal boulder clay measured once every reporting cycle.	No decrease in extent from the established baseline (Woombs 1997), subject to natural change.	This is a fragile biotope, indicative of environmental stress particularly physical disturbance and smothering. It is nationally important due to the rarity of the biotope.
	Intertidal boulder & cobble skears	Extent	Area (ha) of intertidal boulder skears. Measured once every reporting cycle.	No decrease in extent from the established baseline (aerial photography survey 1997), subject to natural change.	Boulder, cobble skears provide an important habitat for range of marine organisms and thus contribute to the structure of the Bay.
		Extent of characteristic biotopes: - Mussel beds -Honeycomb worm (*Sabellaria alveolata*) reefs. - Tide-swept boulders and cobbles with serrated wrack, sponges, sea squirts and red seaweeds.	Area (ha) of characteristic biotopes, measured once during reporting cycle.	No decrease in extent from the established baseline (Woombs 1997), subject to natural change.	The extent of these biotopes provides a key to the structure and stability of the boulder and cobble skears. Any changes in extent may indicate cyclic change in these boulder and cobble skear biotopes.
		Species composition of characteristic biotopes: - Mussel bed communities. - Tideswept boulders and cobbles with	Presence and abundance of composite species of each biotope, measured once during reporting cycle.	Presence and abundance of composite species should not deviate significantly from the established baseline (Woombs 1997).	Composite species are important contributors to the structure of the boulder and cobble skears. Changes in species composition may indicate cyclic changes in the condition of the intertidal.

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
		serrated wrack, sponges, sea squirts and red seaweeds.			
Large shallow inlet & Bay	Intertidal boulder & cobble skears	Characteristic species - Mussels *Mytilus edulis*.	Abundance and age/size class profile of mussels, measured periodically (frequency to be determined).	Percentage of sexually mature mussels and newly recruited mussels on beds should not fall below North Western &North Wales Sea Fisheries Committee baseline, to be established, subject to natural change.	Mussels are a key structuring component of the intertidal boulder and cobble skears and play an important role in the functioning of the Morecambe Bay ecosystem. A range of age classes is an important indicator of mussel recruitment and growth, which supports birds and other wildlife which feed selectively on different sizes of mussels.
		Characteristic species - Mermaids glove sponge *Haliclona oculata,* Breadcrumb sponge *Halichondria panicea* and *Hymeniacidon perleve.*	Abundance (% cover) of characteristic sponge species in m^2 quadrats along two transects. Measured twice during reporting cycle.	Average abundance should not deviate significantly from an established baseline, subject to natural change.	The characteristic sponge species contribute to the structure of the subtidal rocky scars.
	Coastal lagoons	Extent	Area (ha) measured at same time during the year, once during the reporting cycle.	No decrease in extent from the established baseline (aerial survey 1997), subject to natural change.	This habitat contributes to the overall structure of Morecambe Bay European marine site. Changes in extent of the lagoon may reflect changes in processes supporting the embayment as a whole. Coastal lagoons support a range of species not found elsewhere in the embayment.
		Species composition of the lagoon community.	Presence and abundance of composite species, measured once during reporting cycle.	Presence and abundance of composite species should not deviate significantly from the baseline, subject to natural change.	Composite species are important contributors to the structure of the coastal lagoon habitat.
	Brittlestar beds	Extent	Area (ha) measured at same time during the year, once during the reporting cycle.	No decrease in extent from the established baseline (NW&NWSFC RoxAnn survey 1998), subject to natural change.	The extent of brittlestar bed is a key structural component of the sediments, represents a major concentration of biomass within the feature, and may play an important role in local carbon and nutrient cycles. Fluctuations in brittlestar beds have

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
					been shown to relate to both large-scale hydrographic processes and to short-term localised events and as such indicate environmental change at a range of scales.
Large shallow inlet & Bay	Brittlestar beds	Characteristic species- brittlestars.	Density of common brittlestar *Ophiothrix fragilis*, measured at same time during the year, once during the reporting cycle.	Average density should not deviate significantly from an established baseline, subject to natural change.	The sub-feature brittlestar bed is defined by the occurrence of brittlestars at high densities, hence density is critical to the structure of the sub-feature.
Intertidal mudflats and sandflats		Extent	Area (ha) measured once every reporting cycle.	No decrease in extent from an established baseline (aerial photographs 1997), subject to natural change.	The extent of the feature is a reporting requirement of the Habitats Directive. For dynamic coastlines, fluctuations in extent may be great, but are attributable to natural coastal processes.
		Sediment character	Particle size analysis. Parameters include %sand/silt/gravel, mean and median grain size and sorting coefficient used to characterise sediment type, measured periodically (frequency to be determined).	Average PSA parameters should not deviate significantly from an established baseline, subject to natural change.	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.
			Sediment penetrability - Degree of sinking, measured periodically (frequency to be determined)	Average measure should not deviate significantly from an established baseline, subject to natural change.	Penetrability is an indicator of sediment stability, degree of compaction 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.
			Organic carbon. % organic carbon from sediment samples, measured periodically (frequency to be	Average organic carbon content should not increase in relation to an established baseline, subject to natural change.	Organic content critically influences the infaunal community and can cause deoxygenation of the feature which can be detrimental to the biota.

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
			determined).		
		Topography	Tidal elevation and shore slope, measured periodically (frequency to be determined).	Shore profile measured in the summer months should not deviate significantly from an established baseline, subject to natural change.	In the intertidal topography reflects the energy conditions and stability of the sediment, which is key to the structure of the feature. Topography is a major influence on the distribution of communities throughout the feature.
Intertidal mudflats and sandflats		Nutrient enrichment. Macroalgal mats	Extent and seasonal abundance of macroalgae on the feature measured periodically (frequency to be determined).	Average extent and depth of macroalgal cover should not increase in relation to an established baseline, subject to natural change.	Nutrient status is a key functional factor that influences biota associated with sediments including infauna as well as plants/algae at the surface. Indicator macroalgae indicate elevated nutrient levels which reduce the quality of the sediments and their associated communities, primarily through smothering and deoxygenation.
	Eelgrass beds	Extent	Area (ha) of eelgrass bed, measured twice during the reporting cycle.	No decrease from baseline (Tittley 1998), subject to natural change.	The extent of eelgrass is a key structural component of the sediments and provides a long-term integrated measure of environmental conditions across the feature.
		Characteristic species - *Zostera angustifolia & Zostera noltii*	Density expressed as shoots per m^2. Measured twice during the reporting cycle.	Average shoot density should not deviate significantly from the baseline (to be established September 1999), subject to natural change.	An early indicator of seagrass under stress is a reduction in the number of plants. Density is preferred as a surrogate for biomass, being less destructive, based on baseline survey to establish the relationship between density and biomass at a site.
	Intertidal sand communities	Extent	Area (ha) of intertidal sand communities, measured, once during reporting cycle.	No decrease in extent from an established baseline, subject to natural change.	The extent of intertidal sand communities provide a key structural component of the sediments, and are indicative of the processes supporting the intertidal mud and sandflats as a whole.
	Intertidal mud communities	Extent	Area (ha) of intertidal mud communities, measured, once during reporting cycle.	No decrease in extent from an established baseline, subject to natural change.	The extent of intertidal sand communities provide a key structural component of the sediments, and are indicative of the processes supporting the intertidal mud and sandflats as a whole.
Pioneer saltmarsh		Extent.	Area (ha) measured once every reporting cycle.	No decrease in extent of pioneer saltmarsh communities from established baseline level	The extent of the feature is a reporting requirement of the Habitats Directive. For dynamic coastlines fluctuations in extent may be great, but are

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
				(Hawker 1998), subject to natural change.	attributable to natural coastal processes.
		Creek patterns and pans.	Creek density and morphology. Measured once every reporting cycle.	No significant alteration of creek patterns against 1997 aerial photography baseline and saltmarsh mapping survey (Hawker 1998).	Creeks absorb the tidal energy - the efficiency of this process depends on width, length and pattern - and assists with the delivery of sediment into saltmarshes. Pans are important for low marsh communities and protect sensitive plant species from grazing and trampling.
Pioneer saltmarsh	Glasswort communities	Species composition of glasswort community (NVC SM10).	Frequency and abundance of characteristic species measured once during the reporting cycle.	Frequency and abundance of characteristic species should not deviate significantly from the established baseline (Hawker 1998), subject to natural change.	This community covers extensive areas of Morecambe Bay and is an important precursor to the development of more stable saltmarsh.
Saltmarsh		Extent.	Area (ha) measured once during reporting cycle.	No decrease in extent of saltmarsh communities from established baseline level (Hawker 1998), subject to natural change.	The extent of the feature is a reporting requirement of the Habitats Directive. For dynamic coastlines fluctuations in extent may be great, but are attributable to natural coastal processes. The whole system will need to be assessed to take account of the dynamic nature of some of these habitats. A reduction in extent could be further indicated by ground survey to assess signs for erosion toppled vegetation blocks; stepping of saltmarsh edge; signs of stress/damage to plants.
		Range and distribution of characteristic saltmarsh communities (or sub communities) and transitional communities.	Frequency and abundance of characteristic species for each community measured once during reporting cycle.	Frequency and abundance of characteristic species should not deviate significantly from an established baseline, subject to natural change.	Sites with the greatest range of community types from low, mid to upper saltmarsh and transition to other habitats are in most favourable condition (NVC communities: SM13, SM14, SM16, SM18, SM19, SM20, S4, S20, S21, MG11, MG12, MG13).
		Vegetation structure	Range and distribution of varying vegetation heights, measured	Vegetation structure should not deviate significantly from an established baseline subject to natural change.	Vegetation structure is largely affected by the impact of grazing interacting with different vegetation communities. Not all saltmarshes are grazed, but where this has been an established

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
			periodically (frequency to be determined).		practice, the stocking levels need to be appropriate to the interest of the site. Over-grazing can lead to loss of rare plant species and affect bird feeding and breeding habitats. Removal or introduction of grazing can result in changes to plant community composition.
Saltmarsh	Low and low mid marsh communities	Species composition of Saltmarsh grass community (NVC SM13).	Frequency and abundance of characteristic species, measured once during the reporting cycle.	Frequency and abundance of characteristic species should not deviate significantly from the established baseline (Hawker 1998), subject to natural change.	Grazing determines species composition and type of sub-community and structural variation. This community and SM16 (mid marsh) cover extensive areas of saltmarsh in Morecambe Bay.
		Species composition of sea purslane community (NVC SM14).	Frequency and abundance of characteristic species, measured once during the reporting cycle.	Frequency and abundance of characteristic species should not deviate significantly from the established baseline (Hawker 1998), subject to natural change.	This community is uncommon in Morecambe Bay and is indicative of ungrazed areas.
	Mid and mid upper marsh communities.	Species composition of red fescue saltmarsh community (NVC SM16).	Frequency and abundance of characteristic species, measured once during the reporting cycle.	Frequency and abundance of characteristic species should not deviate significantly from the established baseline (Hawker 1998), subject to natural change.	Grazing determines species composition and type of sub-community and structural variation. This community and SM13 (lower marsh) cover extensive areas of saltmarsh in Morecambe Bay.
	Upper marsh communities	Species composition of sea rush community (NVC SM18).	Frequency and abundance of characteristic species, measured once during the reporting cycle.	Frequency and abundance of characteristic species should not deviate significantly from the established baseline (Hawker 1998), subject to natural change.	Upper marsh species. More strongly represented in Morecambe Bay than elsewhere in England.
		Species composition of saltmarsh flat sedge & spiked rush communities (NVC SM19 & 20).	Frequency and abundance of characteristic species, measured once during the reporting cycle.	Frequency and abundance of characteristic species should not deviate significantly from the established baseline (Hawker 1998), subject to natural change.	Both communities are rare in Morecambe Bay.

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
Saltmarsh	Transitional communities	Freshwater transitions - reed/club rush communities (NVC S4, S20 & S21).	Area (ha) of freshwater transition communities measured once during the reporting cycle..	No decrease in extent from an established baseline, subject to natural change.	Freshwater transitions are rare around the Bay and were formerly more extensive.
		Grassland transitions - creeping bent, red fescue & tall fescue (NVC MG11, MG12 & MG13).	Area (ha) of grassland transition communities measured once during the reporting cycle..	No decrease in extent from an established baseline, subject to natural change.	Grassland transitions are rare around the Bay and were formerly more extensive.
Interationally important Annex 1 Bird Populations (Sandwich tern *Sterna sandvicensis*)	Shingle	Extent	Area (ha) measured once during the reporting cycle.	No decrease in extent from an established baseline, subject to natural change.	The extent of shingle areas provide an important nesting habitat for nesting terns.
		Vegetation cover/density	Ratio of open ground with sparse vegetation and bare surfaces, measured periodically (frequency to be determined).	Ratio of open ground with sparse vegetation and bare surfaces should not deviate significantly from an established baseline, subject to natural change.	Important nesting area for sandwich terns. Ratio of open ground with sparse vegetation comprises unrestricted views >200m with vegetation cover <10% and the remainder bare during the breeding period May-July for nesting.
		Predation & disturbance in nesting areas	Reduction in or displacement of nesting birds measured using 5 year peak mean information on populations.	No significant reduction in numbers of or displacement of birds from an established baseline, subject to natural change.	The breeding success of sandwich terns is particularly vulnerable to disturbance and predation.
Internationally important assemblage of waterfowl & seabirds including internationally	Intertidal mudflats and sandflats and intertidal and subtidal boulder and cobble skears	Extent	Area (ha) of intertidal mudflats and sandflats and intertidal boulder and cobble skears, measured once during	No decrease in extent from an established baseline (aerial photographs 1997), subject to natural change.	Important feeding and roosting areas.

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
important populations of regularly occurring migratory species			reporting cycle.		
Internationally important assemblage of waterfowl & seabirds including internationally important populations of regularly occurring migratory species		Presence and abundance of prey species	Presence and abundance of prey species measured periodically (frequency to be determined).	Presence and abundance of prey speciesshould not deviate from an established baseline, subject to natural change.	Prey species are marine invertebrates including molluscs (e.g. *Macoma*, *Mytilus, Hydrobia Cerastoderma*), marine worms (e.g. *Arenicola, Nereis*) & crustaceans (e.g. *Carcinus, Gammarus, Corophium & Crangon*).
	Saltmarsh.	Extent	Area (ha) measured once during reporting cycle.	No decrease in extent from the established baseline (aerial photographs 1997), subject to natural change.	Important roosting area.
		Presence and abundance of food species	Presence and abundance of soft leaved grasses/ herbs, measured periodically (frequency to be determined).	Presence and abundance of characteristic food species should not deviate significantly from an established baseline, subject to natural change.	Maintenance of the correct species as food availability is essential for the grazing birds. Characteristic food species include *Trifolium repens*, *Pucclinellia maritima*, *Festuca rubra* and *Triglochin maritima*.
		Vegetation structure	Range of vegetation heights, measured periodically (frequency to be determined).	Range of vegetation heights should not deviate significantly from an established baseline (10-20cm within feeding areas) subject to natural change.	Important food source.
	Coastal lagoons	Extent	Area (ha) measured once during reporting cycle.	No decrease in extent from the established baseline (aerial photographs 1997), subject to natural change.	Important feeding and roosting area for wildfowl and roosting area for wading birds.
		Presence and abundance of food	Presence and abundance of aquatic	Presence and abundance of characteristic food species	Important food source for wildfowl.

Interest Feature	Sub-feature	Attribute	Measure	Target	Comments
		species	plants and invertebrates, measured periodically (frequency to be determined).	should not deviate significantly from an established baseline, subject to natural change.	
Internationally important assemblage of waterfowl & seabirds including internationally important populations of regularly occurring migratory species		Disturbance in feeding & roosting areas.	Reduction in or displacement of nesting birds measured using 5 year peak mean information on populations.	No significant reduction in numbers of or displacement of birds from an established baseline, subject to natural change.	Excessive disturbance can result in reduced food intake and/or increased energy expenditure.

NB .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 Morecambe Bay and may well be missed by routine monitoring

7. Advice on operations

English Nature has 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 English Nature has developed this advice is given in Section 7.2, and on how it may be reviewed and updated in the future, in Section 7.4.

The advice is provided in summary form in Table 3 and section 7.5 and with more detail in Table 4 and Table 5 and section 7.6, including advice in relation to specific interest features.

7.1 Purpose of advice

The aim of this advice is to enable 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 Morecambe Bay European marine site. The advice is linked to the conservation objectives for interest features and once issued will help provide the basis for detailed discussions within the management group to formulate and agree a management scheme to agreed timescales for the site. The advice given here will inform on, but is without prejudice to, any advice to be given subsequently under Regulation 48 or Regulation 50 on operations that qualify as plans or projects within the meaning of Article 6 of the Habitats Directive.

7.2 Methods for assessment

To develop this advice on operations English Nature has used a three step process involving:

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

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. Through a consistent approach, this process enables English Nature to both explain the reasoning behind our advice and identify to competent and relevant authorities those operations which pose the most current threats to the favourable condition of the interest features on the European marine site.

All the scores of relative sensitivity, exposure and vulnerability are 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 our knowledge and understanding of the marine environment. Information has been gathered from a range of sources including reports such as ABP Research (1999).

7.2.1 Sensitivity assessment

The sensitivity assessment used is an assessment of the relative sensitivity of the interest features or the component sub-features of Morecambe Bay European marine site to the effects of 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 (Hiscock, 1996). As an example, seagrass beds are highly sensitive to increases in turbidity of the

surrounding water. This reduces the light penetration which in turn, prevents adequate photosynthesis.

The sensitivity assessments of the interest features or their component sub-features of the Morecambe Bay European marine site are based upon a series 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 Reviews (Jones *et al.*, in prep.).

The sensitivity assessments are based on current information but may develop with improvements in scientific knowledge and understanding. In particular, English Nature and Scottish Natural Heritage have commissioned the Marine Biological Association of the UK, through its marine life information network (MarLIN) to provide detailed sensitivity information to underpin this advice, over the next three years and available to all over the World Wide Web (www.marlin.ac.uk).

7.2.2 Exposure assessment

This has been undertaken for the Morecambe Bay European marine site by assessing the relative exposure of the interest features or their component sub-features on the site to the effects of broad categories of human activities currently occurring on the site (as at October 1999). For example the exposure of saltmarsh to changes in thermal regime is low whilst the exposure to coastal land reclamation is medium. Information to help assess relative exposure was gathered from a series of one to one interviews with relevant authorities and local experts.

7.2.3 Vulnerability assessment

The third step in the process is to determine the vulnerability of interest features or their component sub-features to operations. This is an integration of sensitivity and exposure. Only if a feature is both sensitive and exposed to a human activity will it be considered to be vulnerable. In this context therefore, 'vulnerability' has been defined as exposure of a habitat, community or individual (or individual colony) of a species to an external factor to which it is sensitive (Hiscock, 1996). For example, eelgrass beds are highly sensitive to physical loss, through coastal development, which would result in the complete removal of habitat. However the eelgrass beds in Morecambe Bay are not currently considered to be highly vulnerable to such activities, due to their location and existing site management. The process of deriving and scoring relative vulnerability is provided in Appendix 1.

7.3 Format of advice

The advice is provided within six broad categories of operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species. This approach:

- 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 to assess 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 English Nature.

These broad categories provide a clear framework against which relevant authorities can assess activities under their responsibility. The more detailed information in Tables 4 and 5 provide relevant authorities with a context against which to consider an assessment of 'significance' for 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 authorities to formally consult English Nature over individual plans and projects where required to do so under the Regulations.

7.4 Update and review of advice

Information as to the operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species, for which the site has been designated, is provided in light of what English Nature knows about current activities and patterns of usage at Morecambe Bay European marine site. English Nature expects that the information on current activities and patterns of usage (which was used to derive Table 4) will be supplemented as part of the process of developing the management scheme through further discussion with the relevant authorities. The option of zoning this information may be appropriate. As such, it is important that future consideration of this advice by relevant authorities and others takes account of changes in the usage patterns that have occurred at the site, over the intervening period, since the advice was issued. In contrast, the information provided in this advice on the sensitivity of interest features or sub-features (Table 5) is relatively stable and will only change as a result of an improvement in our scientific knowledge, which will be a relatively long term process. Advice for sites will be kept under review and may be periodically updated through discussions 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.

7.5 Summary of advice on operations

7.5.1 Large shallow inlets and bay

In pursuit of the conservation objective for the large shallow inlets and bays, the relevant and competent authorities for the Morecambe Bay European marine site are advised to manage human activities within their remit such that they do not result in deterioration or disturbance to habitats or species, for which the site has been selected, through any of the following:

- Removal and/or smothering of embayment habitats.
- Physical damage resulting from siltation, abrasion and/or selective extraction.
- Increased synthetic, non synthetic toxic and/or radionuclide contamination.
- Nutrient and/or organic enrichment.
- Increases in turbidity.
- Introduction of microbial pathogens, introduction of non-native species and/or selective extraction of species for which the site has been selected or which form important food sources for such species.

7.5.2 Intertidal mudflats and sandflats

In pursuit of the conservation objective for the intertidal mudflats and sandflats, the relevant and competent authorities for Morecambe Bay European marine site are advised to manage human activities within their remit such that they do not result in deterioration or disturbance to habitats or species for which the site has been selected, through any of the following:

- Removal and/or smothering of intertidal mudflats and sandflats.
- Physical damage resulting from siltation and/or abrasion and/or selective extraction.
- Increased synthetic, non synthetic toxic and/or radionuclide contamination.
- Nutrient and/or organic enrichment.
- Increases in turbidity.
- Biological disturbance through the introduction of non-native species, microbial pathogens and/or selective extraction of species.

7.5.3 Pioneer saltmarsh

In pursuit of the conservation objective for the pioneer saltmarsh, the relevant and competent authorities for Morecambe Bay European marine site are advised to manage human activities within their remit such that they do not result in deterioration or disturbance to habitats or species for which the site has been selected, through any of the following:

- Removal of pioneer saltmarsh habitats.
- Physical damage resulting from abrasion.
- Increased synthetic and/or non synthetic toxic contamination and/or radionuclides.
- Translocation of species.

7.5.4 Saltmarsh

In pursuit of the conservation objective for the saltmarsh, the relevant and competent authorities for Morecambe Bay European marine site are advised to manage human activities within their remit such that they do not result in deterioration or disturbance to habitats or species, for which the site has been selected, through any of the following:

- Removal of saltmarsh habitats.
- Physical damage resulting from abrasion and/or selective extraction.
- Increased synthetic and/or non synthetic toxic contamination and/or radionuclides.
- Translocation of species.

7.5.5 SPA interest features

Sensitivity and vulnerability have been assessed in relation to the use of habitats by birds.

In pursuit of the conservation objective for habitats supporting internationally important populations of regularly occurring species listed on Annex 1 of the Birds Directive, the relevant and competent authorities for Morecambe Bay European marine site are advised to manage human activities within their remit such that they do not result in deterioration or disturbance to habitats or species, for which the site has been selected, through any of the following:

- Removal of habitats.
- Physical damage from abrasion and or selective extraction.
- Disturbance from noise and/or visual activities.

In pursuit of the conservation objective for habitats supporting the internationally important assemblages of waterfowl and seabirds including internationally important populations of regularly occurring migratory species, the relevant and competent authorities for Morecambe Bay European marine site are advised to manage human activities within their remit such that they do not result in deterioration or disturbance to habitats or species, for which the site has been selected, through any of the following:

- Removal of habitats.
- Physical damage from selective extraction.
- Disturbance from noise and/or visual activities.
- Nutrient and/or organic enrichment and/or changes in thermal regime.
- Changes in salinity and turbidity
- Increased synthetic and/or non synthetic toxic contamination and/or radionuclides.
- Biological disturbance through introduction of microbial pathogens and/or selective extraction of species.

Table 3 Showing operations which may cause deterioration or disturbance to Morecambe Bay European marine site interest features at current levels of use

The advice below is not a list of prohibitions but rather a checklist for operations which may need to be subject to some form of management measure(s) or further measures where actions are already in force. Examples of activities under relevant authority jurisdiction are also provided. Operations marked with a _ indicate those features (or some component of them) that are considered to be highly or moderately vulnerable to the effects of the operations [7].

Standard list of categories of operations which may cause deterioration or disturbance	Large shallow inlets and bays	Intertidal mudflats and sandflats	Pioneer saltmarsh	Saltmarsh	Interationally important Annex 1 birds	Internationally important assemblage of waterfowl & seabirds and migratory species.
Physical Loss						
Removal (eg. harvesting, land claim, coastal development)	✓	✓	✓	✓	✓	✓
Smothering (eg. by artificial structures, disposal of dredge spoil)	✓	✓				
Physical Damage						
Siltation (eg. run-off, channel dredging, outfalls)	✓	✓				
Abrasion (eg. boating, anchoring, trampling)	✓	✓	✓	✓	✓	
Selective extraction (eg. aggregate dredging, entanglement)	✓_	✓		✓	✓	✓
Non-physical disturbance						
Noise (eg. boat activity)					✓	✓
Visual presence (eg. recreational activity)					✓	✓
Toxic contamination						
Introduction of synthetic compounds (eg. pesticides, antifoulants, PCBs)	✓	✓	✓	✓		✓
Introduction of non-synthetic compounds (eg. heavy metals, hydrocarbons)	✓	✓	✓	✓		✓
Introduction of radionuclides	✓	✓	✓	✓		✓

Standard list of categories of operations which may cause deterioration or disturbance	Large shallow inlets and bays	Intertidal mudflats and sandflats	Pioneer saltmarsh	Saltmarsh	Interationally important Annex 1 birds	Internationally important assemblage of waterfowl & seabirds and migratory species.
Non-toxic contamination						
Nutrient enrichment (eg. agricultural run-off, outfalls)	✓	✓				✓
Organic enrichment (eg. mariculture, outfalls)	✓	✓				✓
Changes in thermal regime (eg. power stations)						✓
Changes in salinity (e.g. water abstraction, outfalls)						✓
Changes in turbidity (eg. run-off, dredging)	✓	✓				✓
Biological disturbance						
Introduction of microbial pathogens	✓	✓			✓	✓
Introduction of non-native species and translocation	✓	✓	✓	✓		✓
Selective extraction of species (eg. bait digging, wildfowling, commercial & recreational fishing)	✓	✓			✓	✓

7 This advice has been developed using best available scientific information and informed scientific interpretation and judgement (as at October 1999). This process has used a coarse grading of relative sensitivity, exposure and vulnerability of each interest feature to different categories of operation based on the current state of our knowledge and understanding of the marine environment. This is shown in the sensitivity and vulnerability matrices at Table 3. The advice is indicative only, and is given to guide relevant authorities and others on particular operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species for which the site has been designated. The advice, therefore, is not a list of prohibitions but rather a check list for operations which may need to be subject to some form of management measure(s) or further measures where actions are already in force.

The precise impact of any category of operation occurring on the site will be dependent upon the nature, scale, location and timing of events. More detailed advice is available from English Nature to assist relevant authorities in assessing actual impacts and cumulative effects. Assessment of this information should be undertaken in the development of the management scheme by the management group and through wider consultation.

In accordance with Government policy guidance, the advice on operations is feature and site specific, and provided in the light of current activities and patterns of usage at the site (as at October 1999). 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 will be kept under review and may be periodically updated through discussions with relevant authorities, and others, to reflect significant changes in our understanding of sensitivity together with the potential effects of plans or projects on the marine environment. The provision of the statutory advice given here, on operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species, for which the site has been designated, under Regulation 33(2), is provided without prejudice to specific advice given under Regulation 48 (3) or Regulation 50 on individual operations that qualify as plans or projects within the meaning of Article 6 of the Habitats Directive.

7.6 Interest feature and sub-feature specific advice on operations

This section provides information to help relate general advice to each of the specific interest features of the Morecambe Bay European marine site.

This advice relates to the vulnerability of the interest features and sub-features of the Morecambe Bay European marine site to current levels of human usage as set out in Tables 4 and 5, summarised in Table 3. An explanation of the sensitivity of the interest features or sub-features follows with an explanation of their exposure and therefore their vulnerability to damage or disturbance from the listed categories of operations. This enables links to be made between the categories of operation and the ecological requirements of the European marine site's interest features, as set out in Section 3.

7.6.1 Large shallow inlets and bays

i. Physical loss

- Morecambe Bay is the second largest bay in the England, after the Wash, and supports a wide diversity of habitats and species. It is also important as a habitat for feeding and breeding birds which rely on the structure and function of these habitats. Physical loss of the inlet and bay, or parts of it, as a result of activities such as coastal development, may lead to a changes in coastal processes, such as migration of river channels and changes in the sediment type, with consequences for the species composition of communities within the bay.

- All the sub-features of the embayment are sensitive to loss through direct removal or smothering. Either of these processes can be the result of one-off events or the cumulative effect of continuous activities. The intertidal and subtidal boulder and cobble skears and coastal lagoons are particularly vulnerable to removal as they are both highly sensitive and currently exposed to activities which may cause this effect.

- Many communities within the embayment are interdependent upon the ecological functioning of others and it is important that this potential indirect and cumulative effects are also assessed when the effects of removal or smothering are being considered.

ii. Physical damage

- All the sub-features of the embayment are sensitive to physical damage in the form of siltation. Many of the marine communities which are present within the predominantly sandy bay are sensitive to the siltation of fine material which may clog the feeding or respiratory structures of invertebrates. The subtidal boulder and cobble scar communities in the Walney Channel have a high vulnerability to siltation due to the high sensitivity of the delicate faunal communities which occur there and the exposure to current activities in the area, which may cause the re-suspension of sediment or can introduce fine material to the water column.

iii. Toxic contamination

- All sub-features are indicated as being moderately sensitive to synthetic and non-synthetic toxic contaminants such as PCBs and heavy metal based compounds, and as having a low sensitivity to radionuclides. Such contaminants may have lethal effects or sub-lethal effects on marine organisms and this will vary according to the state and availability of the compound and the characteristics of the organisms of the receiving systems. Lethal effects can remove individuals and species and thus leaving pollution tolerant and opportunistic species. Sub-lethal effects may affect the functioning of organisms such as reproduction, physiology, genetics and health, which will ultimately reduce the fitness for survival (Elliott *et al*., 1998). Sheltered, low energy areas such as enclosed bays are often more susceptible to these pollutants as dispersion is low and the finer substrata within these areas will act as sinks. There are a number of sources of a variety of

both synthetic and non-synthetic toxic contaminants within the Bay, to which all the sub-features within this interest feature are exposed. As a consequence, a moderate vulnerability rating is given It is important to note that toxic contamination can emanate from point sources such as effluent discharges, and from diffuse sources such atmospheric fall out of particulate material.

- Many compounds, present at low levels, can also be bioaccumulated within the tissues of marine organisms. This process has been demonstrated in a number of marine invertebrates, for example, tin in dogwhelks (Bryan *et al*., 1987). The organisms may be affected directly by the toxic effects of accumulated compounds, but importantly, may then enter the food chain if that organism is consumed by a higher predator, such as fish or waterfowl. Eelgrass communities for instance, provide a habitat for a host of invertebrate communities which could be affected by the contamination by toxic compounds such as oil.

- It is important that all stages within the life cycle of marine organisms are considered when assessing the effects of contaminants. Some adult species which occur in the sediments within the bay, for example, display a tolerance of heavy metal contamination, but the larval and juvenile stages can be very sensitive (Davidson and Hughes, 1998).

- The effects of radionuclides have been demonstrated in a number of marine organisms, such as invertebrates and fish (WRC, 1999). Depending on the radioactive dosage, lethal, genetic or reproductive effects may result. There is also evidence to show that radionuclides accumulate in biota, particularly benthic crustacea and molluscs, and saltmarsh grasses (WRC, 1999). Given the current levels of exposure of the sub-features within the shallow inlet and bay to radionuclides, there is concern as to their direct and indirect effects on communities. However, there is little information on both the levels of radionuclides entering the Bay and their effects and hence further investigation is needed.

iv. Non-toxic contamination

- Intertidal mudflats and sandflats and coastal lagoon communities are particularly sensitive to nutrient and organic enrichment. An increase in the nutrient loading within the lagoons, which may occur, for example, as a result of activities currently occurring within the Bay such as agricultural run-off, can cause the elevated growth of algae and phytoplankton. Increased levels of opportunistic algae such as *Enteromorpha* spp. may create anoxic conditions in the sediment below the algal mats, reduce the diversity and abundance of infauna and interfere with bird feeding (Simpson, 1997). Elevations in the organic material content of the water column and sediments, particularly in areas of reduced water exchange such as lagoons, can also result in reduced oxygen levels due to the increased activity of aerobic bacteria which break down the organic material. This can have knock-on effects for marine animals which require oxygen for their healthy functioning.

- Morecambe Bay is a naturally turbid environment. However, increases in turbidity may occur within the site as a result of activities which resuspend sediments such as physical disturbance of the seabed; introduce suspended solids such as domestic effluent discharges; or cause reduction in the clarity of the water column such as nutrient enrichment. Particularly sensitive communities which require sufficient water clarity may be affected in terms of their species diversity and abundance.

v. Biological disturbance

- Intertidal and subtidal boulder and cobble scar communities and intertidal boulder clay communities are moderately sensitive to biological disturbance through selective extraction. Characteristic species such as the edible mussel *Mytilus edulis,* play an important and complex role in the healthy functioning of the embayment, and the unsustainable harvesting or removal of such key species can affect the ecological balance of these communities with subsequent knock-on

effects on species higher up the food chain.

- Saltmarsh, pioneer saltmarsh and eelgrass on the intertidal mudflats and sandflats are sensitive to biological disturbance through the non-native species, cord grass *Spartina anglica.* This species, which occurs on the site and is increasing in its extent, is a robust and aggressive plant which out competes eelgrass and pioneer saltmarsh for suitable substrate and may reduce the diversity of established saltmarsh communities.

- All sub-features have a low sensitivity to the introduction of microbial pathogens. The effects of microbial pathogens will vary according to not only their type and abundance, but also to the nature of the environment which receives them. The ecological pathway of microbial pathogens which enter Morecambe Bay is complex and further research into their sources and effects is necessary. As a precautionary approach however, a moderate vulnerability rating is given for the sub-features of shallow inlets and bays.

7.6.2 Intertidal mudflat and sandflats

i. Physical loss

- Morecambe Bay encompasses the largest area of intertidal mudflats and sandflats in the UK and which support a wide range and number of invertebrate communities. Activities such as coastal development which may result in the physical loss of intertidal sediments through removal or smothering, have the potential to damage habitats directly as well as lead to changes in coastal processes which can alter the structure of intertidal mudflats and sandflats indirectly.

- Many communities that use the intertidal sediments are interdependent upon the ecological functioning of others (for example, invertebrate communities and waterfowl) and it is important that this potential indirect effect is considered when the effects of removal or smothering are being assessed.

ii. Physical damage

- Both mud and sand communities and eelgrass beds are sensitive to physical damage in the form of siltation, abrasion and selective extraction, with eelgrass beds being highly sensitive to abrasion and selective extraction. Physical damage of these communities can alter habitat structure which can lead to a change in the species composition. Ultimately, damage may lead to loss of habitat. Eelgrass is highly vulnerable to abrasion which on the site, may occur as a result of activities such as recreation. This is because the roots of eelgrass are situated within the top few centimetres of the sediment and so are easily damaged by physical disturbance and compaction.

iii. Toxic contamination

- As has been previously described within Section 7.6.1, a number of marine invertebrates, present in intertidal sediments, are sensitive to the lethal and non-lethal effects of toxic contaminants. Sheltered, low energy features such as mudflats and sandflats will act as sinks for many of these contaminants and if disturbed, may become bioavailable to marine organisms. Intertidal areas are also likely to be close to point sources of contaminants such as effluent discharges. A moderate vulnerability rating is therefore given in relation to toxic contamination. It is important to note that toxic contamination can also emanate from non-point sources such as such as atmospheric fall out of particulate material.

- Intertidal sediments within the Bay contain a high number and range of invertebrates which can bioaccumulate contaminants within their body tissues. The organisms may be affected directly by the toxic effects of accumulated compounds, but importantly, may then enter the food chain if that organism is consumed by a higher predator, such as fish or waterfowl. Eelgrass communities for

instance, provide a habitat for a host of invertebrate communities which could be affected by the contamination by toxic compounds such as oil.

- It is important that all stages within the life cycle of marine organisms are considered when assessing the effects of contaminants. Some adult species which occur in the sediments within the bay, for example, display a tolerance of heavy metal contamination, but the larval and juvenile stages can be very sensitive (Davidson and Hughes, 1998).

- The effects of radionuclides have been demonstrated in a number of marine organisms, such as invertebrates and fish, which are common to intertidal sediments (WRC, 1999). Depending on the radioactive dosage, lethal, genetic or reproductive effects may result. There is also evidence to show that radionuclides accumulate in biota, particularly benthic crustacea and molluscs, and saltmarsh grasses (WRC, 1999). Given the current levels of exposure of the sub-features of the intertidal mudflats and sandflats to radionuclides, there is concern as to their direct and indirect effects on communities. However, there is little information on both the levels of radionuclides entering the Bay and their effects and hence further investigation is needed.

iv. Non-toxic contamination

- Eelgrass beds are highly sensitive to nutrient enrichment. An increase in the nutrient levels within the water overlying the flats, or within the sediments themselves can alter the alter the ecology of the eelgrass communities in a number of ways. The growth of ephemeral algae such as *Enteromorpha* may smother developing eelgrass plants, and create anoxic conditions in the sediment below the algal mats which can reduce the diversity and abundance of infauna and interfere with bird feeding (Simpson, 1997). Algal blooms within the water column can reduce the penetration of light in the water column, due to a decrease in the clarity of the water and this can inhibit the growth of eelgrass plants which require light for photosynthesis. Nutrient enrichment can also affect eelgrass physiology and increase its susceptibility to infection from wasting disease. Wasting disease, caused by *Labrynthula macrocystis*, severely reduced eelgrass beds in the 1920's an 1930's all around the British Isles and they are only now starting to recover.

- Elevations in the organic material content of the water column and sediments, particularly in areas where eelgrass is present, can result in reduced oxygen levels due to the increased activity of aerobic bacteria which break down the organic material. This can have knock-on effects for many marine animals living within the eelgrass beds which require oxygen for their healthy functioning.

v) Biological disturbance.

- Eelgrass on the intertidal mudflats and sandflats is sensitive to biological disturbance by the non-native species such as cord grass *Spartina anglica*. This species, which occurs on the site and is increasing in its extent, is a robust and aggressive plant which may out compete eelgrass for suitable substrate and may ultimately lead to a reduction in the extent of the eelgrass bed.

- Mud and sand communities and eelgrass beds have a low sensitivity to the introduction of microbial pathogens. The effects of microbial pathogens however, will vary according to not only their type and abundance, but also to the nature of the environment which receives them. The ecological pathway of microbial pathogens into the intertidal sediment communities is complex and further research into their sources and effects is necessary. As a precautionary approach however, a moderate vulnerability rating is given for the sub-features of intertidal mudflats and sandflats.

- Selective extraction which may occur as a result of activities such as fishing or bait collection can have detrimental effects on the intertidal mudflats and sandflats, especially if the species extracted plays a crucial role in the structure and function of the feature. Key species such as cockles *Cerastoderma edule* have a major function in intertidal sediment ecosystems and their unsustainable harvesting can alter the ecological balance of the food web of which they are a part.

7.6.3 Pioneer saltmarsh

i. Physical loss

- Pioneer saltmarsh communities are sensitive to physical loss through removal, which may occur as a result of activities such as direct land claim and coastal construction. Coastal development may also create a barrier to the inland expansion of saltmarsh as a response to sea level rise. Changes to coastal processes can also alter the tidal regime which can affect the suitability of a habitat to saltmarsh plants. Given pioneer saltmarsh's high sensitivity to removal and current levels of exposure to this process, a high vulnerability rating is given.

ii. Physical damage

- Pioneer saltmarsh is sensitive to abrasion and this may occur on the site as a result of recreational activities such as off-road driving, which can compact the mudflat substrate and damage plants directly. This can lead to localised loss of habitat with a subsequent potential impact on the saltmarsh physical and ecological structure.

iii. Toxic contamination

- Pioneer saltmarsh communities are considered to have a moderate sensitivity to toxic contamination by synthetic and non-synthetic contaminants, and a low sensitivity to radionuclides. Although saltmarsh plants may be reasonably tolerant of heavy metals, they can bioaccumulate toxic compounds and act as sinks for them (Holt *et al*., 1995).

- Pioneer saltmarsh plants in particular are sensitive to contaminants such as oil. These plants are annuals with shallow roots and little underground storage capacity, and in the event of die-back of the surface plants will have little ability to recover. There is also evidence to show that radionuclides accumulate in saltmarsh grasses (WRC, 1999). Given the current levels of exposure of the pioneer saltmarsh to radionuclides, there is concern as to their direct and indirect effects on communities within it. However, there is little information on both the levels of radionuclides entering the Bay and their effects and hence further investigation is needed.

iv. Biological disturbance.

- Pioneer saltmarsh communities may be sensitive to biological disturbance by translocated species such as cord grass *Spartina anglica.* This species, which occurs on the site and is increasing in its extent, is a robust and aggressive plant which may in some circumstances outcompete pioneer saltmarsh for suitable substrate.

7.6.4 Saltmarsh

i. Physical loss

- All the sub-features saltmarsh are sensitive to physical loss through removal, which may occur as a result of activities such as direct land claim and coastal construction. Coastal development may also create a barrier to the inland expansion of the saltmarsh as a response to sea level rise. It can also result in shoreline adjustment and progradation of the saltmarsh. Changes to coastal processes can also alter the tidal regime which can affect the suitability of a habitat to saltmarsh plants.

ii. Physical damage

- Saltmarsh is sensitive to abrasion and selective extraction and this may occur on the site as a result of recreational activities such as off-road driving, which can compact the mudflat substrate and damage plants directly, and as a result of overgrazing which can lead to the loss of key saltmarsh species. The saltmarsh sub-features form a closely interrelated transition and damage of any one or more of the sub-features may affect the overall community structure of the interest feature.

iii. Toxic contamination

- Saltmarsh plants are considered to have a moderate sensitivity to toxic contamination by synthetic and non-synthetic contaminants, and a low sensitivity to radionuclides. Although saltmarsh plants may be reasonable tolerant of heavy metals, they can bioaccumulate toxic compounds and act as sinks for them (Holt *et al*., 1995). This can have implications for the organisms, such as waterfowl, which depend upon a functioning healthy saltmarsh.

- Saltmarshes are very sensitive to oil, even at relatively low levels (Holt *et al.*, 1995). This is mainly by virtue of their ability to trap sediments. Acute events such as oil spills can be particularly damaging to saltmarsh plants. Radionuclides can accumulate in saltmarsh grasses (WRC, 1999). Given the current levels of exposure of the saltmarsh to radionuclides, there is concern as to their direct and indirect effects on communities within it. However, there is little information on both the levels of radionuclides entering the Bay and their effects and hence further investigation is needed.

iv. Biological disturbance.

- Saltmarsh communities may be sensitive to biological disturbance through the translocated species cord grass *Spartina anglica.* This species, which occurs on the site and is increasing in its extent, is a robust and aggressive plant which may outcompete many saltmarsh plants for suitable substrate and light.

7.6.5 Internationally important populations of regularly occurring species listed on Annex 1 of the Birds Directive

i. Physical loss

- Morecambe Bay provides important breeding and feeding habitats for a internationally important population of breeding Sandwich terns *Sterna sandvicensis*. Loss of the shingle habitat on which the terns nest can reduce the overall area available within the site for their breeding. Loss of shallow water overlying intertidal sediment habitat can remove important marine invertebrates on which feeding birds depend. Due to their high sensitivity and their current level of exposure, shingle habitats have a high vulnerability.

- Removal of breeding and feeding habitat may also lead to changes in coastal processes for example increased wave exposure which can exacerbate habitat loss and can change the nature of existing sediments.

ii. Physical damage

- Habitats within Morecambe Bay which support sandwich terns are also sensitive to physical damage, particularly abrasion and selective extraction. Physical disturbance of shingle can reduce its suitability to nesting and feeding terns. Shingle habitats are currently exposed to to activities which may cause physical damage such as recreation and are considered highly vulnerable.

iii. Non-physical disturbance

- Nesting sandwich terns are particularly sensitive to human activities which cause noise or visual disturbance. They are especially sensitive to disturbance during the summer months when they are at their nests. Both noise and visual disturbance can cause terns to move from their nests which will leave the eggs and young at risk to predators and physical damage.

- Disturbance can exclude birds from large areas of suitable habitat which they would otherwise use to breed or feed. Having to feed on less optimal habitats may mean that they use more energy to find a smaller amount of food.

iv. Toxic contamination

- Sandwich terns are sensitive to synthetic and non-synthetic toxic contaminants which can enter the food chain via marine invertebrates which they feed upon. These are eaten by birds which can receive potentially fatal doses as the chemical bioaccumulates in their bodies. Lethal effects depend on the type and concentration of the toxic compound. Sub-lethal effects may occur where the chemical alters the birds functioning (e.g. reproduction, physiology, genetics and immune system).

- Marine organisms, which can be eaten by sandwich terns, are sensitive to toxic contaminants for the reasons outlined in earlier sections. This may have implications for the health of the sandwich terns, not only because of their bioaccumulative properties, but also in relation to quality and extent of the necessary food resource.

vi. Biological disturbance

- Selective extraction of elements of the habitats necessary to the Sandwich terns, for example removal of invertebrates and fish through fishing activities, may reduce the suitability of the habitat to feeding by the terns. The intertidal sediment food web is very complex and many communities interdepend on each other for their healthy functioning.

7.6.6 An internationally important assemblage of waterfowl and seabirds including internationally important populations of regularly occurring migratory species

i. Physical loss

- Morecambe Bay provides important breeding, feeding and roosting habitats for a an internationally important assemblage of waterfowl including internationally important populations of regularly occurring migratory species. Loss by removal of any of the habitats on which they rely would be detrimental to the favourable condition of the feature. Loss of intertidal sediment habitat can remove important marine invertebrates on which waterfowl in particular depend as a source of food.

- Removal of breeding, feeding and roosting habitat may also lead to changes in coastal processes for example increased wave exposure which can exacerbate habitat loss and can change the nature of existing sediments.

ii. Physical damage

- Habitats within Morecambe Bay which support waterfowl and seabirds are also sensitive to physical damage, particularly selective extraction. Removal of key elements of important habitats, such as coastal lagoon communities, can reduce its suitability as a feeding area.

iii. Non-physical disturbance

- Birds can be disturbed by human activities when they are feeding or roosting. They are particularly sensitive to disturbance in the winter months when there are only short daylight hours for feeding and birds cannot afford to loose time and waste energy moving from disturbed areas.

- During winter high spring tides, birds are pushed high up the shore to small roost areas, which are left uncovered by the tide. They can easily be disturbed at these areas and if forced to fly off they will waste their limited energy reserves.

- Disturbance can exclude birds from large areas of suitable habitat which they would otherwise use. Having to feed on less optimal habitats may mean that they use more energy to find a smaller amount of food.

iv. Toxic contamination

- Feeding birds are sensitive to synthetic and non-synthetic toxic contaminants which can enter the food chain via marine invertebrates which they may feed upon. These are eaten by birds which can receive potentially fatal doses as the chemical bioaccumulates in their bodies. Lethal effects depend on the type and concentration of the toxic compound. Sub-lethal effects may occur where the chemical alters the birds functioning (e.g. reproduction, physiology, genetics and immune system).

- Marine organisms, which can be eaten by waterfowl and seabirds, are sensitive to toxic contaminants for the reasons outlined in earlier sections. This may have implications for the health of the birds, not only because of their bioaccumulative properties, but also in relation to quality and extent of the necessary food resource.

v. Non-toxic contamination

- Nutrient and organic enrichment can effect birds feeding habitats either positively by increasing food availability or negatively by altering species composition to less favourable prey species. Changes in thermal regime and salinity can affect coastal lagoons by altering the macroalgal species present and changes in turbidity can reduce suitable habitat for prey species..

vi. Biological disturbance

- Selective extraction of elements of the habitats necessary to waterfowl and seabirds, for example removal of invertebrates through fishing activities, may reduce the suitability of the habitat to feeding. The intertidal sediment food web is very complex and many communities interdepend on each other for their healthy functioning.

7.6.7 Plans and Projects

Under Regulation 48(1), an appropriate assessment needs to be undertaken in respect of any plan or project which:

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

An appropriate assessment is required by law for all European Sites (Regulation 48). A European Site is any classified SPA and any SAC from the point where the Commission and the Government agree the site as a Site of

Community Importance. Appropriate assessment is also required, as a matter of Government policy, for potential SPAs, candidate SACs and listed RAMSAR Sites for the purpose of considering development proposals affecting them. (PPG 9 paras 13 and C7).

Tables 3, 4 and 5 provide relevant authorities with a guide against which to initiate an assessment of the 'significance' of any plans or projects (and ongoing operations or activities) proposed for the site although this will only be the starting point for assessing impacts and does not remove the need for relevant authorities to formally consult English Nature over individual plans and projects where required under the Regulations.

7.6.8 Review of consents

Regulation 50 of The Conservation (Natural Habitats, &c.) Regulations 1994 requires competent authorities to undertake a review of all existing consents and permissions affecting cSAC and SPAs, as soon as possible after the site officially becomes a Site of Community Importance. This will have implications for discharge and other consents, which will need to be reviewed in light of these objectives and may mean that lower targets for background levels of contaminants etc will need to be set.

Table 4. Assessment of the relative exposure of interest features and sub-features of Morecambe Bay European Marine site to different categories of operations based on current level of activities (October 1999)

Key High= High exposure (3) Med =Medium exposure (2) Low= Low exposure (1)

Categories of operation which may cause deterioration or disturbance	Large shallow inlets & bays					Intertidal mudflats and sandflats		Pioneer saltmarsh	Saltmarsh
	Intertidal & subtidal boulder &cobble skear communities	*Brittlestar beds*	*Intertidal mudflats & sandflats, Pioneer saltmarsh, and Saltmarsh*	*Intertidal boulder clay communities*	*Coastal lagoon communities*	*Mud and sand communities*	*Eelgrass bed communities*	*Glasswort communities*	*High, mid, low & transitional communities*
Physical loss									
Removal (e.g. harvesting, land claim)	Med	Low	(For information of the sensitivity and vulnerability of these sub-features see the individual assessments made elsewhere in this table).	Low	Med	Med	Low	Med	Med
Smothering (e.g. by artificial structures, disposal of dredge spoil)	Low	Low		Low	Low	Low	Low	Low	Low
Physical damage									
Siltation (e.g. run-off, channel dredging, outfalls)	Med	Med		Med	Med	Med	Med	Low	Low
Abrasion (e.g. boating, anchoring, trampling).	Med	Low	(For information of the sensitivity and vulnerability of these sub-features see the individual assessments made elsewhere in this table)	Low	Low	Med	High	Med	Med
Selective extraction (e.g. aggregate dredging, entanglement, turf cutting).	Low	Low		Low	Low	Low	Low	Low	Med
Non-physical disturbance									
Noise (e.g. boat activity)	None	None		None	None	None	None	None	None
Visual (e.g. recreational activity)	None	None		None	None	None	None	None	None
Toxic contamination									

Categories of operation which may cause deterioration or disturbance	**Large shallow inlets & bays**					**Intertidal mudflats and sandflats**		**Pioneer saltmarsh**	**Saltmarsh**
	Intertidal & subtidal boulder &cobble skear communities	*Brittlestar beds*	*Intertidal mudflats & sandflats, Pioneer saltmarsh, and Saltmarsh*	*Intertidal boulder clay communities*	*Coastal lagoon communities*	*Mud and sand communities*	*Eelgrass bed communities*	*Glasswort communities*	*High, mid, low & transitional communities*
Introduction of synthetic compounds (e.g. pesticides, antifoulants, PCBs)	Med	Med	this table).	Med	Med	Med	Med	Med	Med
Introduction of non-synthetic compounds (e.g. heavy metals, hydrocarbons)	Med	Med		Med	Med	Med	Med	Med	Med
Introduction of radionuclides	Med	Med		Med	Med	Med	Med	Med	Med
Non-toxic contamination									
Nutrient enrichment (e.g. agricultural run-off, outfalls)	Med	Med		Med	Med	Med	High	Med	Med
Organic enrichment (e.g. mariculture, outfalls)	Med	Med		Med	Med	Med	High	Med	Med
Changes in thermal regime (e.g. power stations)	Low	Low		Low	Low	Low	Low	Low	Low
Changes in salinity (e.g. water abstraction, outfalls).	Low	Low	(For information of the sensitivity and vulnerability of these sub-features see the individual assessments made elsewhere in this table).	Low	Low	Low	Low	Low	Low
Changes in turbidity (e.g. run-off, dredging)	High	High		High	High	Low	High	Low	Low
Biological disturbance									
Introduction of microbial pathogens	High	High		High	High	High	High	High	High
Introduction of non-native species & translocation	Low	Low		Low	Low	Med	High	High	High
Selective extraction of species (e.g. bait digging, wildfowling, commercial & recreational fishing)	Med	Low		Med	Med	Med	Med	Low	Low

Categories of operation which may cause deterioration or disturbance	Internationally important populations of regularly occurring bird species listed on Annex 1 of the Birds Directive.	Internationally important assemblage of waterfowl and seabirds, including the internationally important populations of regularly occurring migratory species			
	Shingle habitats	*Intertidal mudflat and sandflat communities*	*Intertidal and subtidal boulder and cobble skear communities*	*Saltmarsh communities*	*Coastal lagoon communities*
Physical loss					
Removal (e.g. harvesting, land claim)	High	Med	Med	Med	Med
Smothering (e.g. by artificial structures, disposal of dredge spoil)	Low	Low	Low	Low	Low
Physical damage					
Siltation (e.g. run-off, dredging, outfalls)	Low	Med	Med	Low	Med
Abrasion (e.g. boating, anchoring, trampling).	High	Med	Med	Med	Low
Selective extraction (e.g. aggregate dredging, entanglement, turf cutting).	Low	Low	Low	Med	Low
Non-physical disturbance					
Noise (e.g. boat activity)	High	Med	Med	Med	Med
Visual (e.g. recreational activity)	High	Med	Med	Med	Med
Toxic contamination					
Introduction of synthetic compounds (e.g. Pesticides, antifoulants, PCBs)	Low	Med	Med	Med	Med
Introduction of non-synthetic compounds (e.g. heavy metals, hydrocarbons)	Low	Med	Med	Med	Med

Categories of operation which may cause deterioration or disturbance	Internationally important populations of regularly occurring bird species listed on Annex 1 of the Birds Directive.	Internationally important assemblage of waterfowl and seabirds, including the internationally important populations of regularly occurring migratory species			
	Shingle habitats	*Intertidal mudflat and sandflat communities*	*Intertidal and subtidal boulder and cobble skear communities*	*Saltmarsh communities*	*Coastal lagoon communities*
Introduction of radionuclides	Low	Med	Med	Med	Med
Non-toxic contamination					
Nutrient enrichment (e.g. agricultural run-off, outfalls)	Low	Med	Med	Med	Med
Organic enrichment (e.g. mariculture, outfalls)	Low	Med	Med	Med	Med
Changes in thermal regime (e.g. outfalls, power stations)	Low	Low	Low	Low	Low
Changes in salinity (e.g. water abstraction, outfalls)	Low	Low	Low	Low	Low
Changes in turbidity (e.g. run-off, dredging)	Low	Low	High	Low	High
Biological disturbance					
Introduction of microbial pathogens	Low	High	High	High	High
Introduction of non-native species & translocation	Low	Low	Low	High	Low
Selective extraction of species (e.g. bait digging, wildfowling, commercial & recreational fishing)	Low	Med	Med	Low	Med

Table 5. **Assessment of the relative vulnerability of interest features and sub-features of Morecambe Bay European Marine site to different categories of operations. Categories of operations to which the features or sub-features of the site are highly or moderately vulnerable are indicated by shading. Table also incorporates relative sensitivity scores used in part to derive vulnerability.**

Key

High vulnerability

Moderate vulnerability

●●●● High sensitivity

●●● Moderate sensitivity

●● Low sensitivity

● No detectable sensitivity

Categories of operation which may cause deterioration or disturbance	**Large shallow inlets & bays**					**Intertidal mudflats and sandflats and**		**Pioneer saltmarsh**	**Saltmarsh**
	Intertidal & subtidal boulder &cobble skear communities	*Brittlestar beds*	*Intertidal mudflats & sandflats, Pioneer saltmarsh, and Saltmarsh*	*Intertidal boulder clay communities*	*Coastal lagoon communities*	*Mud and sand communities*	*Eelgrass bed communities*	*Glasswort communities*	*High, mid, low & transitional communities*
Physical loss									
Removal (e.g. harvesting, land claim)	●●●●	●●●●	(For information of the sensitivity and vulnerability of these sub-features see the individual assessments made elsewhere in this table).	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Smothering (e.g. by artificial structures, disposal of dredge spoil)	●●●●	●●●●		●●●●	●●●	●●●	●●●●	●●●	●●●
Physical damage									
Siltation (e.g. run-off, channel dredging, outfalls)	●●●●	●●●		●●●	●●●	●●●	●●●	●●	●●
Abrasion (e.g. boating, anchoring, trampling).	●●●	●●		●●●	●●●	●●●	●●●●	●●●	●●●

Categories of operation which may cause deterioration or disturbance	**Large shallow inlets & bays**					**Intertidal mudflats and sandflats and**		**Pioneer saltmarsh**	**Saltmarsh**
	Intertidal & subtidal boulder &cobble skear communities	*Brittlestar beds*	*Intertidal mudflats & sandflats, Pioneer saltmarsh, and Saltmarsh*	*Intertidal boulder clay communities*	*Coastal lagoon communities*	*Mud and sand communities*	*Eelgrass bed communities*	*Glasswort communities*	*High, mid, low & transitional communities*
Selective extraction (e.g. aggregate dredging, entanglement, turf cutting).	●●●●	●●●	(For information of the sensitivity and vulnerability of these sub-features see the individual assessments made elsewhere in this table).	●●●●	●●●●	●●●	●●●●	●●●	●●●
Non-physical disturbance									
Noise (e.g. boat activity)	●	●		●	●	●	●	●	●
Visual (e.g. recreational activity)	●	●		●	●	●	●	●	●
Toxic contamination									
Introduction of synthetic compounds (e.g. pesticides, antifoulants, PCBs)	●●●●	●●●●		●●●●	●●●●	●●●●	●●●●	●●●●	●●●●
Introduction of non-synthetic compounds (e.g. heavy metals, hydrocarbons)	●●●	●●●		●●●	●●●	●●●	●●●	●●●	●●●
Introduction of radionuclides	●●●	●●●		●●●	●●●	●●●	●●●	●●●	●●●
Non-toxic contamination									
Nutrient enrichment (e.g. agricultural run-off, outfalls)	●●	●●		●●	●●●●	●●	●●●●	●●	●●
Organic enrichment (e.g. mariculture, outfalls)	●●	●●		●●	●●●●	●●	●●●	●●	●●
Changes in thermal regime (e.g. power stations)	●●●	●●●		●●●	●●●	●●●	●●●	●●●	●●●
Changes in salinity (e.g. water abstraction, outfalls)	●●	●●		●●	●	●●	●●●	●●●	●
	●●●	●●●		●●●	●●●	●●●	●●●	●●	●●

Categories of operation which may cause deterioration or disturbance	**Large shallow inlets & bays**					**Intertidal mudflats and sandflats and**		**Pioneer saltmarsh**	**Saltmarsh**
	Intertidal & subtidal boulder &cobble skear communities	*Brittlestar beds*	*Intertidal mudflats & sandflats, Pioneer saltmarsh, and Saltmarsh*	*Intertidal boulder clay communities*	*Coastal lagoon communities*	*Mud and sand communities*	*Eelgrass bed communities*	*Glasswort communities*	*High, mid, low & transitional communities*
Changes in turbidity (e.g. run-off, dredging)									
Biological disturbance									
Introduction of microbial pathogens	●●	●●	(For information of the sensitivity and vulnerability of these sub-features see the individual assessments made elsewhere in this table).	●●	●●	●●	●●	●	●
Introduction of non-native species & translocation	●●	●●		●●	●●	●●	●●●●	●●●	●●●
Selective extraction of species (e.g. bait digging, wildfowling, commercial & recreational fishing)	●●●	●●●		●●●●	●●●	●●●	●●●●	●●●	●●●

Categories of operation which may cause deterioration or disturbance	Internationally important populations of regularly occurring bird species listed on Annex 1 of the Birds Directive.		Internationally important assemblage of waterfowl and seabirds, including the internationally important populations of regularly occurring migratory species			
	Shingle habitats	*Intertidal mudflats and sandflats*	*Intertidal mudflat and sandflat communities*	*Intertidal and subtidal boulder and cobble skear communities*	*Saltmarsh communities*	*Coastal lagoon communities*
Physical loss						
Removal (e.g. harvesting, land claim)	●●●●	●●	●●●●	●●●●	●●●●	●●●●
Smothering (e.g. by artificial structures, disposal of dredge spoil)	●	●●	●●●	●●●	●●●●	●●
Physical damage						
Siltation (e.g. run-off, dredging, outfalls)	●	●●●	●●	●●	●●	●●
Abrasion (e.g. boating, anchoring, trampling).	●●●●	●●	●●	●●	●●	●●
Selective extraction (e.g. aggregate dredging, entanglement, turf cutting).	●●●●	●●	●●	●●	●●	●●●●
Non-physical disturbance						
Noise (e.g. boat activity)	●●●●	●●	●●●●	●●●●	●●●●	●●●●
Visual (e.g. recreational activity)	●●●●	●●	●●●●	●●●●	●●●●	●●●●
Toxic contamination						
Introduction of synthetic compounds (e.g. Pesticides, antifoulants, PCBs)	●	●●●●	●●●●	●●●●	●●●●	●●●●
Introduction of non-synthetic compounds (e.g. heavy metals, hydrocarbons)	●	●●●	●●●	●●●	●●●	●●●
Introduction of radionuclides	●●	●●●	●●●	●●●	●●●	●●●
Non-toxic contamination						

Categories of operation which may cause deterioration or disturbance	Internationally important populations of regularly occurring bird species listed on Annex 1 of the Birds Directive.		Internationally important assemblage of waterfowl and seabirds, including the internationally important populations of regularly occurring migratory species			
	Shingle habitats	*Intertidal mudflats and sandflats*	*Intertidal mudflat and sandflat communities*	*Intertidal and subtidal boulder and cobble skear communities*	*Saltmarsh communities*	*Coastal lagoon communities*
Nutrient enrichment (e.g. agricultural run-off, outfalls)	●●●	●●	●●●	●●●●	●●	●●●●
Organic enrichment (e.g. mariculture, outfalls)	●	●●	●●●	●●●●	●●	●●●●
Changes in thermal regime (e.g. outfalls, power stations)	●	●●	●●	●●	●●	●●●●
Changes in salinity (e.g. water abstraction, outfalls)	●	●●	●●	●	●	●●●
Changes in turbidity (e.g. run-off, dredging)	●	●●●	●●	●●	●●	●●
Biological disturbance						
Introduction of microbial pathogens	●	●●	●●	●●	●●	●●
Introduction of non-native species & translocation	●	●●	●●	●●	●●	●●
Selective extraction of species (e.g. bait digging, wildfowling, commercial & recreational fishing)	●	●●●	●●●	●●●	●●●	●●●●

English Nature's advice on operations is derived from an assessment combining relative sensitivity of the features or sub-features with information on human usage of the site, to identify relative vulnerability to categories of operations. In accordance with Government policy guidance this advice is provided in the light of current activities and patterns of usage at the site. It is important therefore that future consideration of this advice by relevant authorities, and others, takes account of changes in the usage patterns at the site. In contrast, the sensitivity of interest features, or sub-features, is relatively stable with alterations reflecting improvement in our scientific knowledge and understanding. To this end, information on sensitivity has been included in this table to assist the management and advisory groups with the future management of the site.

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9. Glossary

Advisory Group	The body of representatives from local interests, user groups and conservation groups, formed to advise the management group
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/sub-feature which provides an indication of the condition of the feature or sub-feature to which it applies.
BAP	Biodiversity Action Plan.
Benthos	Those organisms attached to, or living on, in or near, the seabed, including that part which is exposed by tides.
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.
Biodiversity	The total variety of life on earth. This includes diversity within species, between species and of ecosystems.
Characteristic	Special to or especially abundant in a particular situation or biotope. Characteristic species should be immediately conspicuous and easily identified.
Circalittoral	The rocky subtidal zone below that is dominated by algae (Animal dominated subtidal zone)
Community	A group of 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.
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.
Epifauna	Benthic animals living on the seabed.
European marine site	A European site (SAC or SPA) which consists of, or in so far as it consists of, marine areas.
Favourable conservation status	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.
Favourable condition	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 within an individual Natura 2000 site in the long term. The condition in which the habitat or species is capable of sustaining itself on a long-term basis.
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Habitat	The place in which a plant or animal lives.
Habitats Directive	The abbreviated term for *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.
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 specific component of their fauna and flora, or any Annex II species and any population of a bird species for which and SPA has been designated under the Birds Directive. Any habitat of a species for which a site has been selected, or typical species of an Annex I habitat are also considered to be interest features.
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.
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
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' (*qv*)
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
Plan or project	Any proposed development that is within a relevant authority's function to control, or over which a competent authority has a statutory function to decide on applications for consents, authorisations, licences or permissions.
Peak mean counts (5yr)	Morecambe Bay 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 Morecambe Bay are then averaged over a five year period to give the 5yr peak mean count.
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.
Restore	The action required for an interest feature when it is not considered to be in a favourable condition.
Sensitivity	The intolerance of a habitat, community or individual species to damage from an external force.
Subfeature	An ecologically important sub-division of an interest feature.
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

Appendix I Matrix of relative vulnerability

The relative vulnerability of an interest feature or sub-feature is determined by multiplying the scores for relative sensitivity and exposure, and classifying that total into categories of relative vulnerability.

Relative exposure of the interest feature	Relative sensitivity of the interest feature: High (4)	Medium (3)	Low (2)	None detectable (1)
High (4)	9	6	3	0
Medium (3)	6	4	2	0
Low (2)	3	2	1	0
None (1)	0	0	0	0

Categories of relative vulnerability

High	6 - 9
Medium	3 - 5
Low	1 - 2
None detectable	0

APPENDIX II List of relevant authorities

Relevant Authority	Address
Chair: John Hetherington, Cumbria County Council.	Economy and Environment, Cumbria County Council, County Offices, Kendal. LA9 4RQ
Joyce Holden, Lancashire County Council.	Environment Directorate, PO Box 9, Guild House, Cross Street, Preston. PR1 8RD
Jim Andrews, NW&NW Sea Fisheries Committee.	North Western & North Wales Sea Fisheries Committee, Lancaster University, Bailrigg, Lancaster. L1 4YY
Ed Mycock, Environment Agency	Environment Agency, Dodd Way, Off Seedlee Road, Walton Summit, Bamber Bridge, Preston. PR5 8BX
Steve Garner, Environment Agency.	Environment Agency, Ghyll Mount, Gillan Way, Penrith 40 Business Park, Penrith, Cumbria. CA11 9BP
Julian Inman, Lancaster City Council.	Lancaster City Council, Palatine Hall, Dalton Square, Lancaster. LA1 1PW
Mike Parker, MAFF.	MAFF Fisheries Office, Bradley's Chambers, 26 London Road, Fleetwood. FY7 6JG
Susannah Bleakley, Morecambe Bay Partnership	Morecambe Bay Partnership, 32 Market Place, Kendal, Cumbria. LA9 4TN
Richard Greenwood, South Lakeland District Council	South Lakeland District Council, Planning Department, South Lakeland House, Lowther Street, Kendal. LA9 4DL
Colin Hurst, Wyre Borough Council	Wyre Borough Council, Planning Department, Wyre Civic Centre, Breck Road, Poulton-le-Fylde. FY6 7PU
Captain John Green, Associated British Ports	Associated British Ports, Port Office, Ramsden Dock, Barrow-in-Furness. LA14 2TW
Captain Maclean, Heysham Port Authority	Heysham Port Ltd, North Quay, Heysham, Lancashire. LA3 2XF
Neil Fletcher, English Nature	English Nature, Cumbria Team, Juniper House, Murley Moss, Oxenholme Road, Kendal. LA9 7RL
Chris Lumb, English Nature	English Nature, Cumbria Team, Juniper House, Murley Moss, Oxenholme Road, Kendal. LA9 7RL
Phil Huck, Barrow Borough Council.	Barrow Borough Council, Town Hall, Barrow-in-Furness. LA14 2LD
Alan Chester, North West Water.	North West Water, Minsfeet Road South, Kendal, Cumbria. PO Box 67 LA9 6GR
John Nash, Lake District National Park Authority.	Lake District National Park Authority, Murley Moss, Oxenholme Road, Kendal. LA9 4UG

APPENDIX III SAC and SPA location maps