European Community Directive
on the Conservation of Natural Habitats
and of Wild Fauna and Flora
(92/43/EEC)

Second Report by the United Kingdom under Article 17

on the implementation of the Directive from January 2001 to December 2006

Conservation status assessment for :

H1130: Estuaries

Please note that this is a section of the report. For the complete report visit http://www.jncc.gov.uk/article17

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

H1130 Estuaries

Audit trail compiled and edited by JNCC and the UK Inter-Agency Marine Monitoring Group

This paper and accompanying appendices contain background information and data used to complete the standard EC reporting form (Annex D), following the methodology outlined in the commission document "Assessment, monitoring and reporting under Article 17 of the Habitats Directive, Explanatory Notes and Guidelines, Final Draft 5; October 2006". The superscript numbers below cross-reference to the headings in the corresponding Annex D reporting form. This supporting information should be read in conjunction with the UK approach for habitats (see 'Assessing Conservation Status: UK Approach').

1. National-biogeographic level information

1.1 General description and correspondence with NVC and other habitat types

Table 1.1.1 provides a summary description of H1130 and its relations with UK classifications.

Estuaries are complex ecosystems that link terrestrial and aquatic environments. The structure of estuaries is largely determined by geomorphological and hydrographic factors. There are four main sub-types that have been defined in the UK (Jackson and McLeod, 2000, 2002):

1. *Coastal plain estuaries*. These estuaries have formed where pre-existing valleys were flooded at the end of the last glaciation. They are usually less than 30m deep, with a large width-to-depth ratio. This is the main sub-type of estuary, by area, in the UK.
2. *Bar-built estuaries*. These characteristically have a sediment bar across their mouths and are partially drowned river valleys that have subsequently been inundated. Bar-built estuaries tend to be small but are widespread around the UK coast.
3. *Complex estuaries*. These have been formed by a variety of physical influences, which include glaciation, river erosion, sea-level change and geological constraints from hard rock outcrops. There are few examples of this sub-type of estuary in the UK.
4. *Ria estuaries*. Rias are drowned river valleys, characteristically found in south-west Britain. The estuarine part of these systems is usually restricted to the upper reaches. The outer parts of these systems are little diluted by freshwater and typically conform to Annex I type 1160 Large shallow inlets and bays.

There is a gradient of salinity from freshwater at the estuary head to increasingly marine conditions towards the open sea. Marine inlets where seawater is not significantly diluted by freshwater are considered as Annex I feature type 1160 Large shallow inlets and bays. (JNCC, 2004, Jackson and McLeod, 2000, 2002) and will be discussed in that report.

Estuaries are composed of a mosaic of subtidal and intertidal habitats that support populations of important species. The combination of sediment input from freshwater sources and sheltered inlets and bays in an estuary often leads to the presence of extensive sediment flats, such as intertidal mudflats and sandflats, sandbanks and salt marshes. These together with rocky reefs, are notified features in their own right (e.g. 1140 Mudflats and sandflats not covered by sea water at low tide, 1110 Sandbanks which are slightly covered by sea water all the time and 1170 Reefs).

Table 1.1.1 Summary description of habitat H1130 and its relations with UK vegetation/habitat classifications.

Classification	Correspondence with Annex I type	Comments
EU Interpretation Manual	= H1130	Downstream part of a river valley, subject to the tide and extending from the limit of brackish waters. River estuaries are coastal inlets where, unlike 'large shallow inlets and bays' there is generally a substantial freshwater influence. The mixing of freshwater and sea water and the reduced current flows in the shelter of the estuary lead to deposition of fine sediments, often forming extensive intertidal sand and mud flats. Where the tidal currents are faster than flood tides, most sediments deposit to form a delta at the mouth of the estuary (European Commission, 2003).
CSM reporting categories	Estuaries	No description available.
BAP priority habitat type	Not applicable	Various BAP habitats occur within estuaries (e.g. mudflat, sandflat, eel grass bed, littoral sediment), however these also occur widely outside of estuaries.

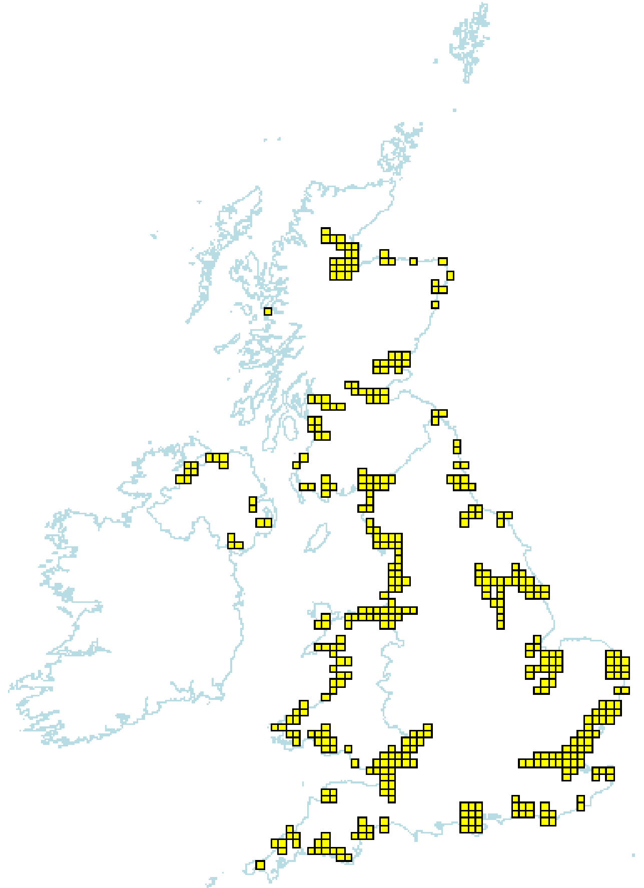
2. Range [2.3]

2.1 Current range

Range surface area[2.3.1]: **3,084 km²** (10-km square count: 404)
Date calculated[2.3.2]: **May 2007**
Quality of data [2.3.3]: **Good**
Maps 2.1.1 and 2.1.2 show the range and distribution of H1110 in the UK.

For the purposes of this assessment, the estuaries used have been taken from shapefiles of estuary locations within the *UKSeaMap* project (Connor, *et al*., 2006) with additional data for Northern Ireland coming from the NCC's *Nature conservation and estuaries in Great Britain* (Davidson *et al*., 1991) and from shapefiles provided by EHS. The range has been calculated from these sources in a GIS environment.

Estuaries are widely distributed around the coast but there are few examples in some areas, such as Northern Ireland and Western Scotland (Jackson and McLeod 2000, updated 2002). The UK has over 120 estuaries; the exact figure varies depending on the definition of an estuary, how these have been surveyed/mapped and how estuaries have been amalgamated into estuary complexes (i.e. where more than one river discharges into the same stretch of coast). For example, the Rivers Ore, Alde and Butley system, and Esk, Mite and Irt system are considered to be single estuaries by Buck (1993, 1997) and in *UKSeamap* (Connor, *et al*., 2006). *UKSeaMap* also combines the Mersey and Alt estuaries, whereas these are considered as separate in the Joint Nature Conservation Committee (JNCC) *Inventory of UK Estuaries* (Buck, 1993, 1997). In addition, the *Inventory* included some sites (mostly embayments, fjords and rias) that have been reclassified since the adoption of the Habitats Directive, and are now considered to correspond to the Annex I feature type 1160 Large shallow inlets and bays - these sites have been removed from the list of estuaries for this assessment. The total number of UK estuaries (given earlier caveats) is therefore 125.

Map 2.1.1 Habitat range map [1.1] for H1130	**Map 2.1.2** Habitat distribution map [1.2] for H1130
	
Data source: *UKSeaMap* for GB (Connor *et al.*, 2006) and Davidson *et al.*, 1991 for NI.	Data source: *UKSeaMap* for GB (Connor *et al.*, 2006) and Davidson *et al.*, 1991 for NI Each red square represents a 10 x 10 km square of the National Grid and shows the known and/or predicted occurrence of this habitat.

2.2 Trend in range since c.1994

Trend in range[2.3.4]: **Stable**
Trend magnitude[2.3.5]: **Not applicable**
Trend period[2.3.6]: **1994-2006**
Reasons for reported trend[2.3.7]: **Not applicable**

Estuaries, as a feature, are defined by their physiographic sub-type rather than by a specific biological community; thus range is determined by physical and geological processes. Estuaries are found wherever rivers flow into the sea and are not dependent on a particular biological community for their existence. While the physical area of some individual estuaries may have declined due to anthropogenic influences or through natural deposition/erosion, the geographic spread and distribution of this feature type has not declined.

The trend therefore for range of estuaries is stable.

2.3 Favourable reference range [2.5.1]

Favourable reference range: **3,084 km²**

The range of estuaries is stable and that this is likely to remain the case given the physiographic nature of the feature. Many of the ecological viability criteria for favourable reference range ('potential habitat range' - where the habitat could ideally exist, 'significant ecological variations' of the feature encompassed in current range, fragmentation and connectivity) are not relevant for this feature, as these are all driven by the physical, rather than the ecological environment. Estuaries are not defined solely in biological terms and many of the communities within them are not exclusively found in estuarine environments and may be found as extensions of communities in contiguous locations or others unrelated to estuaries (for example reefs or sand and mudflats).

Therefore the current range of estuaries can be considered to be the favourable reference range.

2.4 Conclusions on range

Conclusion[2.6.i]: **Favourable**

Current range is stable and not less than the favourable reference range. Therefore, in accordance with EU Commission guidance, the conclusion for this parameter is Favourable.

Estuaries are defined by their physiographic sub-type rather than by a specific biological community; thus range is determined by physical and geological processes. While the physical area of some individual estuaries may have declined due to anthropogenic influences or through natural deposition/erosion, the geographic spread and distribution of this feature type has not declined.

3. Area [2.4]

3.1 Current area

Total UK extent [2.4.1]: **3, 083.55 km^2**
Date of estimation [2.4.2]: **May 2007**
Method [2.4.3]: **3 = ground based survey**
Quality of data [2.4.4]: **Good**

For the purposes of this assessment, the estuaries used have been taken from shapefiles of estuary locations within the *UKSeaMap* project (Connor, *et al.*, 2006) with additional data for Northern Ireland coming from the NCC's *Nature conservation and estuaries in Great Britain* (Davidson *et al.*, 1991) and from shapefiles provided by EHS. The area has been calculated from these sources in a GIS environment.

Table 3.1.1 Area of H1130 in the UK

	Area (ha)	Method [2.4.3]	Quality of data [2.4.4]
England	212,624	3	Good
Scotland	74,949	3	Good
Wales	16,671	3	Good
Northern Ireland	4,111	3	Good
Total UK extent [2.4.1]	308,355	3	Good

Method used to estimate the habitat surface area: 1 = only or mostly based on expert opinion; 2 = based on remote sensing data; 3 = ground based survey. Only the most relevant class is given if more than one applies.
Quality of habitat surface area data: 'Good' e.g. based on extensive surveys; 'Moderate' e.g. based on partial data with some extrapolation; 'Poor' e.g. based on very incomplete data or on expert judgement.

3.2 Trend in area since c.1994

Trend in area[2.4.5]: **Unknown**
Trend magnitude[2.4.6]: **Not applicable**
Trend period[2.4.7]: **1994-2006**
Reasons for reported trend[2.4.8]: **Not applicable**

There are no UK-wide trend data for the period since the implementation of the Habitats Directive.

Figures taken from Davidson *et al.* (1991) list the known extent of reclamation of estuarine intertidal areas for a selection of estuaries in which there has been the greatest reclamation. These data estimate that 41,910 hectares of the intertidal area of estuaries has been lost in historical times. Given the current area of 308,355 ha this would suggest that the historic area was approximately 350,000 ha and that estuaries had suffered an overall loss 12 % of their intertidal area. Individual estuaries have lost large intertidal areas; the Tees has lost 90% in the last 200 years and the inner Forth 50% (McLusky and Eliott, 2004).

3.3 Favourable reference area

Favourable reference area[2.5.2]: 3,083.55 km²

While the current area is clearly substantially below the historical area, this does not mean that its viability has been affected. Many of the ecological viability criteria for favourable reference area (total habitat area, fragmentation and connectivity) are functions of the physiographic nature of the feature and the interaction of physical processes (erosion and accretion). Many of the communities within estuaries are not exclusively found in estuarine environments and may be found as extensions of communities in contiguous locations or others unrelated to estuaries (for example reefs or sand and mudflats).

Given these facts, there is no evidence that the current area of 'estuaries' is not viable and therefore the current area of estuaries can be considered to be the favourable reference area.

3.4 Conclusions on area covered by habitat

Conclusion[2.6.ii]: Favourable

There are no recent trend data for the loss of estuarine area. However large historical losses of area have not led the feature to be unviable because the feature area is largely dependent on non-ecological process. The current area of the feature is judged to be the favourable reference area.

4. Specific structures and functions (including typical species)

4.1 Main pressures [2.4.10]

200 Fish and shellfish aquaculture
210 Professional fishing
211 Fixed location fishing
220 Leisure fishing
221 Bait digging
240 Taking / removal of fauna, general
250 Taking / removal of flora, general
954 Invasion by a species
960 Interspecific faunal relations
970 Interspecific floral relations
974 Genetic pollution
300 Sand and gravel extraction
400 Urbanised areas, human habitation
410 Industrial or commercial areas
420 Discharges
504 Port areas
510 Energy transport
512 Pipe lines
520 Shipping
621 Nautical sports
623 Motorised vehicles
720 Trampling, overuse
800 Landfill, land reclamation and drying out, general
801 Polderisation

802 Reclamation of land from sea, estuary or marsh
803 Infilling of ditches, dykes, ponds, pools, marshes or pits
820 Removal of sediments (mud...)
830 Canalisation
840 Flooding
851 Modification of marine currents
850 Modification of hydrographic functioning, general
853 Management of water levels
860 Dumping, depositing of dredged deposits
870 Dykes, embankments, artificial beaches, general
871 Sea defense or coast protection works
700 Pollution
701 Water pollution
951 Drying out / accumulation of organic material
952 Eutrophication
953 Acidification

For full explanations, see section 5.1:

- Fisheries including bait collecting (200, 210, 211, 220, 221, 240, 250)
- Non-Indigenous Species (954, 960, 970, 974)
- Coastal development/Coastal squeeze/Industrial impacts (300, 400, 410, 420, 504, 510, 512, 520, 621, 623, 720, 800, 801, 802, 803, 820, 830, 840, 850, 851, 853, 860, 870, 871)
- Water Quality (700, 701, 951, 952, 953)

4.2 Current condition

4.2.1 Common Standards Monitoring condition assessments

Condition assessments based on Common Standards Monitoring (see www.jncc.gov.uk/page-2199) provide a means to assess the structure and functioning of H1130 in the UK. The following attributes were examined for all CSM assessments relevant to the habitat (JNCC, 2004):

- Extent of the entire feature.
- Distribution/spatial pattern of habitats.
- Salinity.
- Nutrient status.

SAC condition assessments

Table 4.2.1 and Map 4.2.1 summarise the Common Standards Monitoring condition assessments for UK SACs supporting habitat H1130. These data were collated in January 2007. The maps give an impression of the overall spread of where Unfavourable and Favourable sites exist (summary statistics for the map are given in Section 7.2).

The combined assessments show that of the SACs assessed:

- 42 % of the area and 46 % of the number of assessments were Unfavourable; and
- at least 13 % of the total UK habitat area was in Unfavourable condition.

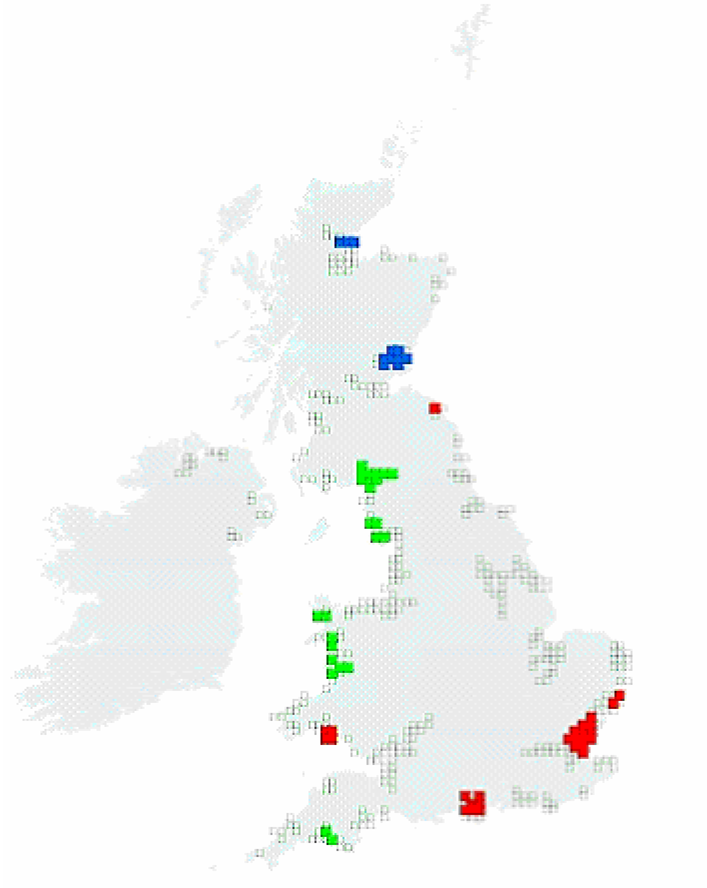
For the feature to be Unfavourable - Inadequate with regard to structure and function, at least 10 % of the area must be in Unfavourable condition. However, only 32 % of the total resource has been assessed and it is likely that the state of estuaries within the SAC series (which have management measures in place) will actually be in better condition than those not designated. If the features within the SAC series are taken as representative of the wider feature, then at least 40% of estuaries would be in unfavourable condition at the UK level. In this case as over 25 % of the resource is in unfavourable condition the feature as a whole would be judged to be Unfavourable - Bad**.**

The overall FCS assessment for 1140 Mudflats and sandflats not covered by sea water at low tide was Unfavourable – Bad and deteriorating. The feature received this assessment for a variety of reasons, including a decline in area and loss of structure and function. This is important because Davidson *et al.* (1991) estimated that 61% of estuaries (by area) are sand and mudflats and that 60 % of the sand and mudflat resource in the UK, occurs in estuaries (based on Davidson *et al.*, 1991 and Jackson and McLeod, 2000, 2002). It has not been possible to calculate the contribution Unfavourable sand and mudflats have made to estuarine sand and mudflats, nor establish if this was the cause of failure of some of some estuaries during the CSM reporting, but it is clear that a significant (probably greater than 25%) proportion of unassessed estuaries will be Unfavourable due to this relationship. While the physical area of some individual estuaries may have declined due to land claim and coastal defences, the relationship between area of loss and effect on the function is not necessarily a straightforward one. For example, land claim in the Forth Estuary has removed 24% of the natural fish habitats in the estuary but 40% of their food supply (McLusky *et al*., 1992 cited in Eliot *et al.*, 1998).

Table 4.2.1 Common Standards Monitoring condition assessment results for UK SACs supporting H1130. See notes below table for details. Information on the coverage of these results is given in Section 7.2.

Condition	Condition sub-categories	Area (ha)	Number of site features
Unfavourable	Declining	41,401	5
	No change		
	Unclassified		
	Recovering	101	1
	Total	41,503	6
	% of all assessments	***42%***	***46%***
	% of total UK resource	***13%***	***unknown***
Favourable	Maintained	5,178	2
	Recovered		
	Unclassified	52,591	5
	Total	57,770	7
	% of all assessments	***58%***	***54%***
	% of total UK resource	***19%***	***unknown***

Notes
1. Data on features that have been partly-destroyed have been excluded from this table because they are not relevant to the consideration of present condition.
2. The data included are from CSM assessments carried out between April 1998 and March 2005, as used for the JNCC Common Standards Monitoring Report 2006.

Current Condition of H130 based on Common Standard Monitoring condition assessments (See Sections 4.2 and 7.2 for further information)
Map 4.2.1 SAC assessments

Key: Red = Unfavourable, i.e. the square contains at least one SAC where this habitat feature is present and has been judged to be Unfavourable. Green = Favourable, i.e. the square contains at least one SAC where this habitat feature is present and has been assessed as Favourable but there are no Unfavourable SAC feature. Blue = SAC not assessed, i.e. the square contains at least one SAC supporting this habitat feature but no assessment has been reported. Transparent = SAC feature not present, i.e. the square does not contain any SAC features of this habitat type.

4.3 Typical species

Typical species[2.5.3]: **None used**

Typical species assessment[2.5.4]: **Not applicable**

'Estuaries' are not defined by the presence of particular species, nor are they structurally dependent upon particular species. Estuaries are habitat complexes made up of a mosaic of subtidal and intertidal habitats and span the full geographic range of the UK. The following information is provided for context only and has not been transferred to Annex D.

The intertidal and subtidal sediments of estuaries support biological communities that vary according to geographic location, the type of sediment, tidal currents and salinity gradients within the estuary. The upper reaches of estuaries furthest away from the open sea are usually characterised by soft sediments and are generally more strongly influenced by fresh water (Jackson and McLeod, 2000, 2002). Here the sediment-living animal communities are typically dominated by oligochaete worms, with few other invertebrates. Where rock occurs, there may be communities characteristic of brackish flowing water, consisting of green unicellular algae, sparse fucoid seaweeds, and species of barnacle and hydroids

(Jackson and McLeod, 2000, 2002). The silt content of the sediment decreases towards the mouth of the estuary, and the water gradually becomes more saline. Here the sediment animal communities are dominated by species such as ragworms, bivalves and sandhopper-like crustaceans. In the outer estuary, closer to the open sea, the substrate is often composed of fine sandy sediment, and supports more marine communities of bivalves, polychaete worms and amphipod crustaceans. Where rock occurs, a range of species more characteristic of the open coast is found. The upper reaches of estuaries often support saltmarsh at the top of the shore, whilst nearer the estuary mouth this may be replaced by sand dune systems (Jackson and McLeod, 2000, 2002).

In addition to sedentary subtidal and intertidal communities, the water column of estuaries is an important conduit for free-living species, such as fish, and juvenile stages of benthic plants and animals. In particular, it is the means by which migratory fish species make the transition between the marine and freshwater environments to important breeding areas (Jackson and McLeod, 2000, 2002).

Davidson *et al.* (1991) list 16 major soft substrata and 17 major hard substrata communities as occurring in UK estuaries.

4.4 Conclusions on specific structures and functions (including typical species)

Conclusion[2.6.iii]: **Unfavourable – Bad and deteriorating**

The EC Guidance states that where "more than 25% of the area of the habitat is Unfavourable as regards its specific structures and functions", the conclusion should be Unfavourable – Bad. In the UK this was generally taken to mean that more than 25% of the habitat area in Unfavourable condition.

Based on the CSM results, at least 13% of the national resource for the feature is Unfavourable in terms of structure and function, most of this is also deteriorating. However, the true figure is likely to be substantially higher. If the SAC series is considered indicative of the national picture, around 40% is Unfavourable (see Table 4.2.1). In addition, sand and mudflats (which make up a large proportion of the estuarine area) are in Unfavourable - Bad conservation status

5. Future prospects

5.1 Main factors affecting the habitat

5.1.1 Conservation measures

Elements of this habitat are covered by national action plans under the UK BAP (see www.ukbap.org.uk), with targets to maintain, improve, restore and expand the resource.

In addition, 39 % of the estimated extent of the feature is covered in the SAC series with conservation objectives to maintain the resource or restore sites to favourable condition. Thirteen SACs have H1130 as the primary qualifying feature; while for a further two SACs, H1130 is a qualifying feature but not the primary reason for site selection.

5.1.2 Main future threats[2.4.11]

The most obvious major future threats to H1130 are listed below, several of which are referred to in Section 4.1.

200 Fish and shellfish aquaculture
210 Professional fishing
211 Fixed location fishing
220 Leisure fishing
221 Bait digging
240 Taking / removal of fauna, general
250 Taking / removal of flora, general

900 Erosion
910 Silting up
920 Drying out
954 Invasion by a species
960 Interspecific faunal relations
970 Interspecific floral relations
974 Genetic pollution
300 Sand and gravel extraction
400 Urbanised areas, human habitation
410 Industrial or commercial areas
420 Discharges
504 Port areas
510 Energy transport
512 Pipe lines
520 Shipping
621 Nautical sports
623 Motorised vehicles
720 Trampling, overuse
800 Landfill, land reclamation and drying out, general
801 Polderisation
802 Reclamation of land from sea, estuary or marsh
803 Infilling of ditches, dykes, ponds, pools, marshes or pits
820 Removal of sediments (mud...)
830 Canalisation
840 Flooding
850 Modification of hydrographic functioning, general
851 Modification of marine currents
853 Management of water levels
860 Dumping, depositing of dredged deposits
870 Dykes, embankments, artificial beaches, general
700 Pollution
701 Water pollution
951 Drying out / accumulation of organic material
952 Eutrophication
953 Acidification

- Fisheries including bait collecting (200, 210, 211, 220, 221, 240, 250)

Fishing activities are the most widespread source of anthropogenic physical disturbance of benthic communities of Northern Europe and represent the most significant human activity causing change in the UK's marine environment (de Groot and Lindeboom, 1994, LaFolley and Tasker, 2004). Of the six 'Class A - Priority Human Pressures' identified by OSPAR, fisheries account for three (OSPAR, 2000). The effects of fisheries include:

- Removal of target species (including genetic effects) – given the size of most fish stocks the fishing pressure exerted upon them is outside safe biological limits.
- Mortality of non-target species.
- Physical disturbance of the seabed.
- Shifts in community structure.
- Indirect effects on the food web.

There is also evidence indicating that over-fishing is often a precondition for eutrophication, disease outbreaks, or species introductions (Jackson *et al*., 2001). The combined effect of all these impacts is to reduce the overall stability of marine ecosystems (Royal Commission on Environmental Pollution, 2004). It is often difficult to establish direct relationships between specific fisheries activities and ecological effects as many ecosystem properties and components that are affected directly or indirectly by fishing also show substantial natural variability. In addition, there are many gaps in our knowledge of marine ecological processes, and so it is not always possible to establish clear links between ecological change and environmental or anthropogenic factors.

Unlicensed commercial fishing is considered to be one of the top threats to marine biodiversity (Boyes *et al.*, 2006). However, the effect of this is currently unquantified due to the lack of data on unlicensed activities of vessels under 11m.

Estuaries are highly accessible and a wide range of fisheries such as salmon netting, collecting (seaweed, winkles, cockles, bait) and dredging (especially oysters) may take place, some of which may have been conducted for centuries (Sewell and Hiscock, 2005). Aquaculture may also take place in suitable locations (McLusky and Eliott, 2004). As well as being a source of pollution, aquaculture has also been linked to the spread of Non-Indigenous Species, (NIS, see below) such as *Sargassum muticum*, the escape of cultured species, and possible displacement of native species (Sewell and Hiscock, 2005).

- Climate change (900, 910, 920)

There is at present no general agreement about the degree of physical change that might be acceptable in the marine environment. It is therefore not currently possible to define what is an acceptable coastal erosion and coastal flooding risk. Shoreline areas will be affected by increased storminess and windiness: the distribution of some shoreline habitats may be altered or reduced by these effects (Brooker and Young, 2005). The greatest impact of sea level rise would be in sedimentary areas protected by hard defences (Boorman *et al.*, 1989). This would lead to erosive forces becoming more dominant and considerable losses of fine sediment which would not be balanced by deposition elsewhere. There are no UK-wide projections for how this would affect estuaries as a whole, although projected losses are considerable. For example, Pye and French (1993) estimated that England alone would suffer losses of 8 – 10,000 ha of intertidal mud and sand flats over twenty years (to 2013), although the proportion of that in estuaries is not given.

There has already been a major change in the plankton species and abundance since the early 1980s (Hays, 2005). This affects a large area of the North Atlantic and appears to be linked to changes in the North Atlantic Oscillation and climate (Defra, 2005).

Patterns of species response to climate change are not straightforward, due to factors such as current flow and barriers to species movement. The positive effects of increased temperatures, for example increased primary productivity may be offset by the negative impacts of increased disturbance from wave and storm surge action (Brooker and Young, 2005). All of these effects will change the structure and function of estuaries to some degree; however, uncertainties exist with respect to predictions including: species' specific responses to climate change; the possible influx of new invasive species; the impact of increasing ocean acidity due to absorption of atmospheric CO_2. In addition, sectoral activities – for example, managed retreat to enable persistence of some coastal habitats might be inhibited by coastal development and construction of sea defences, whilst changes in fishing policy could substantially alter the pressure on the marine biodiversity resource.

- Non-indigenous Species (954, 960, 970, 974)

Non-indigenous species (NIS) present a significant threat to the marine environment and their effects can have both economic and ecological ramifications, including biodiversity loss (e.g. Ruiz *et al.*, 1997; Cohen and Carlton, 1998). The deleterious impacts of NIS have been shown across global regions, habitat types, and taxonomic groups worldwide, including marine systems (Ruiz *et al.*, 1997; Cohen and Carlton, 1998; Ruiz *et al.*, 2000). Within marine systems, ships' ballast water, used to improve ship stability and trim, is one of the primary mechanisms for the transport and introduction of non-indigenous marine species to ports worldwide (Carlton, 1996). Given the continued growth of global trade and the complexity of shipping patterns globally, with numerous different source regions, ship types and routes operating worldwide, it is clear that non-indigenous species will continue to be transferred to UK waters for the foreseeable future.

There is some legislation currently in place to reduce the introduction of NIS via Ballast Water through the International Maritime Organization (International Maritime Organization, 2004). This legislation aims to limit the number of viable organisms within ballast tanks in the future, but NIS remain a grave concern, and could potentially lead to habitat alteration and biodiversity loss within marine Annex I habitat features. Our ability to predict invasions is severely limited by the complexity of the invasion process itself, and therefore it is difficult to identify those marine Annex I features that are at greatest risk. Nonetheless, certain areas are known to be at a particularly high risk:

(i) Areas within the vicinity of ports. Because the marine environment is essentially an open system, there is also potential for rapid and widespread secondary transfer of NIS within the UK once species establish reproducing populations.
(ii) Areas with a high diversity of habitat types (including diversity of substrate, salinity and temperature regimes and exposure). These habitats are most likely to be successfully invaded because, as the number of habitat types increases, so does the chance that a particular species will locate a suitable habitat for its establishment.
(iii) Areas already altered or damaged by anthropogenic effects.
(iv) Areas that have already been invaded by high numbers of NIS.
(v) Areas of low indigenous species richness.

Estuaries in particular are susceptible to NIS as they fulfil many of the above conditions. It is unlikely that we will be able to accurately predict which species will arrive, establish or what their impacts might be on native communities in the future (Ruiz *et al.*, 1997; Cohen and Carlton, 1998).

- Coastal development/coastal squeeze/Industrial impacts (300, 400, 410, 420, 504, 510, 512, 520, 621, 623, 720, 800, 801, 802, 803, 820, 830, 840, 850, 851, 853, 860, 870)

The Environment Agency assessed shoreline defences along estuaries as part of its Water Framework Directive Risk Assessment Programme (England and Wales only). From this data approximately 30% (1,702 km of a total 5,652 km) of the length of estuaries measured in England and Wales had been subject to some form of defence, which equates to 21.4 % of the perimeter of the UK resource. The CCW Marine Intertidal Phase 1 survey showed that 68% of 5k squares of the coast of Wales are in some way altered by gabions, slipways, coastal defence or other man made structures and that many of the most affected areas are in estuaries particularly the Dee and Severn (Brazier *et al.*, in prep). No figures currently exist for Scotland or Northern Ireland.

Sedimentary areas protected by hard defences will suffer the greatest impact of sea level rise (Boorman *et al.*, 1989). Erosive forces would become more dominant and losses of fine sediment would produce narrower intertidal areas, with coarser sediment. The change of sediment characteristics would reduce the content of organic matter in the sediments and change the community structure accordingly. Taken to its conclusion, a greater proportion of estuaries on open-coasts would become marine and sandy and the brackish section would move inland and up-river. In more sheltered areas, there would be more deposition, extending areas of fine sediment and marsh. However, this process would cease once the sediment supply was reduced and ultimately erosion would become the dominant process (Boorman *et al.*, 1989). Table 5.1.2.1 shows the situation is most critical in coastal plain estuaries where the greatest proportion of shoreline is defended.

Table 5.1.2.1 Percentage of shoreline defended by hard defences, from EA WFD Risk Assessment (TRAC Risk Assessment Database_v0_4.mdb)

	Type				
	Bar-built	**Coastal Plain**	**Complex**	**Ria**	**Total**
Perimeter	933	4203	356	160	5652

Perimeter defended	155	1494	26	27	1702
% Defended	**16.6**	**35.5**	**7.3**	**16.9**	**30.1**

Note that there are no figures for Scotland and Northern Ireland so the total percentages are lower than the actual values.

With some notable exceptions few major coastal construction projects are currently planned or in progress; those that are taking place are required to mitigate for areas of habitat loss (Defra, 2005). There is a presumption against coastal development in Great Britain (this does not apply in Northern Ireland) which is described by the following documents: NPPG 13 (Scotland) (Scottish Executive, 2006); TAN 14 (Wales) (Welsh Assembly Government, 1998); and PPG 20 (England) (Department of Environment, 1992) – the following is taken from NPPG 13.

The presumption against development includes: projects for which a coastal location is not required; projects that are approved should be accommodated on the developed coast; reuse available and suitable brownfield land; incorporate conservation interests; and work within natural processes at work on the coast. In addition, where potential damage to the environment is both uncertain and significant, a precautionary approach is required and the criteria required by the various bodies responsible for environmental protection should be met.
However, small scale developments (e.g. marinas) continue. There is an expanding demand for these and there is concern that no mechanisms exist to assess what the combined impact of these is (Gabriellle Wyn, *pers. comm.*). In addition, barrage schemes for water storage, amenity, tidal power and flood defence could pose a threat to the integrity and ecological value of intertidal habitats in estuaries (UKBAP, 2006). The proposed Severn Barrage could cause up to 50% loss of intertidal area of the estuary (8,000 ha) which would be approximately 2.5% of the UK area (Mitchell *et al.*, 1981).

- Water Quality (700, 701, 951, 952, 953)

For the Water Framework Directive (WFD) (EA, 2006a), the Environment Agency (England and Wales) and the Scottish Environmental Protection Agency (SEPA) conducted risk assessments of their transitional (estuarine) and coastal water bodies to assess the likelihood of waters failing to achieve Good Ecological Status (GES) by 2015 (EA, 2006b).

The risk is an aggregation of the likely effects of the following: point source pollution (including effluent discharges from sewage treatment and industry); diffuse source pollution (including run-off from the land and acid rain); water abstraction and flow regulation (including the removal of water for public supplies or manufacturing and the control of river flows for hydro-electric power, navigation, water supplies or other purposes); physical or 'morphological' alteration to water bodies (including land claim for development, flood defence structures or channel modifications); and non-indigenous species. Note that there is not a complete match between EA/SEPA and JNCC estuary definitions and demarcations - however, the entire GB coastline was assessed for this process.

Table 5.1.2.2: Risk that estuaries will fail to meet Water Framework Directive Good Ecological Status by 2015

	Risk Category					
	1a	**1b**	**2a**	**2b**	**Not assessed**	**Total**
England	39	20	0	0	8	67
Northern Ireland	0	0	0	0	3	3
Scotland	10	3	2	7	3	25
Wales	8	12	0	0	7	27
Total	**57**	**35**	**2**	**7**	**20**	**122**
%	**46.7**	**28.6**	**1.6**	**5.7**	**16.4**	

1a - Water body at significant risk of failing objectives, 1b - Water body probably at significant risk of failing objectives; 2a - Water body probably not at risk of failing objectives; 2b - Water body not at risk of failing objectives (data from EA TRAC Risk Assessment and SEPA Risk assessment (summary supplied by David Ross)).

From Table 5.1.2.2 it can be seen that from combined EA and SEPA figures approximately 47% of UK estuaries are at significant risk of failing to meet Good Ecological Status (category: 1a). Around a further 29 % are 'probably at significant risk' (category 1b). While the immediate future for estuarine waters is that they will fail to meet the necessary standards, over time the WFD should have the effect of improving those quality elements to which the Directive relates.

5.2 Future condition (as regards range, area covered and specific structures and functions)

5.2.1 Common Standards Monitoring condition assessments

The Common Standards Monitoring condition assessments reported in sections 4.2.1-2. provide a basis to predict the potential future condition of H1130 in the UK. This involved treating all assessments currently identified as either Favourable or Unfavourable recovering as future-Favourable: remaining categories were treated as future-Unfavourable – see Table 5.2.1.1 There are a number of caveats to this approach, which are set out beneath this table.

SAC condition assessments

Table 5.2.1 and Map 5.2.1 summarise the predicted potential future condition of H1130 on UK SACs. This is based on the approach described above. The maps give an impression of the overall spread of where future-Unfavourable and future-Favourable sites are predicted to occur (summary statistics for the map are given in Section 7.2). The combined assessments show that of the SACs assessed:

- 58 % of the area and 62 % of the number of assessments fall within the future-Favourable category;
- at least 19 % of the total UK habitat area falls within the future-Favourable category.

Table 5.2.1 Predicted future condition of UK SACs supporting H1130 based on current Common Standards Monitoring condition assessments.

Future condition	Present condition	Area (ha)	Number of site features
Future - Unfavourable	Unfavourable declining	41,401	5
	Unfavourable no change		
	Unfavourable unclassified		
	Total	***41,401***	***5***
	% of assessments	**42%**	**38%**
	% of total UK extent	**13%**	**Unknown**
Future - Favourable	Favourable maintained	5,178	2
	Favourable recovered		
	Unfavourable recovering	101	1
	Favourable unclassified	52,591	5
	Total	57,871	8
	% of assessments	**58%**	**62%**
	% of total extent	**19%**	**Unknown**

Note that the scenario presented above is based on the same information as used to construct Table 6. It is based on the following premises:

(i) the Unfavourable-recovering condition assessments will at some point in the future become Favourable;

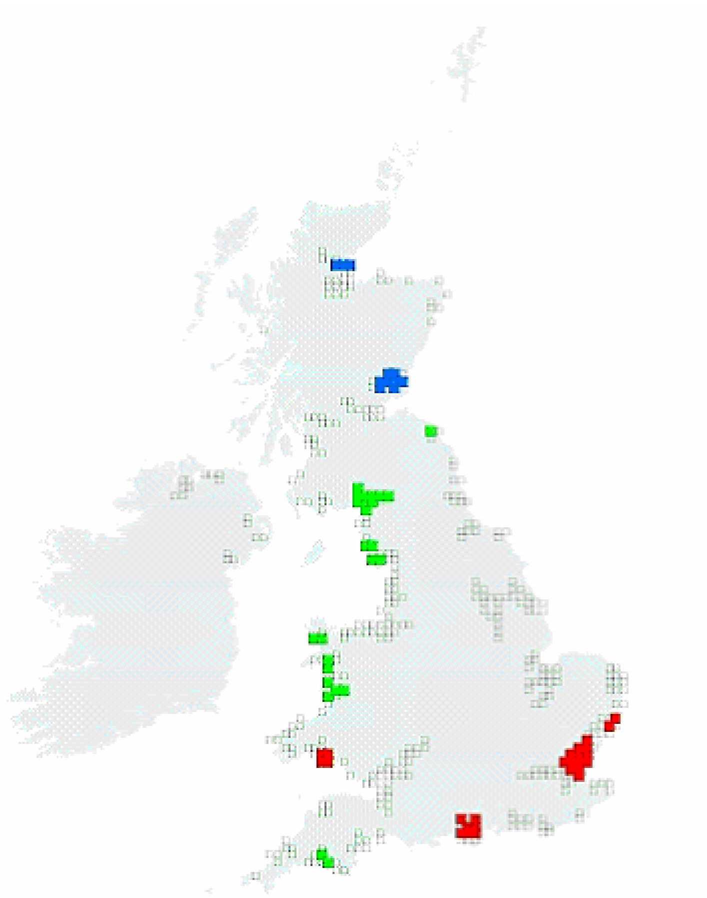
(ii) all Unfavourable-unclassified sites will remain Unfavourable, which is probably overly pessimistic; and

(iii) sympathetic management will be sustained on sites already classified as Favourable and these will not be seriously damaged by any unforeseen events.

IMPORTANT NOTE: we do not have information on the timescale of the predicted recovery, which may be influenced by many past, natural and human related factors. A sustained, sympathetic management regime is more likely to result in Favourable condition being attained.

Predicted future condition of H1130 based on Common Standard Monitoring condition assessments
(See Sections 5.2 and 7.2 for further information on these maps)

Map 5.2.1 SAC assessments



Key:
Red = Future - Unfavourable, i.e. the square contains one or more SACs where this habitat feature is present and has been predicted to be Future – Unfavourable.
Green = Future - Favourable, i.e. the square contains at least one SAC where this habitat feature is present and has been predicted to be Future – Favourable.
Blue = SAC not assessed, i.e. the square contains at least one SAC supporting this habitat feature but no assessment has been reported.
Transparent = SAC feature not present, i.e. the square does not contain any SAC features of this habitat type.

5.3 Conclusions on future prospects (as regards range, area covered and specific structures and functions)

Conclusion[2.6iv]: **Unfavourable – Bad and deteriorating**

The EC Guidance states that where "habitat prospects are bad, with severe impacts from threats expected and long-term viability not assured", the judgement should be Unfavourable – Bad. In the UK, this was generally taken to mean that habitat range and/or area are in decline, and/or less than 75% of the habitat area is likely to be in Favourable condition in 12-15 years.

For Estuaries, 42% of the assessed resource will be Unfavourable and declining in the future, therefore the conclusion on future prospects is Unfavourable - Bad and deteriorating.

Future threats are unlikely to cause a decline in range due to the inherent stability of this parameter for H1130. However, coastal development and erosion could have significant effects on the total area of the feature. The main problem for estuaries is that there are serious threats from water quality and structure and function perspective that can be extrapolated from the WFD and CSM work. Only small amounts of recovery are predicted from the CSM figures and there is no way to gauge how quickly the requirements of WFD will have significant positive impacts on the poor state of estuaries.

6. Overall conclusions and judgements on conservation status

Conclusion[2.6]: Unfavourable – Bad and deteriorating

On the basis of structure and function and future prospects, the conclusion is Unfavourable – Bad and deteriorating.

Table 6.1 Summary of overall conclusions and judgements

Parameter	Judgement	Grounds for judgement	Confidence in judgement*
Range	Favourable	Current range is stable and not less than the favourable reference range. Therefore, in accordance with EU Commission guidance, the conclusion for this parameter is Favourable.	1
Area covered by habitat type within range	Favourable	There are no recent trend data for the loss of estuarine area, however large historical losses of area have not led the feature to be unviable because the feature area is largely dependent on non-ecological process. The current area of the feature is judged to be the favourable reference area.	1
Specific structures and functions **(including typical species)**	Unfavourable – Bad and deteriorating	More than 25% of the habitat area is considered to be Unfavourable as regards its specific structures and functions. Based on the CSM results, at least 13% of the national resource for the feature is Unfavourable in terms of structure and function, most of this is also deteriorating. However, the true figure is likely to be substantially higher. If the SAC series is considered indicative of the national picture, around 40% is Unfavourable (see Table 4.2.1). In addition, sand and mudflats (which make up a large proportion of the estuarine area) are in Unfavourable - Bad conservation status The feature is not defined by the presence of particular species, nor is it structurally dependent upon particular species.	2

Future prospects (as regards range, area covered and specific structures and functions)	Unfavourable – Bad and deteriorating	Habitat prospects over next 12-15 years considered to be bad, with severe impact from threats expected and long term viability not assured. For estuaries, 42% of the assessed resource will be Unfavourable and declining in the future, therefore the conclusion on future prospects is Unfavourable: bad and deteriorating. Future threats are unlikely to cause a decline in range due to the inherent stability of this parameter for H1130. However, coastal development and erosion could have significant effects on the total area of the feature. The main problem for estuaries is that there are serious threats from a water quality and structure and function perspective that can be extrapolated from the WFD and CSM work. Only small amounts of recovery are predicted from the CSM figures and there is no way to gauge how quickly the requirements of WFD will have significant positive impacts on the poor state of estuaries.	2
Overall assessment of conservation status	Unfavourable – Bad and deteriorating	One or more Unfavourable – Bad and deteriorating judgement	2

* Key to confidence in judgement: 1 = High; 2 = Medium; 3 = Low

7. Annexed material (including information sources used 2.2)

7.1 References

BOORMAN, L.A., GOSS-CUSTARD, J.D., MCGRORTY, S. 1989. Climatic change, rising sea level and the British coast. *ITE Research Publication* No. 1.

BOYES, S., BURDON, D. & ELLIOTT, M. 2006. Unlicensed Activities: A review to consider the threats to marine biodiversity: Building the evidence base for the Marine Bill. CRO354 Living Land and Seas Science Division, DEFRA.

BROOKER, R. & YOUNG, J. 2005. Climate change and biodiversity in Europe: a review of impacts, policy responses, gaps in knowledge and barriers to the exchange of information between scientists and policy makers, NERC Centre for Ecology and Hydrology, Banchory research station, Final Report for Defra Research Contract CRO326, Report presented at the European Platform for Biodiversity Research, Strategy meeting held under the UK Presidency. October 2005.

BUCK, A.L. (compiler). 1993/1997. An Inventory of UK Estuaries: Volumes 1 – 7. Peterborough, Joint Nature Conservation Committee.

COHEN, A. N. & CARLTON, J. T. 1998. Accelerating invasion rate in a highly invaded estuary. *Science*, **279**, 555–557.

CONNOR, D.W., ALLEN, J.H., GOLDING, N., HOWELL, K., LIEBERKNECHT, L., NORTHEN K.O., & REKER, J. 2004. The Marine Habitat Classification for Britain and Ireland Version 04.05 JNCC, Peterborough ISBN 1 861 07561 8 (internet version) www.jncc.gov.uk/MarineHabitatClassification

CONNOR, D.W., GOLDING, N., ROBINSON, P., TODD, D., & VERLING, E. 2006. *UKSeaMap: The mapping of marine seabed and water column features of UK seas. Final report.* Joint Nature Conservation Committee, Peterborough.

DAVIDSON, N.C.D., D'A LAFFOLEY, D., DOODY, J.P., WAY, L.S., GORDON, J., KEY, R., DRAKE, C.M., PIENKOWSKI, M.W., MITCHELL, R. & DUFF, K.L. 1991. Nature conservation and estuaries in Great Britain. Nature Conservancy Council.

DEFRA. 2005. Physical processes and climate changes and effects, Integrated Assessment, in *Charting Progress 5: Integrated regional assessment*.

DE GROOT, S.J. & LINDEBOOM, H.J. 1994. Environmental impact of bottom gears on benthic fauna in relation to natural resources management and protection of the North Sea. Netherlands Institute for Sea Research, Texel.

DEPARTMENT OF ENVIRONMENT. 1992. Planning policy guidance: coastal planning. www.communities.gov.uk/pub/94/PlanningPolicyGuidance20CoastalplanningPDF88Kb_id1144094.pdf

ELLIOTT, M., NEDWELL, S., JONES, N.V., READ, S.J., CUTTS, N.D. & HEMINGWAY, K.L. 1998. Intertidal Sand and Mudflats and Subtidal Mobile Sandbanks (volume II). *An overview of dynamic and sensitivity characteristics for conservation management of marine SACs.* Scottish Association for Marine Science (UK Marine SACs Project). 151 Pages.

ENVIRONMENT AGENCY. 2006a. The Water Framework Directive (WFD). www.environment-agency.gov.uk/business/444217/444663/955573/

ENVIRONMENT AGENCY. 2006b. Generation and combination of risk outputs. www.environment-agency.gov.uk/commondata/acrobat/gen_comb_risk_v2_1008518.pdf

ENVIRONMENT AGENCY. 2006c. Surface water bodies at risk of not achieving WFD objectives (combined pressures). www.environment-agency.gov.uk/commondata/acrobat/sw_at_risk_v1_1007365.pdf

EUROPEAN COMMISSION. 2003. Interpretation Manual of European Union Habitats, EUR 25 October 2003, DG Environment Nature and biodiversity.

INTERNATIONAL MARITIME ORGANIZATION. 2004. International Convention for the Control and Management of Ships' Ballast Water and Sediments. http://www.imo.org/Conventions/mainframe.asp?topic_id=867

JACKSON, D.L. & MCLEOD, C.R. (EDITORS). 2000. Handbook on the UK status of EC Habitats Directive interest features: provisional data on the UK distribution and extent of Annex I habitats and the UK distribution and population size of Annex II species. Revised 2002, *JNCC Report* 312, 180 pages, ISSN 0963-8091.

JACKSON, J.B.C., KIRBY, M.X., BERGER, W.H., BJORNDAL, K.A., BOTSFORD, L.W., BOURQUE B.J., BRADBURY, R.H., COOKE, R., ERLANDSON, J., ESTES, J.A., HUGHES, T.P., KIDWELL, S., LANGE, C.B., LENIHAN, H.S., PANDOLFI, J. M., PETERSON, C.H., STENECK, R.S., TEGNER, M.J. & WARNER, R.R. 2001. Historical Overfishing and the Recent Collapse of Coastal Ecosystems. *Science*, **293** (5530), 561-748.

JNCC. 2004. Common Standards Monitoring Guidance for Generic Introduction for Marine Feature Guidance. ISSN 1743-8160 (online).

LAFFOLEY, D. & TASKER, M. 2004. Marine Environment Analytical paper produced to support the report *Net Benefits – a sustainable and profitable future for UK fishing.*

MITCHELL, R., PROBERT, P.K., MCKIRDY, A.P. & DOODY, J.P. 1981. Severn tidal power: Nature conservation. Nature Conservancy Council.

OSPAR. 2000. Quality Status Report 2000 Chapter 5 – Biology. www.ospar.org/eng/html/welcome.html

PYE, K. & FRENCH, P.W. 1993. Targets for coastal habitat recreation. *English Nature Science 13.* English Nature, Peterborough.

ROYAL COMMISSION ON ENVIRONMENTAL POLLUTION. 2004. Turning the Tide: Addressing the Impact of Fisheries on the Marine Environment, Twenty Fifth Report.

RUIZ G.M., CARLTON J.T., GROSHOLZ E.D. & HINES A.H. 1997. Global invasions of marine and estuarine habitats by non-indigenous species: Mechanisms, extent, and consequences. *American Zoology*, **37**: 621–632.

SCOTTISH EXECUTIVE. 2006. NPPG13 - COASTAL PLANNING. www.scotland.gov.uk/Publications/1997/08/nppg13-coastal

SEWELL, J. & HISCOCK, K. 2005. Effects of fishing within UK European Marine Sites: guidance for nature conservation agencies. *Report to the Countryside Council for Wales, English Nature and Scottish Natural Heritage from the Marine Biological Association.* Marine Biological Association, Plymouth. CCW Contract FC 73-03-214A. 195 pp.

UKBAP. 2006. Habitat Action Plan: Mudflats. www.ukbap.org.uk/ukplans.aspx?id=34

WELSH ASSEMBLY GOVERNMENT. 1998. Technical Advice Note (Wales) 14, March 1998. http://new.wales.gov.uk/docrepos/40371/403823112/40382/40382/403821/403824/TAN_14_Full.doc?lang=en&ts=4

WILLIAMS, J.M., ED. 2006. *Common Standards Monitoring for Designated Sites: First Six Year Report*. Peterborough, JNCC.

7.2 Further information on Common Standards Monitoring data as presented in sections 4.2 and 5.2

Table 7.2.1 Summary of the coverage of the data shown in Tables 4.2.1 and 5.2.1

Data	Value
Number of SACs supporting feature (a)	15
Number of SACs with CSM assessments (b)	13
% of SACs assessed (b/a)	87
Extent of feature in the UK – hectares (c)	308,355
Extent of feature on SACs – hectares (d)	121,035
Extent of features assessed – hectares (e)	99,273
% of total UK hectarage on SACs (d/c)	39
% of SAC total hectarage that has been assessed (e/d)	82
% of total UK hectarage that has been assessed (e/c)	32

Table 7.2.2 Summary of grid square map data shown in Maps 4.2.1 and 5.2.1

Status	Number of squares	Proportion of all squares
Current – Unfavourable (red)	34	9%
Current – Favourable (green)	28	8%
On SAC but not assessed (blue)	11	3%
Not on SAC (transparent)	298	80%
Total number of 10km squares (any colour)	371	
Future – Unfavourable (red)	33	9%
Future – Favourable (green)	29	8%

7.3 Note on EA data

EA_Risk_data_011204_tracs – Contains tables showing which quality elements would be monitored in which water bodies for operational monitoring. Most recent tables are 'Coast_risk_011204_using_v1_5' and 'Transitional_risk_011204_using_v1_5'. Tables were created by linking the results of risk assessment, to the 'Quality Element Pressure Matrix v 1.5'. These tables assume that every quality element is available in every water body to be monitored, but for seagrass and saltmarsh this may not be the case. Also, it does not distinguish between which NIS causes the water body to be at risk and so assumes all possible affected quality elements are measured. In fact, if a water body was at risk from *Spartina anglica* only, it is likely only saltmarsh would be monitored.