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Nature conservation objectives in shoreline management plans

A suggested approach

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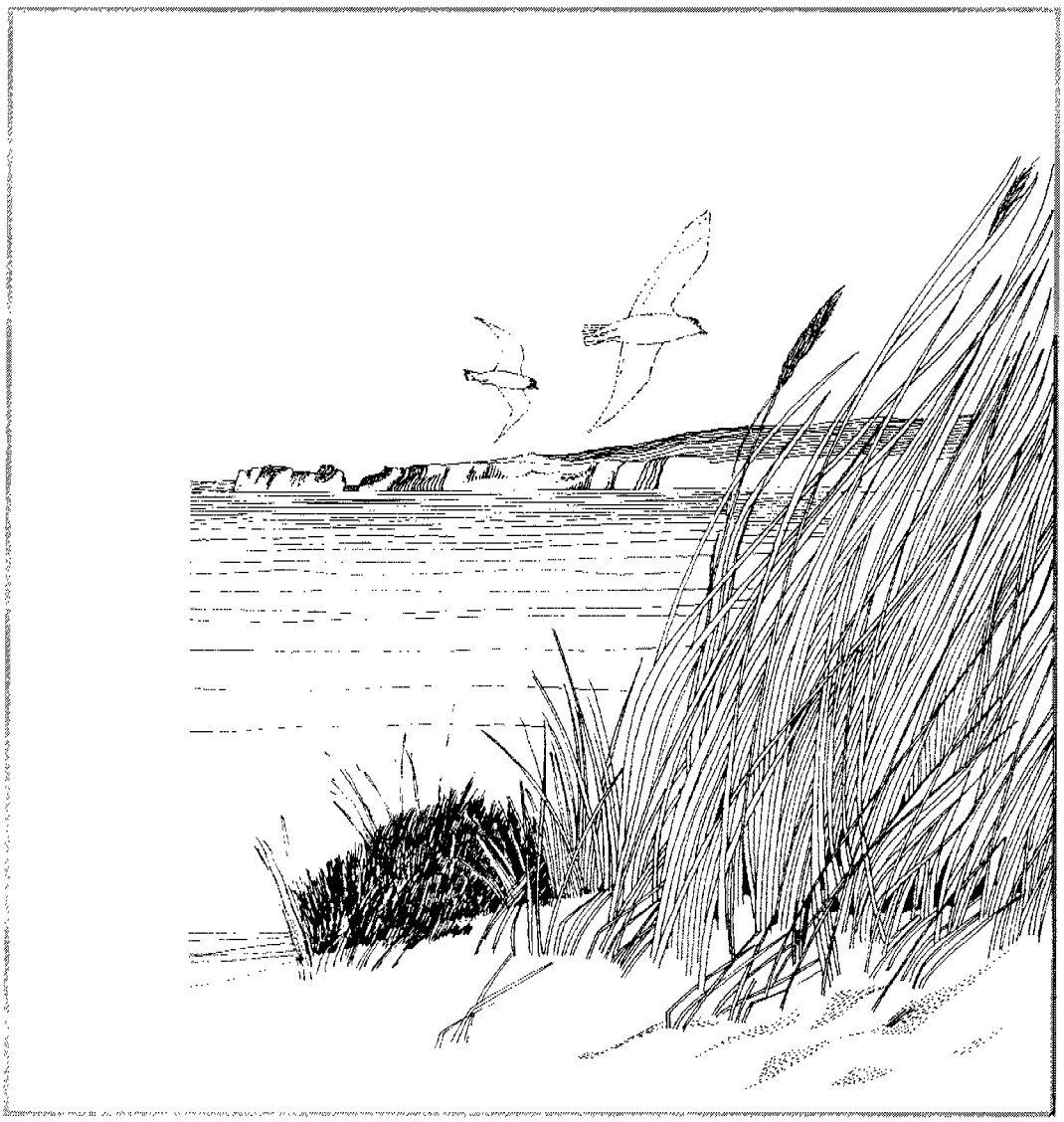

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Nature Conservation Objectives in Shoreline Management Plans: A Suggested Approach

March 1997

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PREFACE

English Nature believes that this research report will make a positive contribution to the way in which nature conservation issues and objectives are tackled in Shoreline Management Plans; enhancing the way in which the natural environment is handled in the Shoreline Management Planning process and assisting in the development of best practice.

While the report endeavours to be as comprehensive as possible, covering both biological and earth sciences, it does not anticipate being the final word on the subject. English Nature would therefore welcome comments on the application of the suggested methodology or any other aspect of the report.

Comments should be sent to:-

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June 1997

Nature Conservation Objectives in Shoreline Management Plans: A Suggested Approach

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SUMMARY

A series of Shoreline Management Plans is presently being developed under guidelines produced by the Ministry of Agriculture, Fisheries and Food. The incorporation of appropriate objectives relating to nature conservation is a fundamental requirement for sustainable shoreline management planning.

Shoreline Management Plans need to distinguish between two types of natural environmental assets: critical natural capital (essentially those assets which cannot be re-created during the lifespan of the plan) and constant natural assets (dynamic features with the possibility of re-creation). English Nature has recently published two research reports setting out criteria for identifying critical natural capital for both biological and earth sciences in the terrestrial and maritime zones. These stress the importance of re-creatability as the fundamental criterion in distinguishing critical natural capital. For the purposes of practical shoreline management planning, it is recommended that priority should be given to the identification of critical natural capital in relation to habitats, species or geological features of designated national or international importance. Emphasis should also be placed on identifying the ability to re-create features *in principle* since practical issues of location and land ownership are often outside of the scope of Shoreline Management Plans. The feasibility of re-creation depends on the existence of sites where re-creation could potentially be undertaken, and this does need to be taken into account.

Once environmental assets have been identified and categorised as critical natural capital or constant natural assets, the next step is to identify recent rates of loss or change, including those arising from both natural processes and human activities. An estimate then needs to be made of future rates of loss or change, taking into account present processes and others which can be foreseen.

The final Shoreline Management Plan should incorporate four levels of nature conservation objectives. These are the *preservation* of critical natural capital; the *conservation* of at least the existing stock of constant natural assets (but not necessarily in their present locations); the *creation* of new natural assets where appropriate; and the *modification* of other coastal defence objectives to allow for the protection of critical natural capital and the conservation of constant natural assets. All of these considerations are relevant to determining the most appropriate coastal defence strategy for each coastal management unit.

The Shoreline Management Plan may need to be followed by an *Implementation Plan*, which will address the practicalities of recommended habitat re-creation, together with associated legal, technical and economic issues.

1. INTRODUCTION

Shoreline Management Plans (SMPs) provide a strategic framework for decisions on the management of the coastal defences for a specified length of coast. They take account of natural coastal processes together with human and environmental influences and needs. SMPs generally cover an area of coast defined as a discrete cell or subcell, on the basis of geomorphological processes and natural boundaries to sediment movement. Guidance on the production of Shoreline Management Plans has recently been published by the Ministry of Agriculture, Fisheries and Food[1].

English Nature has recently been developing a methodology for setting nature conservation objectives as part of Shoreline Management Plans. An SMP should develop a set of objectives and targets for the natural environment in the same way as it should for coastal defence issues. The objective is to attain environmental sustainability, in accordance with the UK's strategy for sustainable development[2], produced in response to the UN Conference on Environment and Development's "Agenda 21: Programme for Action for Sustainable Development".

In 1994 English Nature published a paper on sustainable development[15] which recognises that:

> "Sustainable development seeks to improve the quality of human life without undermining the quality of our natural environment"; and
>
> "The natural environment can only support human life, health and well-being if its own resources are healthy and if it can continue to assimilate wastes and support a wealth of native biodiversity - our heritage of natural features, wild plants and animals and their natural communities"

English Nature advocates environmental sustainability as meaning the maintenance of the environment's natural qualities and characteristics and its capacity to fulfill its full range of functions, including the maintenance of biodiversity.

Environmental sustainability is a central concern of sustainable development. To achieve environmental sustainability, biodiversity must be maintained in order to ensure the continued presence of a functioning environment and that future generations inherit as diverse an environment as possible. To maintain biodiversity we must identify those elements or features of the natural environment that are non-tradable: those which are, in the case of habitats and sites, irreplaceable; and which are, in the case of species, features essential to the continuance of viable populations throughout their geographical range[10].

This report outlines the practical application of techniques for setting nature conservation objectives relating to both the biological and earth sciences. The methodology described is based on that recently applied by Mouchel Consulting Ltd in the preparation of Shoreline Management Plans for the Lizard Point to Land's End coastal subcell in Cornwall and the North Norfolk coastal subcell. The concepts and criteria described here have, however, been described in general terms and can be applied to any SMP in England.

2. THE PROCESS OF OBJECTIVE SETTING

Setting nature conservation objectives within the SMP involves the following stages[13]:

(i) Identifying, describing and evaluating important environmental assets.

(ii) Determining recent rates of loss of change as a result of both human and natural processes;

(iii) Predicting future rates of loss or change as a result of both human and coastal processes;

(iv) Specifying objectives for incorporation into the SMP.

Each of these steps is now examined in turn.

3. IDENTIFICATION, DESCRIPTION AND EVALUATION OF ENVIRONMENTAL ASSETS

The gathering of baseline information regarding the natural environment should cover all biological, geological and geomorphological resources of international, national or county importance. These are identified from statutory and non-statutory site designations and from other records held by a range of organisations.

The study area encompassed by Shoreline Management Plans encompasses terrestrial, intertidal and subtidal zones. All of these may be important to nature conservation and need to be fully addressed. However, knowledge of marine habitats and features is very much more limited than that of the terrestrial and intertidal zones owing to their relative inaccessibility. This disparity is reflected in the relative paucity of designations in the subtidal zone as well as a lack of survey data.

It must also be remembered that the absence of environmental designations at a particular location does not necessarily imply an absence of nature conservation importance requiring consideration within the SMP. For this reason, the collation of data from desk studies, consultation and field studies needs to be as comprehensive as possible throughout the study area.

Government guidance on nature conservation and on coastal planning is contained in two Planning Policy Guidance notes[19,20], to which reference should be made when preparing an SMP. Further guidance on strategic issues relating to shoreline management planning and coastal defence, including environmental issues, is provided by a number of MAFF publications[1,11,17,24].

3.1 Designated Sites

Sites of importance to the natural environment may be designated at international, national or county levels. Many sites may have more than one designation, for example all terrestrial Ramsar Sites, Special Protection Areas and Special Areas of Conservation in the UK are also Sites of Special Scientific Interest, and many Ramsar Sites are also Special Protection Areas. Designated sites which need to be considered in SMPs include the following:

(i) *International Designations*

- **Ramsar sites**, designated under the Convention on Wetlands of International Importance especially as waterfowl habitat[5].

- **Special Protection Areas** (SPAs), designated under the European Union Directive of 2 April 1979 on the conservation of wild birds[6] (79/409/EEC) (implemented into UK Law by the Wildlife and Countryside Act 1981[8]).

- **Special Areas of Conservation** (SACs), designated under European Union Directive 92/43/EEC[7] and implemented into UK Law by the

Conservation (Natural Habitats & C.) Regulations 1994[18]. These can apply to both terrestrial and marine habitats and species.

- **Biosphere Reserves**, designated under UNESCO's Man and the Biosphere programme.

- **World Heritage Sites**, designated by UNESCO (there are no natural World Heritage sites in England at present).

(ii) *National Designations*

- **Sites of Special Scientific Interest**
  The principal national designation of nature conservation importance is Site of Special Scientific Interest (SSSI). SSSIs are designated by English Nature as being "of special interest by reason of... flora, fauna, or geological or physiographical features"[3]. They represent the areas of greatest significance to nature conservation in Britain, a collective national total of protected areas sufficient to guarantee the survival of Britain's wildlife and physical features. It should be noted that some SSSIs may be of biological interest, geological interest or both. SSSIs designated for their ecological interest may be divided into Nature Conservation Review (NCR) sites[4] (essentially those which are most important in national terms) and non-NCR sites. All geological sites are Geological Conservation Review (GCR) sites. SSSIs can include terrestrial and intertidal habitats, but not the subtidal zone.

- **National Nature Reserves**
  National Nature Reserves (NNRs), all of which are also designated as SSSIs, are examples of Britain's best areas of natural or semi-natural habitat. They are likewise designated by English Nature, but unlike other SSSIs they are managed primarily in the interests of nature conservation. NNRs may be owned and managed by English Nature, or by arrangement with other approved organisations.

- **Marine Nature Reserves**
  Marine Nature Reserves are a statutory designation for the subtidal zone, but there is presently only one in England (Lundy MNR).

- **Sensitive Marine Areas (Areas of Importance for Marine Wildlife)**
  This is a non-statutory designation for the subtidal zone, established by English Nature.

- **Environmentally Sensitive Areas**
  ESAs are designated by the Ministry of Agriculture, Fisheries and Food to promote farming methods which preserve and enhance wildlife habitats, characteristic landscapes and historic features.

(iii) *Designations of County Importance*

- **Local Nature Reserves (LNRs)**
  LNRs are a statutory designation made by local planning authorities for areas of county or local significance to wildlife, which also have recreational value.

- **County Wildlife Sites**
  Most English counties have a non-statutory system of county wildlife sites, generally established by the County Wildlife Trust. These sites are increasingly recognised by the statutory development plans and accorded some degree of protection under the planning system.

- **Regionally Important Geological/Geomorphological Sites (RIGS)**
  RIGS are a non-statutory designation for geological sites of at least county importance, but which do not merit SSSI status. They are administered by a variety of organisations such as County Wildlife Trusts and geological societies. In some counties, the process of identifying RIGS is not yet far advanced and in such cases it is especially important to seek information on known sites which may qualify as RIGS, though not presently designated.

(iv) *Other Conservation Areas*

Land-holdings by non-governmental organisations may be managed as nature reserves, whether or not they overlap with statutory designated sites. Organisations with significant conservation land-holdings include the National Trust, the Royal Society for the Protection of Birds, the Wildfowl and Wetlands Trust and the County Wildlife Trusts.

3.2 Designated Species

In Shoreline Management Planning, species of flora and fauna which are protected or endangered at a national or international level should also be considered. This is particularly important since some protected or endangered species may occur outside designated areas. EC Directives place an obligation on member states to take special measures for the protection of listed species, which needs to be complied with in Shoreline Management Planning. Protected species are listed in the following Acts, European Directives and Convention:

- **Wildlife and Countryside Act 1981**[8]
  This Act protects certain species of birds, mammals, reptiles, amphibians, fish, invertebrates and plants in the UK.

- **Protection of Badgers Act 1992**[22]
  Protects both badgers and their setts

- **Birds Directive 1979 (EC Directive 79/409/EEC)**[6]
  Birds listed on Annex I are protected at a European level.

- **Habitats Directive 1992 (EC Directive 92/43/EEC)**[7]
  Mammals, reptiles, amphibians, fish and plants listed in Annexes are protected at a European level.

- **The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)**[23]
  The Convention gives strict protection to certain endangered migratory species, and establishes Agreements to promote the conservation of others.

Rare and endangered species may be identified by reference to the British Red Data Books, which categorise listed species as endangered, vulnerable or rare according to the degree of threat (a fourth category, scarce, is not included in the Red Data Books but may also be relevant to conservation objective setting). The British Red Data Books cover mammals, birds, insects, other invertebrates and plants. They are particularly useful for evaluating the conservation importance of plants, insects and other invertebrates, since few of these are specifically protected under legislation.

Species records for a study area can be obtained from English Nature, County Wildlife Trusts, County Naturalists' Societies, county biological recorders and county museums, the Sea Mammal Research Unit, landowners and literature reviews.

Data on population sizes of protected and endangered species in the study area should also be obtained where possible, though for many groups, particularly invertebrates, this is unlikely to be available. In the case of birds, the size of breeding or overwintering populations may be crucial to determining the conservation importance of the site in national or international terms. Data from breeding bird surveys and overwintering bird counts are held by the British Trust for Ornithology and the Wildfowl and Wetlands Trust.

3.3 Habitat Survey Data

An important element of baseline ecological data is identification and quantification of the natural and semi-natural terrestrial habitats present in the SMP study area. This information is frequently available as Phase I habitat surveys, which may be held by English Nature, County Wildlife Trusts or county biological recorders. These maps identify broad habitat types, usually at 1:10,000 scale, and are derived from field survey data, aerial photographs or both[14]. The area of each habitat type should be quantified within each coastal process unit defined as part of the SMP. Coastal habitat types which can be identified in this way include:

- sand dunes
- saltmarsh
- intertidal flats
- shingle
- saline lagoons
- freshwater lagoons
- freshwater marsh
- unprotected soft cliffs
- hard rock cliffs

- maritime cliff grassland
- coastal heath
- unimproved grassland/freshwater grazing marsh

Information on habitats in the subtidal zone is less readily available, but information may be available from diving surveys or grab samples for some areas of coast. Such surveys may have been undertaken for Regional Water and Sewerage Companies or by universities. The Joint Nature Conservation Committee also holds subtidal and intertidal survey data as part of its Marine Nature Conservation Review.

The conservation importance of habitats is often evaluated according to their scarcity, how natural they are, or how representative they are of particular ecosystems. The EC Habitats Directive[7] lists habitats of priority European interest and habitats of European interest, and examples of these merit particular attention in Shoreline Management Plans.

3.4 Critical Natural Capital

Work recently undertaken for English Nature has identified the concept of "critical natural capital" in relation to shoreline management planning. Critical natural capital is defined as "those elements of the natural environment whose loss would be serious, or which would be irreplaceable, or which would be too difficult or expensive to replace in human timescales"[9]. The preservation of critical natural capital is essential to achieve environmental sustainability, and is therefore a central objective of the Shoreline Management Plan.

Within the inherently dynamic coastal environment, many natural features are created and maintained by processes of coastal change; this implies that their modification and movement are inevitable. Such dynamic features, discussed further in section 3.5, are usually best conserved by allowing natural processes to take their course, and they will only rarely qualify as critical natural capital.

Separate criteria are needed to identify critical natural capital in relation to ecology and in relation to geology.

3.4.1 Ecology and Nature Conservation

Criteria for identifying critical natural capital are still under development by English Nature. A recent English Nature research report (Number 136)[9] proposes a series of criteria relating to ecosystem function which may be used in identifying critical natural capital for ecological sites in the maritime zone. The proposed criteria suggest that critical natural capital should be identified independently of existing designations. Conversely, since Article 4 of the EU Birds Directive and Article 6 of the EU Habitats Directive require EU member states to take appropriate steps to avoid the deterioration of habitat within SPAs and SACs (including proposed SPAs and SACs), it could be argued that all SPAs and SACs should automatically qualify as critical natural capital. The correct interpretation of the obligations on EU member states under these two Directives has not been fully tested, however it should be taken into account that coastal habitats within such sites are often of interest because of natural

processes, which themselves bring about increases and decreases in habitat size, or because of their modification by man. The legal implications of international designations are discussed further in section 7.

More detailed guidance on the identification of critical natural capital is provided by another English Nature research report (Number 141) dealing with the terrestrial environment[10]. This again suggests that critical natural capital should be identified independently of existing designations, because the two concepts have different objectives. Report 141 proposes that critical natural capital should be identified within "Natural Areas", which are a geographical framework covering England based on broad land-use, geological and physiographic characteristics. Within the coastal zone, this idea can be extended to include maritime natural areas, of which English Nature has identified 24 based on broad coastal types and the habitats represented. In many cases, the extent and boundaries of maritime natural areas are similar to those of coastal cells and subcells defined by MAFF on the basis of sediment transport characteristics. Boundaries of terrestrial and maritime natural areas identified by English Nature are shown in Figure 1.

Within each natural area, Report 141 identifies re-creatability as the key concept in identifying critical natural capital, whilst recognising the difficulties which may arise through uncertainties over what can and cannot be replaced. Relevant considerations in determining replaceability include:

- can the feature under consideration be replaced in the locality?
- is replacement technically feasible?
- timescale (25 to 50 years is identified as an appropriate timescale over which to judge replaceability).

Report 141 presents criteria for identifying four categories of critical natural capital:

(i) rare, threatened and declining species;
(ii) habitats and species assemblages;
(iii) environmental service provision (i.e. features which are critical to the survival of other important features);
(iv) earth science (see section 3.4.2).

Full details of the proposed process for identifying critical natural capital are included in Report 141 and are not reproduced here. However, it is evident that the criteria require detailed knowledge of the natural features being considered, as well as the application of ecological theory dealing with island biogeography, habitat fragmentation, minimum population size, habitat sources/sinks, population dynamics and species niche requirements. In the context of Shoreline Management Planning, this level of information is unlikely to be available for the whole of a coastline under examination, and even if it were, the resources required to collate and process the necessary data would be considerable. The authors therefore propose that for practical purposes, the identification of critical natural capital in Shoreline Management Plans should be based on whether it meets both of the following two criteria:

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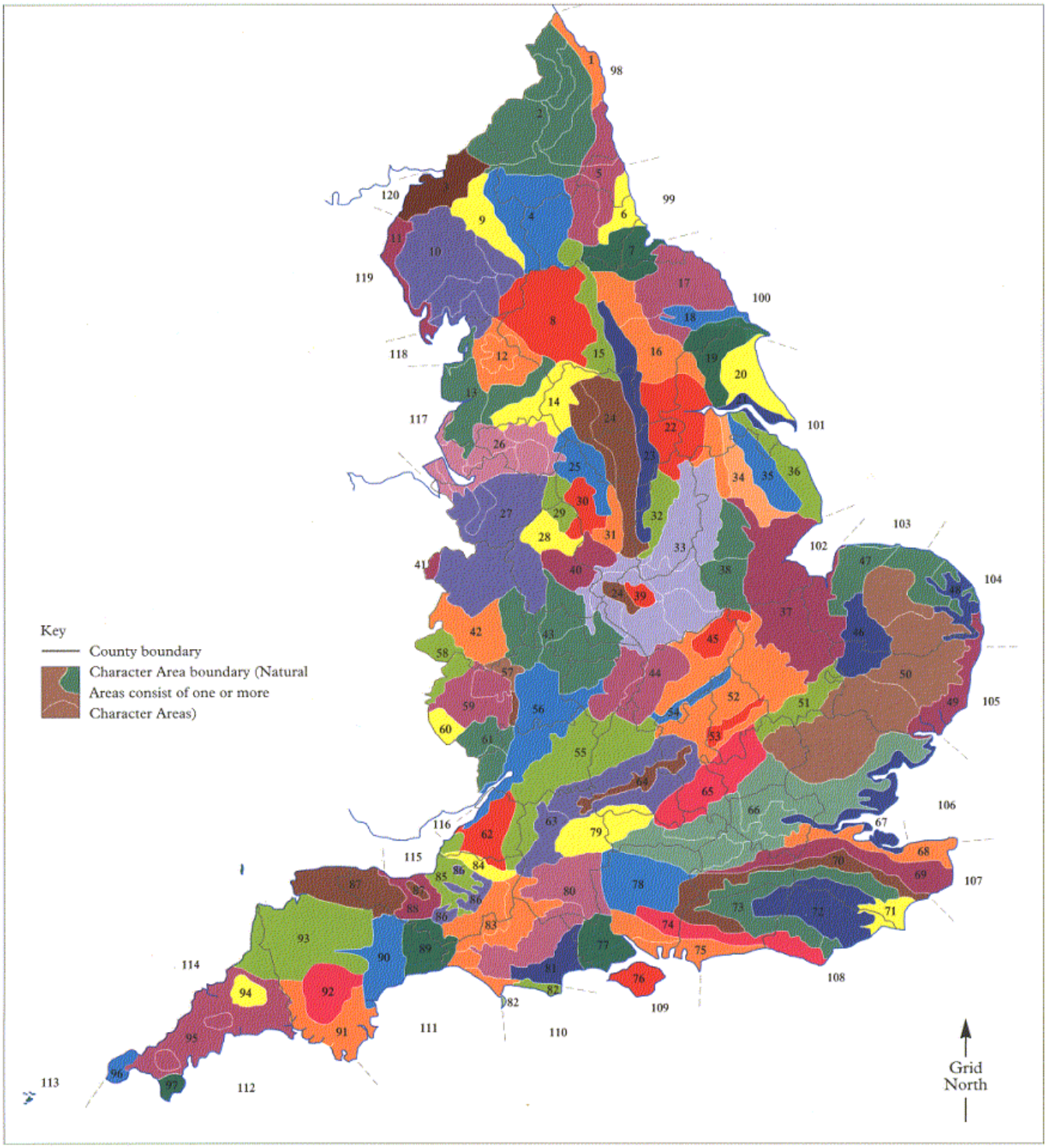
Natural Areas



1 North Northumberland Coastal Plain
2 Border Uplands
3 Solway Basin
4 North Pennines
5 Northumbria Coal Measures
6 Durham Magnesian Limestone Plateau
7 Tees Lowlands
8 Yorkshire Dales
9 Eden Valley
10 Cumbria Fells and Dales
11 West Cumbria Coastal Plain
12 Forest of Bowland
13 Lancashire Plain and Valleys
14 Southern Pennines
15 Pennine Dales Fringe
16 Vale of York and Mowbray
17 North York Moors and Hills
18 Vale of Pickering
19 Yorkshire Wolds
20 Holderness
21 Humber Estuary
22 Humberhead Levels
23 Southern Magnesian Limestone
24 Coal Measures
25 Dark Peak
26 Urban Mersey Basin
27 Mosses and Meres
28 Potteries and Churnet Valley
29 South West Peak
30 White Peak
31 Derbyshire Peak Fringe and Lower Derwent
32 Sherwood
33 Trent Valley and Rises
34 North Lincolnshire Coversands and Clay Vales
35 Lincolnshire Wolds
36 LIncolnshire Coast and Marshes
37 The Fens
38 Lincolnshire and Rutland Limestone
39 Charnwood
40 Needwood and South Derbyshire Claylands
41 Oswestry Uplands
42 Shropshire Hills
43 Midlands Plateau
44 Midland Clay Pastures
45 Rockingham Forest
46 Breckland
47 North Norfolk
48 The Broads
49 Suffolk Coast and Heaths
50 East Anglian Plain
51 East Anglian Chalk
52 West Anglian Plain
53 Bedfordshire Greensand Ridge
54 Yardley-Whittlewood Ridge
55 Cotswolds
56 Severn and Avon Vales
57 Malvern Hills and Teme Valley
58 Clun and North West Herefordshire Hills
59 Central Herefordshire
60 Black Mountains and Golden Valley
61 Dean Plateau and Wye Valley
62 Bristol, Avon Valleys and Ridges
63 Thames and Avon Vales
64 Midvale Ridge
65 Chilterns
66 London Basin
67 Greater Thames Estuary
68 North Kent Plain
69 North Downs
70 Wealden Greensand
71 Romney Marshes
72 High Weald
73 Low Weald and Pevensey
74 South Downs
75 South Coast Plain and Hampshire Lowlands
76 Isle of Wight
77 New Forest
78 Hampshire Downs
79 Berkshire and Marlborough Downs
80 South Wessex Downs
81 Dorset Heaths
82 Isles of Portland and Purbeck
83 Wessex Vales
84 Mendip Hills
85 Somerset Levels and Moors
86 Mid Somerset Hills
87 Exmoor and the Quantocks
88 Vale of Taunton and Quantock Fringes
89 Blackdowns
90 Devon Redlands
91 South Devon
92 Dartmoor
93 The Culm
94 Bodmin Moor
95 Cornish Killas and Granites
96 West Penwith
97 The Lizard
98 Northumberland Coast
99 Tyne to Tees Coast
100 Saltburn to Bridlington
101 Bridlington to Skegness
102 The Wash
103 Old Hunstanton to Sheringham
104 Sheringham to Lowestoft
105 Suffolk Coast
106 North Kent Coast
107 East Kent Coast
108 Folkestone to Selsey Bill
109 Solent and Poole Bay
110 South Dorset Coast
111 Lyme Bay
112 Start Point to Land's End
113 Isles of Scilly
114 Land's End to Minehead
115 Bridgwater Bay
116 Severn Estuary
117 Liverpool Bay
118 Morecambe Bay
119 Cumbrian Coast
120 Solway Firth

Revised to December 1996

(a) that the site (or population of species) is of national or international importance; and

(b) that the site (or population of species) is essentially irreplaceable within the lifespan of the Shoreline Management Plan (25-50 year timescale), whether because of technical or economic considerations, or both.

The inclusion of the first criterion has the effects of narrowing the search to areas of known importance (and by implication those for which the information needed to address the second criterion is likely to be available). These can usually be identified on the basis of existing or proposed designations. It will be appreciated that the restriction of potential critical natural capital to areas of designated national or international importance will result in the identification of a subset of critical natural capital as defined in Report 141. The possibility that areas outside the statutory designation system may well qualify as critical natural capital must not be ignored and should be addressed within Shoreline Management Plans where the necessary information is available.

The issue of replaceability is discussed separately for terrestrial and marine habitats below.

Terrestrial Habitats

Determination of whether a site is irreplaceable within a 25 - 50 year time period requires consideration of the habitats and species assemblages present. As a first step, the habitats need to be identified and catalogued at the level of a Phase I Habitat Survey. A mixture of theoretical considerations and evidence from the history of the site can be used to determine whether habitats can be re-created. The degree of natural dynamism exhibited by a site and/or specific features is of key importance; some coastal features are highly dynamic over the short-term (less than 25 years), whereas others are only dynamic over much longer time-scales. Coastal habitats which are only dynamic over the long term and are likely to be irreplaceable within a 50 year time scale include:

- mature semi-natural broadleaved woodland;
- mature heathland requiring particular soil types;
- grey dune systems;
- extensive, long-established vegetated shingle habitats;
- highly mature salt marsh at the landward side of an extensive marsh complex;
- extensive habitats or habitat complexes which can only exist in their present location, or for which there is clearly no space for replacement within the coastal subcell.

Applying similar considerations, species which may be regarded as critical natural capital include:

- those whose range is extremely restricted (e.g. to fewer than ten 10 km^2 in the UK) because of habitat, soil, climatic or other factors;

- those for which specific habitat requirements (e.g. roost or feeding sites) cannot be practically re-created;
- species which are not mobile and whose translocation to other sites is unlikely to be successful.

The importance of the location of a habitat may be difficult to determine. In some cases it may be argued that the special interest of a site, for example to over-wintering or migrating birds, is at least in part a function of its location. However, experience has shown that birds and other migratory species are highly mobile and will usually colonise suitable habitat once it is created.

Another issue which needs to be taken into account is whether there is room to re-create a habitat feature within the local landscape. Clearly this is a central consideration before a feature can in fact be replaced. However, in the context of Shoreline Management Planning it is not always an easy issue to address at an early stage. In some cases, the scale or nature of a habitat feature may be such that it would be practically impossible to re-create it elsewhere, and this may qualify it as critical natural capital. However, in other cases, whilst there may be no space to re-create certain features within the coastal subcell under study, opportunities for re-creation may exist in adjacent subcells or even inland. There may also be theoretical opportunities to re-create features on land presently under other uses, e.g. arable farming. The preparation of a Shoreline Management Plan should address the feasibility of habitat creation in sufficient detail to establish whether physically suitable sites exist. However, detailed consideration of the actual location and practicality of habitat creation is likely to fall outside the scope and budget of many Shoreline Management Plans, at least in the initial stages. The authors therefore recommend that Shoreline Management Plans concentrate on issues of re-creatability *in principle*, including broad issues of feasibility but leaving the details of practical issues of location and land ownership/stewardship requirements to a later stage. This implies that there will be a need for the Shoreline Management Plan to be followed by an *Implementation Study*, which will examine the practical aspects of replacing habitats likely to be lost as a result of coastal change. This is discussed further in section 7.

Marine Habitats

Within the subtidal zone, the identification of critical natural capital is much more difficult owing to the shortage of survey data and practical difficulties in applying the criterion of "re-creatability". In practice it will often be difficult to determine whether marine features qualify as critical natural capital. This is an area which requires further research.

3.4.2 Geology and Geological Conservation

A somewhat different approach is needed to the identification of critical natural capital in relation to geological assets. Sites of national or international importance to geological conservation (including geomorphology) are generally identified on the basis of their value in study, teaching and research. Such sites may, therefore, include type localities from which particular strata or fossils were described. As such, the

interpretation of their importance is a value-based judgement which depends on our theoretical understanding of geological processes. Report 141[10] proposes that to qualify as critical natural capital for earth science, a site must support land forms, exposures or deposits of importance for each science, *and* must meet *one* of the following criteria:

- it is a geological integrity site (this means that it is a site whose scientific value arises from the fact that it is a finite and limited deposit or a land form that is irreplaceable);
- there is no opportunity to replace the feature elsewhere within the natural area;
- the feature cannot be replaced for either technical or financial reasons within an acceptable timescale.

In relation to Shoreline Management Plans, we consider that the following considerations are also relevant to identifying critical natural capital and should be addressed in consultation with English Nature or other specialists:

- the national or international importance of the site for geological, geomorphological or palaeontological study, teaching or research;
- the extent of the geological exposures;
- the occurrence of similar features elsewhere in the locality, nationally or internationally;
- the role of natural coastal processes in creating and/or maintaining the features;
- the opportunities for re-creating or replacing certain types of feature elsewhere on the coast or inland;
- the role of recording and sample collection in preserving the value of the site.

3.5 Constant Natural Assets

Environmental resources which do not qualify as critical natural capital are termed "constant natural assets"[9]. It is important to note that constant natural assets are not those features of secondary importance to nature or geological conservation, but those whose importance can potentially be conserved by re-creation on other sites. Indeed, within the coastal zone, many natural features depend on dynamic processes for their existence, and can only be conserved by allowing them to evolve in response to coastal processes. Examples include salt marshes, dune systems and many geomorphological features. Attempting to arrest coastal processes in order to preserve such features in their present state is liable to have serious negative effects in the long term, and may lead to their being lost altogether.

Criteria for identifying constant natural assets are as follows.

3.5.1 Ecology and Nature Conservation

Constant natural assets may include designated sites or species populations of international, national, county or local importance. The Shoreline Management Plan should aim to conserve, and where appropriate enhance, the total stock of these assets overall, but not necessarily in their present positions. It is the possibility of moving ecological assets to another location which makes irreplaceability a fundamental

criterion in distinguishing critical natural capital. In assessing the ability to replace such features, it is not necessary to be able to re-create every detail of a site; it is the important features for nature conservation (e.g. particular habitats or species) which would have to be re-created in order to achieve success. In some cases, these need to be distinguished from the particular recreational, cultural and historic values which may attach to certain existing sites, such as wildlife reserves. Whilst material considerations within shoreline management planning, these other issues should be treated separately from the scientific and nature conservation value of a site.

In some cases, site history will provide evidence that habitats and species assemblages are re-creatable, for example if the habitat has existed on that site for less than 50 years. Alternatively, evidence may be obtained from the history of other similar habitats elsewhere. Furthermore, the availability of sites for re-creation, at least in principle, needs to be taken into account to establish its feasibility. The following are examples of the types of coastal habitats which are inherently dynamic over the short-term and/or generally re-creatable, and will in most cases represent constant natural assets:

- mud flats;
- sand flats;
- yellow dunes;
- salt marsh (but some very mature marsh may take more than 50 years to form);
- freshwater and brackish lagoons;
- freshwater grazing marsh;
- freshwater reed beds;
- woodland plantations.

However, some of these habitats may not be re-creatable for reasons discussed in section 3.4.1, and these may qualify as critical natural capital.

3.5.2 Geology and Geological Conservation

In general, all sites of recognised international, national or county importance (whether currently designated or not) which have not been identified as critical natural capital will constitute constant natural assets. This will include geological exposures and geomorphological features which have the possibility of being re-created in adjacent locations or elsewhere.

4. RECENT RATES OF LOSS OR CHANGE

Coastal change and loss of environmental resources may be the result of natural processes, human intervention or a combination of the two. Information on recent rates of loss or change can generally be obtained from historical maps, reports and field visits. Not all coastal change is detrimental to the natural environment; much may be beneficial. Important processes to be included in the study are as follows.

(i) *Natural Processes of Coastal Change*

- loss of terrestrial habitats as a result of landward recession of the high water mark;
- loss of intertidal habitats as a result of landward recession of the low water mark, coupled with slower recession of the high water mark ("coastal squeeze");
- the creation of new intertidal habitats such as shingle ridges, saltmarshes, sandflats and mudflats as a result of sediment deposition;
- the creation of features of geomorphological interest (e.g. sand bars) as a result of natural processes;
- the creation and maintenance of geological exposures by wave action;
- loss of freshwater habitats in the coastal zone as a result of saline inundation.

(ii) *Processes of Coastal Change Resulting from Human Activities*

- loss of terrestrial habitats in the coastal zone to built development or agricultural practices;
- loss of intertidal or terrestrial habitats as a direct result of coastal defence construction;
- loss of intertidal habitats as an indirect result of coastal defence construction preventing natural recession of the high water mark ("coastal squeeze");
- obscuration of geological exposures as a direct result of coastal defence construction;
- loss of geomorphological features or intertidal habitats as a result of sand or gravel mining in the intertidal or subtidal zone;
- loss of geomorphological features or intertidal habitats as a result of coastal defences reducing sediment supply (either sediment generation or sediment transport);
- degradation of terrestrial or intertidal habitats by recreational activities or research/educational use;
- the creation or preservation of terrestrial habitats in the coastal zone (e.g. freshwater lagoons, marshes and reedbeds) by the construction of coastal defences;
- the creation of intertidal habitats (e.g. saltmarsh) as part of "soft" coastal engineering measures or the implementation of managed retreat policies;

- the creation or maintenance of terrestrial habitats in the coastal zone as a result of agricultural practices and/or nature conservation management.

5. FUTURE RATES OF LOSS OR CHANGE

The prediction of future rates of loss or change is probably the most difficult aspect of objective setting for the natural environment, since quantification of all the variables may not be readily achieved. It is necessary to take into account all the factors influencing historical rates of loss or change listed in section 4, and to extrapolate the rates at which they may continue in the future. The following additional factors need to be addressed.

(i) rates of sea-level change relative to the land;
(ii) the probability of significant coastal change occurring as a result of single storm events;
(iii) the need for future coastal defence works to protect property interests;
(iv) other management strategies proposed in the SMP.

The period of time to be considered in the formulation of a Shoreline Management Plan is generally 25-50 years. Prediction of coastal change over this period will require close liaison with the geomorphological study conducted as part of the SMP. It will, however, be inevitable that a degree of uncertainty will remain. The output of this phase of the study is a statement of the expected changes in the number, distribution and quantity of all identified environmental resources (both critical natural capital and constant natural assets) over the lifespan of the Plan, on the basis of "do nothing" or other defined scenarios.

6. SPECIFICATION OF OBJECTIVES

According to MAFF guidelines, Shoreline Management Plans should assess a range of coastal defence options. Coastal defence options can be divided into the following broad categories[1,11,17]:

(a) do nothing;
(b) maintain existing alignment (may include sustaining existing defences or their reconstruction);
(c) retreat from existing alignment;
(d) advance from existing alignment.

Risk management (e.g. evacuation procedures to protect life) also needs to be considered as an option[1].

In selecting appropriate options for shoreline management, a wide range of considerations relating to coastal processes, property, the human and built environment need to be taken into account. Nature conservation objectives need to be integrated into objective setting at four levels:

(i) The preservation of critical natural capital needs to be a central objective of the plan. In some cases, this will favour a policy of non-intervention or "do nothing" to allow natural processes to take their course. In other cases, intervention may be needed to protect assets from loss which would otherwise occur as a result of either natural processes or human activities. Careful consideration will need to be given to how the need for such intervention can be accommodated within MAFF cost-benefit guidelines, and what techniques of economic valuation may be appropriate for environmental assets (see also section 7). In the case of stratigraphic and palaeontological sites whose interest is maintained and exposed by marine erosion, "do nothing" will almost always be the favoured option. Other possible options which may be appropriate within geological sites are described in a guide produced by HR Wallingford[12].

(ii) The conservation of the existing stock of constant natural assets, either in their present position, elsewhere within the coastal subcell or, if necessary, outside the coastal subcell. The most appropriate option will depend on technical, economic and practical factors. As noted in section 3.5, where re-creation is proposed it is not necessary to attempt to re-create every detail of a site, the objective is to re-create the features which are important. Information from habitat surveys (see section 3.3) provides an essential baseline to enable the setting of quantified objectives for maintaining the stock of constant natural assets over the lifetime of the SMP. Targets for maintaining populations of protected or endangered species in the study area will generally be difficult to set, owing to a lack of existing population data and insufficient information about what constitutes a viable population. For some high profile species, such as breeding birds, the data needed to quantify objectives may, however, be readily obtainable.

(iii) The creation of new nature conservation assets in appropriate locations. These may be to replace assets lost elsewhere, to expand the stock of existing assets, or to provide features of a type not presently represented in the area. Habitat creation may be a possibility in a wide range of situations, and a particular case is where managed retreat is being considered as a defence option. Setting back of hard flood defences on a soft coastline will often provide the opportunity to enable valuable new intertidal habitat such as saltmarsh to be formed on land which was previously of low nature conservation value. Guidance on this is provided by a recent English Nature report[21].

(iv) The modification of coastal defence objectives derived from other parts of the SMP, in order to allow for the protection of critical natural capital and the conservation (including movement and re-creation) of constant natural assets. These may include modifying objectives related to property protection and/or other environmental assets (e.g. cultural heritage or recreation).