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Environmental opportunities in low lying coastal areas under a scenario of climate change

Final report

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**ENVIRONMENTAL OPPORTUNITIES IN LOW LYING
COASTAL AREAS UNDER A SCENARIO
OF CLIMATE CHANGE**

FINAL REPORT

**Prepared for:- National Rivers Authority
Department of Environment
Nature Conservancy Council
Countryside Commission**

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**Posford Duvivier Environment
Rightwell House
Bretton Centre
Peterborough
PE3 8DW**

PREFACE

Many of the low lying areas of England and Wales are currently protected from salt water inundation by artificially maintained sea or tidal defence structures. A significant proportion of Britain's richest coastal ecological sites are also situated in these low-lying areas, either to the seaward side of the defences, or immediately behind them.

Current concerns over the extent and significance of past coastal habitat losses due to development, and the possible future losses under a scenario of climate change and sea level rise, combine to demonstrate the need to promote the restoration or creation of sites of nature conservation interest in Britain's coastal zone.

This report demonstrates that significant opportunities for environmental enhancement of this nature might arise if a retreat from the existing line of flood defence is accepted as an option.

Various retreat strategies can be identified, ranging from the do nothing option, through a minimum intervention approach, to the implementation of engineering works to create a desirable habitat. Under a true do-nothing strategy, the sea defence is abandoned and no further action of any kind is taken. The way in which the site evolves over time is left entirely to natural forces. "Managed" retreat, on the other hand, covers a variety of different potential options which are specifically directed towards restoring or creating desirable habitat, landscape or amenity features.

The coastal environment is dynamic and the mechanisms at work are powerful. Particularly on exposed coasts, the coastal process regime will need to be understood if habitat restoration/creation opportunities are to succeed and are not to cause problems elsewhere. The physical characteristics which are likely to be of greatest importance in the development and control of sustainable coastal habitats are waves; tidal currents; sediment regime; surges; elevation; grade; drainage; and site size.

In addition to these physical parameters, a number of biological and chemical parameters must also be assessed and possibly controlled, if a more environmentally desirable habitat is to be restored or created. The major biological considerations associated with the retreat option include the proximity of similar sites and the related availability of soil fauna, and also the preferred method of establishing vegetation cover. Primary chemical parameters relate to soil chemistry and structure, and the quality of the water entering and leaving the site.

The conclusions of this study indicate that carefully planned, managed and monitored habitat restoration and creation projects could provide a means of significantly reducing the impact of both recorded and anticipated coastal habitat loss. Such artificially created habitats could, however, take upwards of ten or twenty years to realise their maximum environmental value.

Recommendations are therefore made in respect of short-term experimental needs and long-term monitoring requirements. Funding opportunities are examined and a framework is developed to ensure that the managed retreat option is properly considered in terms of its technical, economic and legal viability as well as its site specific environmental and ecological desirability.

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EXECUTIVE SUMMARY

BACKGROUND TO THE REPORT

Many of the low lying areas of England and Wales are currently protected from salt water inundation by artificially maintained sea or tidal defence structures. A significant proportion of Britain's richest coastal ecological sites are also situated in these low-lying areas, either to the seaward side of the defences, or immediately behind them.

Current concerns over the extent and significance of past coastal habitat losses due to development, and the possible future losses under a scenario of climate change and sea level rise, combine to demonstrate the need to promote the restoration or creation of sites of nature conservation interest in Britain's coastal zone.

This report demonstrates that significant opportunities for environmental enhancement of this nature might arise if a retreat from the existing line of flood defence is accepted as an option. In particular, the report investigates the issues surrounding the concept of a "managed" retreat specifically designed to maximise nature conservation benefits.

The term "managed retreat" is used throughout the report. Managed retreat should not, however, automatically be interpreted as meaning that extensive and/or expensive engineering works will be required on a particular site. The term is used to imply a level of awareness and, if appropriate, control. Experience both in the United States and in Europe has demonstrated that understanding and careful planning are likely to be two of the most important criteria determining the success of habitat creation/restoration initiatives. Good management does not necessarily involve intervening in the natural processes of site evolution.

The Scope of the Study

Preliminary results from the National Rivers Authority's Sea Defence Survey (England and Wales) indicate that a total of around 40km of sea defences, protecting in excess of 10,000 ha of agricultural land, currently have a residual life of less than five years. Where these defences protect lives and property it is likely that a decision will be made in favour of reinstatement. Where the defences protect agricultural land, however, managed retreat should be considered as an option.

A series of meetings with Regional National Rivers Authority and Nature Conservancy Council (now English Nature and the Countryside Council for Wales) personnel led to the identification of more than forty sites at which the opportunities and constraints associated with the retreat option might be further investigated. While the NRA Sea Defence Survey identifies only those sites protected by sea defences, these Regional meetings identified a number of candidate sites in estuaries which are currently protected by tidal defences, as well as sites protected by sea defences.

Agricultural Land

The scenario of creating saline or brackish water habitats in areas which were formerly protected against inundation forms the principle basis of the report. Once an area has been subjected to brackish or saltwater inundation for any length of time, options for reclamation are significantly reduced. Retreat for nature conservation benefits in the coastal zone has significant implications for agricultural land-use over the short to medium term and the needs of both interests must therefore be very carefully assessed at local, regional and national levels.

Climate Change Scenarios

For the purposes of this study, the climate change and sea level rise predictions described by the Intergovernmental Panel on Climate Change (IPCC, 1990) as being most likely under their "business as usual" scenario have been adopted. It has also been assumed that both increased storminess and increased saline intrusion might be anticipated in the coastal zone as a result of global warming.

The United States Experience

Throughout the report, the situation in England and Wales is compared to that in other countries, notably the United States. The emphasis on the US stems largely from the requirements of their 1972 Clean Water Act which introduced a requirement for mitigation on development projects damaging wetland resources. As a result of this Act, the Americans have built up an extensive literature on habitat creation and restoration and, although it is recognised that care needs to be taken in applying the results of this research in Great Britain, the US nevertheless provides an invaluable source of information of direct relevance to this study.

THE IMPACTS OF SEA LEVEL RISE ON COASTAL HABITATS

Mean sea level, tidal rise and fall, meteorological surges, tidal streams and other currents, and wave action are all important in shaping Britain's coastline. All of these factors may be modified to some extent by climate change, most particularly through the predicted rise in mean sea level and by the possible increase in the occurrence and severity of storms.

Around 70% of the world's shores are currently eroding, to a large extent irrespective of any change in climate. Erosion is influenced locally by a number of factors. Two key factors are the "hardness" of the coast and human intervention. The increase in global warming is likely to lead to increased erosion and hence to more littoral material being freed for transport into sheltered areas. Assuming such erosion is not prevented by man (e.g. by coast protection works), sediment necessary for the accretion of mudflats, sandflats, saltings and shingle beaches may be generated in at least as great, if not greater, quantities than at present. The littoral zone is, however complex. **The need for monitoring, both of coastal processes and of ecological changes, cannot be overstated if climate change and sea level rise is to be both accommodated and managed in order to maximise opportunities and minimise threats.**

Sand Dunes and Sandbanks

Under a scenario of climate change and sea level rise, some sand dune systems may retreat landwards or even disappear depending on sand supply, wind characteristics, and man's willingness to allow the particular dune system to retreat. To some extent, however, instability within certain dune systems may not be detrimental. Coastal ecosystems are dynamic and change is important.

The process behaviour of many of the sandflats and sandbanks around the coast of the UK is not fully understood. The effect of global sea level rise may be significant, but whether it would lead to a net loss or gain of such features - and hence seal haul out areas and bird breeding and feeding sites - cannot be ascertained.

Saltmarshes and Mudflats

With an adequate supply of sediment, saltmarshes can accrete upwards by 2-10mm/year. Some saltmarshes might therefore be expected to "keep up with" sea level rise. Without an adequate supply of sediment, however, saltmarsh plants would be detrimentally affected because they can only tolerate limited submergence. The edges of saltmarshes are also likely to become cliffed, and creeks might become steeper and wider. Most importantly, sea walls and other hard defence structures will prevent the inland migration of saltmarshes in many areas. Sea level rise might therefore be expected to lead to a reduction in the overall area of such habitats where they are backed by sea defence structures.

Mudflats generally occur in sheltered areas. The processes that shape mudflats are very site specific and it is not possible to generalise on how they will respond to global warming. A rise in sea level might lead to a decrease in the extent and exposure of mudflats but deposition would tend to counteract this tendency if there is an adequate supply of sediment.

Other Coastal Habitats

Sea level rise is likely to have a variety of impacts on shingle features. Transgressional adjustment at a few of the large shingle structures could compensate for sea level rise to some extent. Many other single features, however, would be vulnerable to both erosion and breaching, and shingle vegetation communities might be lost due to increased inundation, storminess and the general increased mobility of shingle under a scenario of sea level rise.

The general rise in water level under a scenario of sea level rise will tend to increase saline intrusion into coastal lagoons. This is likely to disturb existing lagoons whilst possibly encouraging the formation of new ones. Flora and macrofauna lagoon communities are also very sensitive to salinity levels and increased salinity could therefore lead to significant changes in lagoonal species composition.

Sea level rise could affect reedbeds as a result of changes in salinity, currents and water depth. There is likely to be some loss of existing reedbeds with sea level rise, with colonisation in other areas.

The effects of sea level rise on coastal grazing marshes will depend on changes in the frequency and duration of tidal inundation and the salinity range.

Cliffs composed of hard rock would be largely unaffected by global warming, their durability protecting them from marginal increases in wave attack. Softer rocks might be expected to erode more rapidly than at present. Sites which are dependent on cliff falls to maintain their geological interest might benefit from sea level rise, but sites of conservation value because of their vegetation and invertebrate interest might be lost if the frequency of cliff falls increases to the point where cliff communities are unable to become re-established.

Sub-tidal habitats are unlikely to be severely affected by a rise in sea. There may, however, be significant opportunities for the creation of new sub-tidal habitats under a scenario of sea level rise.

TECHNICAL VIABILITY

On a site-specific basis, the decision-making process in respect of the retreat option should start with an assessment of the technical viability and the management implications of a range of alternatives. These alternatives should include both maintaining the flood defence and creating coastal habitats. It is then necessary to determine their relative benefits in terms of ecological desirability and to assess the economic implications of each option.

In many situations an option involving a retreat from the existing line of flood defence will offer significant environmental benefits. If this is the case, the degree of management or intervention which might be required to achieve different environmental objectives must be carefully considered. This is important because of the possible cost implications of a long-term management policy based on intervention; the general desirability of creating or restoring a sustainable habitat; and the need to avoid undesirable consequences (e.g. increased erosion or deposition) elsewhere in the estuary or along the coast. **In particular, sustainability criteria are of vital importance if habitat creation or restoration initiatives are to succeed. It is not an objective of this study to promote the creation of habitats which subsequently require as much maintenance as the flood defence structures which preceded them.**

The study demonstrates that there are dozens of sites throughout England and Wales where flood defences have failed and the land formerly protected against flooding has reverted to various types of coastal habitat. Very few such sites have been properly documented, yet the information which could be collated from photographic records and discussions with local conservationists could be invaluable for future decision-making in respect of the retreat option. **It is therefore recommended that research be undertaken to identify a series of sites where the necessary information is likely to be available, albeit in a somewhat subjective form, and to establish and compare rates of habitat development or habitat change. The physical, biological and chemical controls on the nature and extent of ecosystem development could then be evaluated, and a database would ultimately be established against which future retreat options might be assessed.**

Experience, in the United States in particular, has demonstrated that a key factor in successful habitat creation/restoration initiatives is a careful prior appraisal of the situation and, if appropriate, well researched design undertaken by suitably qualified personnel. The physiology of a created site, its biodiversity and its long-term sustainability will then determine its eventual success. The development of the soil physiology will, in many cases, affect the rate and extent of vegetation colonisation. If the soil invertebrates, algae and other organisms, nutrients and structure are not properly established, vegetation growth will be inhibited. Similar problems will be experienced if physical processes are not fully effective. **A key to successful habitat creation, from a biological as well as a physical viewpoint, is understanding and re-establishing natural processes, and then allowing enough time for the habitat to develop.**

Physical Considerations

The coastal environment is dynamic and the mechanisms at work are powerful. Particularly on exposed coasts, the coastal process regime will need to be understood if habitat restoration/creation opportunities are to succeed and are not to cause problems up or down-stream. The physical characteristics which are likely to be of greatest importance in the development and control of sustainable coastal habitats are waves; tidal currents; sediment regime; surges; elevation; grade; drainage; and site size.

Biological and Chemical Considerations

In addition to these physical parameters, a number of biological and chemical parameters must also be assessed, and possibly controlled, if a more environmentally desirable habitat is to be restored or created. The major biological considerations associated with the retreat option include the proximity of similar sites and the related availability of soil fauna, and also the preferred method of establishing vegetation cover. Primary chemical parameters relate to soil chemistry and structure, and the quality of the water entering and leaving the site.

A great deal of practical research has been carried out, notably in the United States, into the potential beneficial uses of dredged material in habitat creation and restoration. In general terms, these materials simply provide a substrate on which to work. A number of further factors must, however, be considered in terms of the testing and use of materials and the monitoring of sites if contaminated or potentially contaminated dredged materials are to be used.

Technical Manuals

It is not the purpose of this report to provide site specific technical guidelines for habitat creation or restoration. The report's objective is to highlight the factors which must be considered if such projects are to have a reasonable chance of success. Nevertheless, a great deal of technical information was examined during the preparation of the report and a list of the manuals, reports and other papers dealing specifically with methods and techniques for restoration and creation is therefore appended to the report. It should be noted, however, that much of this guidance is American: there is very little in the way of documented technical support for coastal habitat creation or restoration in the British context.

Experience with Restoration and Creation of Coastal Habitats

All the examples of British sand dune restoration/creation investigated related to sites which already support, or are in the immediate vicinity of, an existing dune system. Dune creation on sites without any previous evidence of dune systems is apparently unprecedented.

In Great Britain there are very few examples of saltmarsh creation. There are, however, a number of examples of restoration, and most schemes are either designed to stabilise an area of sediment or to re-establish a damaged marsh.

In the British context, mudflats are a particularly valuable coastal habitat because of their importance for migratory birds. Notwithstanding this, British experience in the deliberate creation or restoration of mud or sandflats is minimal.

Experience in the creation or restoration of shingle features, both in the US and in Great Britain, is largely limited to beach recharge schemes. Creating or restoring shingle habitats is likely to be very difficult because of the mobility of the material and because of the sensitivity of shingle vegetation to disturbance.

Several examples of the creation and/or restoration of coastal lagoons, reedbeds, sea grass beds, bird islands and other habitats were investigated during the study process. The physical and biological requirements for the first two habitat types in the British context are reasonably clearly defined. Experience in the others, however, is largely restricted to work in the United States.

For most of the coastal habitats mentioned above, tables have been prepared setting out the primary physical and biological requirements for the successful restoration or creation of that habitat. Where records exist, however, it is clear that some coastal habitats will take up to 20 years to become properly established and hence "successful".

In Great Britain, although we can learn a great deal from overseas experience, some experimentation will be required simply to establish which management techniques are likely to be most successful. **If the country is to sustain its coastal ecological resource in the face of rising sea levels, it would therefore be prudent to explore opportunities for creation and restoration sooner rather than later.**

ASSESSMENT AND EVALUATION OF RETREAT

The decision rule generally adopted in the evaluation of flood defence options is based on economic viability. If the damage-costs-avoided (the "benefits") are greater than the engineering costs, then the maintenance or improvement works are justified. When comparing a number of different options for a particular scheme, the option which provides the highest level of net benefit or is the most cost-effective in meeting a given set of criteria should be chosen. If the engineering costs are greater than the damage-costs-avoided, however, the engineering works are not justified and a decision may therefore be taken to do-nothing.

Various retreat strategies can be identified, ranging from the do nothing option through a minimum intervention approach to the implementation of engineering works to create a desirable habitat. In a true do-nothing strategy, the sea defence is abandoned and no further action of any kind is taken. The way in which the site evolves over time is left entirely to natural forces. Managed retreat, on the other hand, covers a variety of different potential options with the common aim of restoring or creating "desirable" habitat, landscape or amenity features.

The identification of potential retreat options should take into account not only technical viability but also the environmental desirability of the restored or created habitat. A mixture of ecological and landscape criteria should therefore form the basis not only for identifying restoration and creation priorities, but also for assessing and evaluating potential options.

The appraisal process for managed retreat will therefore frequently involve more than one stage. The ecological and landscape criteria will generally be used first, to screen and assess potential options. A more formal evaluation within an overall cost-benefit analysis (CBA) framework should then be carried out using non-monetary and/or monetary techniques. The type of technique chosen will depend on the nature of the impact and the most suitable assessment approach.

Qualitative and Quantitative Techniques

Qualitative techniques aim to provide information which allows comparisons to be made between sites or proposals, rather than providing some absolute figure representing conservation or habitat "value". The techniques are generally based on the use of subjective judgement to determine performance in respect of different evaluation criteria. Some criteria may be measured in objective terms in that they are based on scientific assessments, but qualitative descriptions or values are generally used for assessment purposes.

Quantitative techniques were developed in response to the need for more scientific and objective assessments of environmental goods such as habitat, landscape and amenity. They also help to provide greater differentiation between sites or proposals, in that they indicate not only that one is better than another, but also by how much.

Valuation Options

Where the mechanism for funding an option requires evidence of economic viability, a simple cost-effectiveness approach (i.e. demonstrating best value for money) towards assessment and evaluation may not be acceptable and cost-benefit analysis (CBA) may be preferable. The CBA framework dictates that as many of the costs and benefits as possible - including non-market effects such as those generally associated with environmental goods and services - should be quantified in money terms. Because costs and benefits occur at different times over the project lifetime, a discounting exercise is then undertaken to convert them into a comparable money value. A project is then deemed economically viable if its net present value (NPV) is positive: that is if the discounted stream of benefits is greater than the discounted stream of costs. When a number of alternatives are being considered, the option with the highest NPV should be the preferred choice.

In many cases when dealing with habitat creation or restoration, it may not be possible to place money values on impacts on environmental goods and services due to the absence of markets in which they can be traded. These impacts must still be described or quantified within the CBA framework, however, and presented together with the monetary values. The option providing the greatest overall level of net benefits will remain the preferred choice.

Coastal habitats provide benefits which correspond to three different categories of value held by individuals towards environmental goods: use values (associated with the benefits gained from use of the environmental resource, along with option values which relate to the desire of an individual to maintain the ability to use the resource in the future); bequest values (the preservation of the environment so that future generations may also have the option of use); and existence values (the values which result from an individual's altruistic desire to assure the availability of a good or service for other individuals and for future generations).

It is important that both use and non-use values are taken into account in the assessment of any particular project. If an analysis only assesses the values related to direct use, a gross underestimation of the total economic benefits to be gained from any restoration or creation activities could result.

The application of cost-benefit analysis techniques to the evaluation of activities, including those affecting the environment, requires that all future costs and benefits are discounted. This ensures that money values are converted into comparable units and can, therefore, be added together to give an overall estimate of net benefit.

Valuation Techniques

The aim of CBA is to quantify in money terms as many costs and benefits as possible. This report identifies six potential methods for the monetary valuation of benefits associated with coastal habitat restoration and creation activities. These are methods which could be used to develop either "reference values" or "specific values". Reference values are values which are based on benefit estimates calculated for existing sites, but which are considered to be comparable to the habitat resulting from restoration or creation. Specific values are developed for the proposed restored or created resource itself, and are generally based on predictions of the functions and services that will be provided.

Change in productivity approaches can be used to value benefits related to services or functions for which either direct or indirect markets exist. This method may, therefore, seem to be of limited applicability to the valuation of habitat creation initiatives, but where such benefits have been identified specific values for the created resource could be developed.

Preventive expenditure and replacement cost methods rely on using measures of expenditure incurred (such as costs of engineering works) to place a value on an environmental good or service. These methods would have to be used in the development of reference values and, due to their site-specific nature, the reliability placed on the resulting benefit estimates would be low. They are, however, easily applied techniques.

Damage-costs avoided, as defined here, involves determining the value of an environmental good or service using the damage that would otherwise be incurred should that good or service be removed. Specific values could be produced through this type of approach as long as the nature and type of functions that would result from the restoration or creation activities could be predicted.

Travel cost techniques infer the value placed on an environmental good by determining the amount of money spent to travel to that good. Although a frequently used method for the valuation of recreational benefits, its application to the valuation of restoration or creation initiatives is likely to be limited to sites which have an existing or adjacent use value.

Contingent valuation methods use various survey techniques to develop direct valuations of individuals' willingness to pay for a particular environmental good or service. These methods are the most flexible of those reviewed, and can be used to estimate both use and non-use related values. CVM therefore offers the most potential for the valuation of environmental benefits associated with habitat creation or restoration initiatives. Care must be taken, however, to minimise potential bias in the survey, and to validate the results as far as possible through the use of statistical techniques.

Energy analysis approaches rely on estimating the total energy produced by an environmental system and converting this to a monetary value using prices placed on fossil fuels. Although this method is attractive in that it produces a total value for the habitat, there is considerable debate over the use of energy prices as the measure of monetary value. The use of this technique is not therefore recommended for valuation of the environment benefits associated with habitat creation or restoration initiatives.

In summary, the techniques which are likely to prove most applicable to the assessment of benefits associated with habitat creation or restoration are preventative expenditure and replacement cost methods (reference values), and contingent valuation methods (reference and specific values). Only contingent valuation could be used to provide estimates of non-use related benefits including option, bequest and existence values.

Acceptability of Different Valuation Techniques to Interested Agencies

The monetary valuation of environmental costs and benefits is generally accepted by the National Rivers Authority as being of use in the benefits assessment process, notably as a means of demonstrating economic viability to MAFF when applying for grant-aid funding. The Nature Conservancy Council prefers the use of qualitative evaluation methods but accepts that there may be a need in some circumstances to place monetary values on a particular site of nature conservation interest. The RSPB supports the quantification of environmental costs and benefits, but has some reservations about the implications of applying monetary valuation techniques and would urge caution in their use. The Countryside Commission does not support, in general, the principle of monetary valuation, particularly when applied to landscape assets.

Future Evaluation of the Retreat Option

There are considerable difficulties in applying monetary assessment techniques to the valuation of environmental assets such as habitat or landscape. This may limit the feasibility of valuing habitat creation/restoration initiatives and hence the reliability of any estimates generated through these techniques for input into CBA.

It is nevertheless recommended that managed retreat options should be evaluated as far as possible within a cost-benefit framework. This approach provides an indication of whether or not benefits exceed costs and has the advantage over a cost-effectiveness approach in that it takes into account the full range of environmental (habitat, conservation and amenity) implications associated with each option. Assuming that quantitative and qualitative impacts are fully considered alongside monetised benefits and cost within the benefit-cost framework, this approach will help to ensure that the most beneficial or worthwhile options are selected.

IMPLEMENTATION

A large number of organisations have an interest in the management of Britain's coastal zone. The National Rivers Authority (NRA) is arguably one of the most important of these agencies, having powers and duties in respect of both Flood Defence and Conservation, the latter under Section 8 of the Water Act 1989. The Nature Conservancy Council (now English Nature and the Countryside Council for Wales), Ministry of Agriculture, Fisheries and Food, Countryside Commission, and the local planning authorities are among the other statutory authorities with powers and duties to conserve or enhance environmental resources through designation and enforcement policies. Voluntary organisations such as the National Trust and the Royal Society for the Protection of Birds could also play a key role in the implementation of the managed retreat option.

Support for the principle and objectives of the retreat option from groups such as the Country Landowners Association and National Farmers Union would, however, also be desirable. Such support is unlikely to be forthcoming in the absence of an adequate compensation provision. In the long-term, if the creation of environmentally desirable coastal habitats is to become widely accepted, the issue of compensation for the landowner must therefore be both addressed and resolved.

There are two primary mechanisms for compensation. The first involves the purchase of the land in question; the second, the negotiation of some form of on-going payment to the landowner. Several of the agencies listed above have compulsory purchase abilities in respect of nature conservation. Compulsory purchase is, however, generally regarded by these agencies as a last resort and this study does not advocate any change in that presumption.

Some managed retreat options may offer opportunities for landowners to continue to utilise their land productively. In particular there may be potential spin-offs in the form of financial gains from managing a site for nature conservation as a form of diversification. Wildfowling may be prepared to pay the farmer to pursue their interests; if there is an adequate supply of freshwater reeds might be grown commercially; reedbeds may be set up to treat sewage or waste water; or a nature reserve might be developed. In these cases, it may be possible for one of the interested agencies to negotiate a management agreement with the landowner to ensure that environmental objectives are also achieved. Alternatively, an agency may assume the control of a site in return for the payment of an agreed "rent" or lease.

NRA's Legal Responsibilities in Respect of Conservation

Counsel's Opinion in defining the Water Act 1989 S.8(1)(a) duty for NRA appears to offer positive support for the retreat option, where that retreat is planned and/or controlled to ensure nature conservation benefits. Counsel's Opinion states that "Attention needs to be given to its positive expression: the duty is concerned not merely with the assessment of harm but also the achievement of a better environmental result by the use of one alternative [e.g. retreat] even if the other, or others, [e.g. flood defence] are not in themselves particularly harmful to ecology or amenity" [authors' parentheses].

Under S.17 of the 1976 Land Drainage Act, the drainage authorities (including the NRA) have a permissive power to maintain and improve existing works and construct new works. In certain circumstances, therefore, the NRA can make a decision to abandon a defence when it reaches the end of its residual life without becoming liable to pay compensation. However, if the NRA intervenes and does something (e.g. undertaking habitat creation work in line with their S.8 duties) which actively reduces that residual life and hence the value of private land, there may be a requirement for compensation.

In this situation the NRA might, for example, consider negotiating a management agreement and/or setting up a nature reserve. There is no precedent for the NRA setting up nature reserves, but they would be able to do so under the Water Act 1989. The NRA may also charge any visitors to such a reserve under the same Act.

The Role of Other Statutory Bodies

The Nature Conservancy Council is generally supportive of the retreat option. Under the terms of the Environmental Protection Act 1990, NCC may be able to use their management agreement budget to provide funding for managed retreat in areas adjacent to sites of existing conservation interest. The NCC's ability to contribute towards individual projects may also be important, particularly in early applications of the managed retreat approach where experimentation is required. The NCC has, in the past, acquired some sites for research or experimental purposes but land acquisition by the NCC is regarded as a last resort to protect threatened sites for which no other safeguard mechanisms are felt to be appropriate.

The Ministry of Agriculture, Fisheries and Food has a wide range of powers and duties of direct relevance to this report, notably flood defence and coast protection (the latter under the Coast Protection Act 1949); environmental responsibilities under the terms of the Agriculture Act 1986; and the issuing of dumping licences under the terms of the Food and Environment Protection Act 1985. MAFF also provide funds for sea defence, tidal defence and coast protection schemes (among others) in the form of grant-aid. The managed retreat option might, in some cases, attract funding from MAFF, if it can be demonstrated either that the particular habitat restoration/creation initiative serves a coastal engineering function, or that it is essential to meet planning permission or Environmental Assessment requirements.

A major new countryside initiative has been announced recently by the Countryside Commission to help to enhance and re-create valued English landscapes and habitats, whilst making them more accessible to the public. This pilot scheme, known as Countryside Stewardship, will initially target chalk and limestone grasslands, heathlands, waterside landscapes, coastal land, freshwater and estuarine grazed marsh, and grazed dune systems. It also offers enormous potential for the implementation of the managed retreat option. **The recreation and restoration of natural coastal landscapes and habitats could represent an appropriate application of the Countryside Stewardship objectives, but it may be necessary to amend the list of targeted habitats to specifically include coastal lowlands.**

Local planning authorities (LPA) have a number of flood defence, coast protection and nature conservation powers and duties relevant to the retreat option. Many LPAs regularly or occasionally carry out projects specifically to create habitats of conservation value, preferring to support site specific projects. This approach is very encouraging in respect of possible future implementation of the managed retreat option - either in areas where the LPA are responsible for the flood defences, or in support of NRA or NCC initiatives.

Local planning authorities also have what is arguably a crucial role to play in enabling the option of retreat for nature conservation benefit to be implemented, because managed retreat, in some cases, might require planning permission from the LPA. On the other hand, if proposed new developments in low-lying coastal areas are granted planning permission future potential sites for retreat will be lost. Similarly, if new cliff top developments go ahead, a source of sediment to support existing and new coastal habitats might be lost if coast protection works are subsequently undertaken.

The role of the Crown Estates Commissioners under a retreat scenario will be important, primarily because the Crown owns all land between Mean High Water (MHW) and Mean Low Water (MLW) subject to admitted claims only. In cases where, as a result of erosion, additional areas gradually and almost imperceptibly become "intertidal", these areas are automatically taken over by the Crown. If, however, the "movement" in MHW and MLW is achieved deliberately through the actions of the NRA, District Council or other body, the situation in respect of ownership is, as yet, untested in law.

The voluntary agencies contacted during the preparation of this report - including the National Trust, RSPB, Wildfowl and Wetlands Trust, Worldwide Fund for Nature, Royal Society for Nature Conservation and others - have all expressed support for the principle of managed retreat for nature conservation benefits. Most of these agencies would be able to contribute towards the funding of certain retreat options using existing monies and all would be keen to become actively involved should new monies become available.

The Mitigation Option

Section 404 of the United States Clean Water Act 1972 makes provision for a thorough review of proposals which are likely to have a significant detrimental impact on wetlands. Steps are first taken to see if the proposed development project can be relocated, or if damage can be minimised to an acceptable level. If this is not possible, but a habitat creation initiative would represent an acceptable alternative, compensation in the form of mitigation (e.g. the creation of a site of at least equivalent interest elsewhere) may be required.

At the present time there is no parallel requirement for mitigation in Great Britain. Much British environmental "protection" relies on a largely voluntary approach to conservation, through the type of initiatives discussed above. **A mandatory requirement to minimise the environmental damage caused by waterside developments and, if this cannot be achieved, the introduction of a requirement for mitigation measures might provide an opportunity for developers in the private sector to meet some of the capital costs of the type of habitat creation initiatives discussed in this report.**

A fundamental problem associated with the concept of habitat creation as mitigation, however, is the risk factor. Habitat creation and restoration is not a precise science. The risks of a perceived failure, at least in the short term, can be quite high and some scientists are now arguing that it may not be possible to recreate all the characteristics of a natural wetland habitat. **It is therefore essential that a "no loss" policy is still pursued to try to protect Britain's most valuable habitats from development, and that habitat creation/restoration "experiments" are carried out, in the first instance, on sites with little or no existing nature conservation interest.**

New Funding for Coastal Habitat Creation Initiatives

One alternative to redirecting existing monies (as discussed above) to meet the capital and/or management costs of habitat creation or restoration projects would be to set up a new budget from which the promoting agencies could draw. This concept is already being put into practice in both the United States and Canada, where the respective Federal Governments are providing funding for habitat creation initiatives. An example of an equivalent existing budget provision in Great Britain is that associated with the Environmentally Sensitive Areas scheme, administered by MAFF. **The viability of setting up a similar budget specially aimed at funding coastal habitat creation/restoration initiatives needs to be further investigated.**

KEY RECOMMENDATIONS

The conclusions of this study indicate that carefully planned, managed and monitored habitat restoration and creation projects could provide a means of significantly reducing the impact of recorded and anticipated coastal habitat loss. Such artificially created habitats could, however, take upwards of ten or twenty years to realise their maximum environmental value. With both the need for a period of experimentation and the possibility of future coastal habitat losses due to increased rates of sea level rise in mind, it is therefore recommended that NRA, NCC (now English Nature and CCW), Countryside Commission, DoE and other appropriate bodies :-

- **promote an active consideration of the potential benefits of the managed retreat option at an early stage in the decision-making process for all non-urban sea and tidal defence schemes;**
- **ensure that habitat creation and restoration opportunities are considered, not in isolation but as part of an integrated approach to coastal management;**
- **initiate, wherever possible, programmes for monitoring coastal processes and ecological changes to help to ensure that data is available for future decision-making;**

- carry out research to establish the lessons which can be learned from sites where defences have failed in the past and use this information in the future assessment of the retreat option;
- undertake a series of experimental pilot projects to test the practical application of the framework identified in this report;
- implement a study aimed at producing a set of technical guidelines for the managed retreat option;
- examine the possibility of extending the Countryside Commission's "Countryside Stewardship" scheme to incorporate explicitly coastal habitat creation and restoration initiatives in low-lying areas;
- investigate the need for the modification of existing funding mechanisms to enable agencies to fund managed retreat initiatives;
- investigate the need for additional funding for managed retreat through the establishment of a new "coastal habitats" budget.