

National Rivers Authority

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**SALTMARSH MANAGEMENT FOR  
FLOOD DEFENCE**

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Framework Report : Issue 2

July 1995

**HALCROW**

National Rivers Authority

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FLOOD DEFENCES**

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ENVIRONMENT AGENCY



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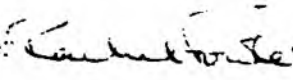
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SALTMARSH MANAGEMENT FOR FLOOD DEFENCE


FRAMEWORK REPORT : ISSUE 2

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**SALTMARSH MANAGEMENT FOR FLOOD DEFENCE**

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# NRA R & D SALTMARSH MANAGEMENT FOR FLOOD DEFENCE

## FRAMEWORK REPORT : ISSUE 2

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## SUMMARY

This report develops the framework within which research into saltmarshes, and related areas, is being conducted in the UK. The objectives of each of the major funding organisations are presented, together with their current and proposed areas of research. The aim is to indicate the interest of all parties concerned, throughout England and Wales.

In some research areas significant benefits can be gained from a structured and coordinated approach so that any overlap of work is minimised. Such collaboration is particularly applicable to the funding of saltmarsh research because the costs of working in the marine environment severely constrain what can be achieved within isolated projects.

Regular meetings and interaction between the various funding organisations and research contractors are proposed to assist in developing collaboration and coordination in saltmarsh research.

## INTRODUCTION

The first issue of this report was prepared in response to a meeting held at NRA headquarters, Bristol, 7th May 1992, on Saltings Research. Present at this meeting were representatives from Cambridge Environmental Research Centre (CERC), Energy Technology Support Unit (ETSU), Sir William Halcrow and Partners Ltd (Halcrow), Hull University, Institute of Terrestrial Ecology (ITE), MAFF and the NRA. The aim of the meeting was to identify areas of common interest amongst the various organisations attending and to promote coordinated development of saltmarsh research in a way that would best reflect those interests.

Since that first meeting, much progress has been made in the area of saltmarsh research with several funding organisations actively involved in programmes of research. It was felt, therefore, that an update of the original framework report was required, which is presented herein.

The purpose of this report is to:

- present an organisational framework showing the research interests of the funding organisations and researchers against research needs;
- identifies research areas;
- indicate areas where benefits could be gained from collaborative research;
- provide a working document on which all funding organisations are able to comment;

In essence, this report constitutes a statement of the way forward for saltmarsh related research and development. The involvement of the interested organisations in the process has the benefit of avoiding possible overlap and duplication of work, promoting the communication and discussion of results and identifying areas of possible collaboration.



## 2 SALTMARSH R & D FRAMEWORK

The aim of the proposed framework is to make clear what aspects of Saltmarsh research each of the funding agencies are presently involved in or seek to cover, and to identify the relevant contractors.

The funding agencies involved and their primary aims can be summarised as follows:

MAFF	MAFF Flood Defence Division regards the evaluation of engineered roll back techniques, the response of mud flats and saltmarshes to wave energy and the quantification of the hydrodynamic benefits of these systems as high priorities for R & D funding, following the recommendations of the Advisory Committee for Flood and Coast Defence R & D (Ackers).
NRA	To further advance the understanding of saltmarshes in sea defences and to consequently utilise this capability in sound engineering and environmental management.
NERC/ITE	To increase understanding of the fundamental structure and function of saltmarsh ecosystems in relation to adjoining communities and, through applied studies, to advise on their management.
EPSRC	To develop a high quality Coastal, Estuarine and Waterways Engineering Research Programme.
English Nature	<p>To measure the saltmarsh resource of England, to monitor changes to that resource and to identify the causes of change.</p> <p>To find ways of conserving saltmarshes as components of dynamic systems on eroding coastlines.</p>
ETSU	To complete a series of projects associated with the possible environmental effects of tidal power barrages.

The areas of research currently identified and being actively pursued can be classified under nine headings, these are:

- General
- Practical Guidelines
- Conservation
- Set back or Managed Retreat
- Sea Level Rise
- Morphology and Wave Climate
- Saltmarshes processes
- Sediments

## Flora and Fauna

The contractors currently or recently engaged in this research are:

CERC  
Halcrow  
Institute of Terrestrial Ecology  
Institute of Coastal & Estuarine Studies, Hull University  
English Nature  
HR Wallingford  
Imperial College, University of London

The interaction between the funders, research areas and researchers is summarised in Figure 2.1. In the top half of the figure the links between funding agencies and research needs are shown. The numbers refer to the section number in this report which describes the particular activity in more detail. The lower half of the diagram then identifies the research contractor(s) associated with each project.

Figure 2.1 : Framework Table

Funding Organisation	RESEARCH NEEDS (a)									
	General	Practical Guidelines	Conservation	Set back	Sea Level Rise	Morphology Wave Climate	Saltmarsh Processes	Sediments	Flora and Fauna	Modelling
NRA	3.1, 3.2	3.2, 3.3	3.4, 3.8	3.5		3.6	3.7			3.5
MAFF	4.1			4.4		4.5	4.2, 4.3	4.5	4.4	4.5
NERC	5.1, 5.2		5.5	5.6, 5.9	5.7, 5.9		5.3	5.3, 5.9	5.4, 5.7, 5.8	5.7
EPSRC	6.1					6.1	6.1			
English Nature	7.1, 7.2	7.8	7.4, 7.9	7.4, 7.5, 7.6, 7.7, 7.8		7.10	7.3	7.9	7.2	
ETSU	8.1							8.2	8.3, 8.4	
										Contractors
.										ITE
.										Hull University
.										Reading/Cambridge University/CERC
.										Halcrow
										HR Watlingford
										Silsoe College

Note : (a) The numbers refer to sections of the text giving a full description

### 3 NRA R & D

#### 3.1 Overview

Commission C of the R & D programme is concerned with flood defence related issues and the furtherance of conservation and environmental enhancement in relation to these issues. The Commission coordinates research in six topic areas:

- Fluvial Defences and Processes
- River Flood Forecasting
- Catchment Appraisal and Control
- Operational Management
- Coastal and Tidal Defences and Processes
- Response to Emergencies.

The project 'Saltmarsh Management for Flood Defence' is one of six on-going projects in the Coastal and Tidal Defences and Processes topic areas.

The overall objective of this project is to undertake research that will improve the ability of the Authority's staff to manage sea defences that incorporate saltmarshes in a sound environmental manner. This work will incorporate research into the processes involved, as well as methods of monitoring and regulation.

The initial task of this project was the undertaking of a comprehensive review of saltmarshes as part of sea defences. This was reported in R & D Note 29 in January 1992 which comprised the following components:

- a literature review
- an appraisal of previous and current research activities
- a regional review to examine the extent to which saltmarshes were utilised in the sea defences and to elicit particular problems or concerns
- identification of areas for further research.

From this review, a phased programme of research was proposed and implemented. The research packages identified were:

- Saltmarsh management practical guidelines
- Maintenance and enhancement of saltmarshes

- Historic changes in saltmarshes
- Set back of saltmarshes
- Estuary morphology
- Saltmarsh processes.

Each of these packages is outline below. The R & D programme is guided by a Steering Group, lead by Nick Stevens, NRA South Western Region, while day to day management and technical advice is provided by Sir William Halcrow and Partners Ltd.

### **3.2 Package 1 - Practical Guidelines**

The objective of this first package of work was to produce a management guide that combined all the existing knowledge on saltmarshes to assist the practising engineering in the operation and management of saltmarshes that are part of sea defences. A practical, working document was required which could be updated, with new chapters added as the research programme progressed. As such the guide did not require further research to be undertaken prior to its completion.

Short term contracts were awarded to selected leading experts in the relevant fields for each chapter of the guidelines. The first edition was produced in March 1995 as R&D Note 324, titled "A Guide to the Understanding and Management of Saltmarshes". This consisted of the following six chapters.

- **Management Guidelines**  
Author : Anne Toft, Sir William Halcrow and Partners Ltd  
  
The role and importance of saltmarshes as the first line of defence and in the provision of soft flood defence options is examined. The legislative framework is explained and the main impacts on saltmarshes and some remedial techniques described. Coastal management issues and the need for an holistic approach is discussed. The chapter concludes with a section on environmental considerations.
- **Estuarine Processes**  
Author : Prof. John Pethick, Institute of Estuarine and Coastal Studies, Hull University  
  
This chapter provides a wide ranging view of estuary processes as a precursor to the understanding of saltmarsh behaviour. It describes tidal processes, waves and surges as mechanisms for morphological change and for shaping the estuary channel and mudflat/saltmarsh interactions, together with sediment supply. The historic geomorphological aspects of estuary development are considered and anthropogenic influences on estuary

development are reviewed. There is a discussion on models. The chapter concludes with a summary of the major physical issues to be addressed in developing a management strategy.

- **Saltmarsh Ecology**

Author : Dr Alan Gray, Institute of Terrestrial Ecology

An overview of the ecology of saltmarshes is made as well as a description of the processes of saltmarsh development, including zonation and succession. There is a description of the key species and communities and the main types of saltmarshes found in Britain. It contains a detailed discussion on saltmarshes as ecosystems; primary production, decomposers and consumers. The final section on prospects, deals with the implications of sea level rise.

- **Saltmarsh Conservation and Amenity**

Author : Dr J Pat Doody, National Coastal Consultants

This chapter details information on the conservation value of saltmarshes and includes discussions on the conservation importance of plants, plant communities, invertebrates, birds, mammals and fish. The management of designated sites for nature conservation is explained as is grazing and other anthropogenic uses of saltmarshes together with their impacts on conservation. There is a section on sea level rise and the concept of 'coastal squeeze'. The chapter concludes with a summary of potential conflicts and a section on the evaluation of saltmarsh interests.

- **Saltmarsh Maintenance and Regeneration**

Author : Fiona Burd, Institute of Estuarine & Coastal Studies, Hull University

This chapter provides guidance regarding remedial techniques in the management of saltmarshes. It provides details of general considerations in the design phase of remedial schemes, practical information about the techniques themselves and guidance for carrying out baseline and monitoring studies, with consideration of the financial implications of remedial work.

- **Economics**

Author : Prof. Edmund Penning-Rowell, Flood Hazard Research Centre, Middlesex University

The nature of the value of saltmarshes is examined as well as methods for assessing and comparing gains and losses associated with various saltmarsh management and protection options. The chapter includes sections on economic theory, economically important uses of saltmarshes and project appraisal

techniques. The application of these techniques is presented through a case study of Keyhaven Marsh and the Pennington sea wall.

Overall editorial control remained with the Project Steering Group with assistance from, and collation of the document by Sir William Halcrow and Partners Ltd. A Saltmarsh Management Seminar was held in early June 1995 to launch the Guide, with presentations given by each of the authors to an audience of NRA staff, university lecturers, researchers and students, and to members of other research and commercial organisations.

The total value of this package of work was £34,000

### **3.3 Package 2 - Maintenance and Enhancement of Saltmarshes**

The objective of this package of work is to review methods for maintaining and enhancing saltmarshes, to identify those factors that contribute to the success or failure of these methods and to evaluate all likely environmental impacts and related issues taking into account predicted sea level rise.

Various schemes for regeneration of saltmarshes have been used in the past, with differing degrees of success. Recently some new methods have been suggested, but with the limited knowledge of the basic processes affecting saltmarshes, the effectiveness of any method can only be gauged through field trials. With large portions of existing saltmarshes showing significant losses at present, an effective method of maintaining and enhancing them would bring many benefits.

The contract for this research work was awarded to HR Wallingford Ltd in January 1995 and the results will be reported in August 1995. Along with an R & D Project Report, a new chapter will be produced for the "Guide to the Understanding and Management of Saltmarshes".

The value of this package of work is £10,800.

### **3.4 Package 3 - Historic Changes in Saltmarshes**

The objective of this project is to examine historic changes in saltmarshes, establish the likely reasons for these changes and to investigate the extent to which sea level rise is responsible for the changes.

As future sea levels are predicted to rise, as a consequence of both eustatic and isostatic changes, the response of saltmarshes will become critical. In the absence of anthropogenic influences on the environment, saltmarshes would naturally adjust to increases and decreases in sea level by level variations and by migration landward and seaward respectively. Where defences have been constructed this natural readjustment is impeded and the response of the saltmarsh is more complex as the pressures on it are increased. In these circumstances guidance is required on:

- i) how the natural defences offered by the saltmarsh can be sustained; and
- ii) the appropriateness of maintaining the existing line of built defence or whether a realignment inland or set back is more appropriate.

Relative sea levels have been increasing significantly in the south and east of the UK, while they have been stationary or even decreasing in the north and west. An examination of the behaviour of the saltmarshes in these different regions will therefore give important guidance on future behaviour.

The contract for this package of work was awarded to HR Wallingford Ltd in January 1995 and the results will be reported on in February 1996. A chapter will be produced for the "Guide to the Understanding and Management of Saltmarshes" along with an R & D Project Report.

The value of this package is £20,000.

### **3.5 Package 4 - Set back of Saltmarshes**

The option of the set back of flood defences, or 'managed retreat', is now considered by the NRA when examining remedial works or the reconstruction of flood defences. However, the long term impact of managed retreat schemes on the environment and on the financial commitments of the NRA must be fully understood. To make such assessments a detailed examination of the impacts of any schemes which adopt this option is proposed.

Package 4 is aimed at studying the processes involved in a managed retreat scheme in order to determine the environmental impacts. There are also proposals to extend this package to cover financial issues. The NRA is conducting a major managed retreat scheme at Orplands, on the Blackwater in Essex, which is central to the research work being planned or executed under this package.

One research contract, entitled "Set Back : Pollution of Managed Retreat Sites", has been let to Imperial College. This is a collaborative project whereby the NRA contributes to a pool of funds from various organisations, in order to achieve greater added value for a fixed sum of money. Funding is being provided by the Royal Society, English Nature, SERC studentship and through an EPSRC studentship. The NRA is contributing 36% of the funding to the overall project, a sum of £39,900.

The aim of the project is to undertake a study of a managed retreat site (Orplands) to determine the pollution effects of saline inundation on agricultural soil. This contract was awarded in March 1995 and is due for completion in August 1997. The findings of this research will be published via an R & D Note and a chapter for the "Guide to the Understanding and Management of Saltmarshes". Saline inundation of agricultural soil may result in the release of metals, organic micro-pollutants and nutrients held within the soil which could consequently affect estuarine water quality, groundwater



quality and the establishment of marsh plant species on the site. Conversely the inundated soil may act as a sink for pollutants carried in tidal water and surface runoff, and thus may have a beneficial impact on estuarine water quality but with adverse implications for saltmarsh development, sediment stability and groundwater quality.

A second research project has been defined : "Set Back : Mathematical Modelling Techniques". The objective of this work is to develop a 2-D model to study the effects of erosion and deposition in estuaries produced by tides, surges and waves as well as set back. The study will use existing data from the MAFF experimental set back site at Tollesbury. The budget allocated for this project is £40,000 with a duration from July 1995 to May 1996. No contract has yet been awarded for this work.

The remaining projects within this package have yet to be defined, but a further budget of £94,000 is available. In addition, a further budget of £148,000 has been proposed for more projects covering sources of fill material, mathematical modelling, benefit/cost analyses, legislation, environmental studies, etc.

### **3.6 Package 5 - Estuary Morphology**

Funding is provided in this package to investigate the relationship between key saltmarsh design parameters and estuary processes. This subject area is receiving considerable funding from MAFF and it is hoped that the NRA can benefit from collaborative projects. NRA funding is therefore limited to £15,000 for this package.

### **3.7 Package 6 - Saltmarsh Processes**

This final research package is designed to further investigate the basic processes governing the growth and decay of estuarine and coastal saltmarshes. The results of such research would have practical benefits to the design of appropriate remedial works and also for the management and implementation of set back. Funds available total £170,000.

Possible projects within this package may include studying the dissipation of wave energy across the mudflat/saltmarsh profile and the role of creeks in dissipating tidal energy.

To date one project has been defined and awarded, titled "Sedimentation Processes of Managed Retreat". The research contract, worth £80,000, was awarded to the Institution of Estuarine and Coastal Studies (IECS) at Hull University. The overall objective of the study is to understand the response of the estuarine system to a change in the tidal prism due to set back. The forms and rates of response will be identified in the near and far fields, over short and long time scales.

Additional funding of £40,000 has been proposed for this package to study the hydrodynamics of sedimentation and, in particular, to model the processes of sediment transport, erosion and accretion.

### **3.8 Other NRA Research Areas**

#### **3.8.1 Commission G**

As part of the NRA cross-functional Commission, G1, a project has been established entitled "Estuarine Morphology and Processes Scoping Study". The objective of this project is to investigate the possible lines of research and/or development towards the goal of developing techniques to predict large scale, long term, morphological changes and other sediment related impacts within estuaries and assess their consequences for estuarine management. The content for this study has been awarded to a consortium of HR Wallingford, IECE, ABP Research, University of Southampton and MAFF DFR Lowestoft. Work on this study began in early June 1995 and is due to be completed by the end of 1995. This is jointly funded by MAFF and EPSRC.

#### **3.8.2 Commission F**

Research on conservation issues is being pursued at present under Commission F, in two topic areas:

- conservation resource appraisal and impact assessment; and
- conservation management.

Outputs to date have included an assessment of the NRA's legal responsibilities in relation to conservation in coastal areas, and an assessment of the physical environment required to support invertebrate communities and development of a unified method for ecological assessment of "functional habitat" which can be used by other, non-conservation NRA staff.

## **4 MAFF**

### **4.1 Overview**

MAFF has a substantial programme of strategic flood and coastal research (over £3.0m in 1995/96) of which over sixty five percent relates to coastal and estuarine research. Much of this is concerned with furthering a basic understanding of coastal processes and the development of modelling capabilities for waves, currents and sediments and their effects on coastal forms and structures. Many of these general developments will be of use in furthering the understanding of saltmarsh process, but the projects listed below are confined to those of a more specific nature.

### **4.2 Erosion and Accretion Processes on British Saltmarshes**

A two year project was let in 1991 to Cambridge Environmental Research Consultants (CERC) to carry out a number of tasks to:

- provide a better understanding of the processes of sediment transport, erosion and deposition on British saltmarshes;
- predict the effects of sea level change;
- identify means of understanding marsh restoration and protection.

A major element of this study was the compilation of a database which includes information about saltmarsh geomorphology, erosion or accretion status, prevailing environmental conditions, vegetation, sediments, land use and sources of information. The database was compiled from published sources, field surveys on the east, south and west coast of England and detailed investigations of erosion in parts of Essex, Kent and Hampshire.

A further aspect of the work, some of which was sub-contracted to HR Wallingford, was a computer modelling study of flows of water and sediment in mud flat and saltmarsh environments to look at longer term response and possible consequences of sea level rise and other estuarine changes. The results of this work were published in a five volume report in August 1993. Copies of the report and the accompanying database text are available for purchase from Prof. K. Pye, PRIS, University of Reading, P O Box 227, Reading RG6 2AB.

#### **4.3 Mechanisms of Accretion and Erosion Processes on Saltmarsh**

This contract, started in 1992 and reported in early 1993, was based around laboratory flume tests to consider the most effective forms of vegetation or artificial substitutes which may be used in saltmarsh protection or regeneration schemes. The work was carried out by the Institute of Estuarine and Coastal Studies at the University of Hull and the results published in a report titled "Sediment Deposition under Saltmarsh Vegetation". This is available for purchase from Dr. J. Lowe, IECS, Hull University, Hull, HU6 7RX.

#### **4.4 Full Scale Trial of Managed Retreat**

This is a major study, initially of three years duration, to set up a trial of managed set back on a site of some 21 ha in the Blackwater Estuary, Essex. The lead research contractors are the Institute of Terrestrial Ecology and English Nature, but the work is being co-ordinated by an advisory group with membership including MAFF, NRA, Association of District Councils (ADC), English Nature, RSPB and the National Trust. It is part funded by English Nature and will involve complementary studies funded by others.

Detailed measurements will be made of sediment deposition/erosion and botanical change, both within and adjacent to the site. It is also intended to carry out plot scale experiments within the managed set back area. These plots will be used to determine the optimum methods for establishment of salt tolerant vegetation and timely achievement of a good erosion resistant vegetative cover. The experimental plots will be replicated for different levels of the site, and where possible, different pre-inundation treatments. Base line surveys and preparation work were carried out during 1994 and the set back works will be implemented in the summer of 1995.

#### **4.5 Other Work Associated with the Full Scale Set Back Trial**

##### **4.5.1 Bathymetric Survey and Estuary Modelling**

HR Wallingford have carried out a detailed bathymetric survey of the estuary adjacent to the set back site. They have used this information to model the tidal flows in the major creeks adjacent to the site and used this model to predict the effects on erosion and sediment transport for a range of breaching options. After breaching the model's performance will be assessed against field data.

##### **4.5.2 Soil Strength and Stability in the Set Back Area**

Silsoe Research Institute are carrying out a project to assess the changes in soil strength and stability as the soil chemistry and structure changes through the process of salt water inundation. They have carried out baseline sampling in 1994 and will carry out post-breach sampling and analysis in 1995 and 1996.

#### **4.5.3 Post Breach Monitoring of Hydrodynamic and Sediment Transport Process**

The Institute of Estuarine and Coastal Studies, University of Hull, will be carrying out a detailed investigation of the waves, currents and sediment transport within the site during the initial inundation period from mid 1995 until September 1996.

#### **4.5.4 Further Work**

It is anticipated that development of the managed set back research site will be a long term process. The initial stages will be reviewed in late 1996 and a comprehensive report prepared on the basis of which the extent and scope of ongoing field measurements will be determined.

#### **4.6 Other Saltmarsh Related R & D**

Further opportunities for field based research will be reviewed as other operational set back sites or saltmarsh enhancement projects are identified. Such further work may include investigation of the beneficial use of fine grained dredged materials for saltmarsh recharge.

Other studies related to estuary modelling are likely to be initiated following completion of the multi-agency scoping review of estuary process and morphology.

## **5 NERC**

### **5.1 Overview**

The Natural Environment Research Council, establishment by Royal Charter in 1965, has responsibility for planning, encouraging and executing research in those physical and biological sciences which explain the natural processes of the environment. A major aim is an understanding of Man's impact on his surroundings. The Council carries out research and training through its own institutes and grant-aided associations and by awards to Universities and other Higher Education institutes.

Currently NERC's research in the coastal zone is being boosted by a major Community Research Project, the Land-Ocean Interaction Study (LOIS). Among NERC's institutes the focus for research on saltmarsh ecology lies within the Institute of Terrestrial Ecology (ITE). The total ITE programme on coastal research costs in excess of £1 million per annum (at Full Economic Costs) and is supported by NERC and a range of contract customers. The following are the main saltmarsh related research projects of ITE.

### **5.2 Remote Sensing**

New methods of processing data from multi-spectral imagery are enabling surface cover and even variations in sediment composition to be mapped in detail over large areas. The next steps are to test the methodology developed over a wider scale and to combine these results with the data obtained with the Land Cover Map to construct integrated estuarine models. In addition, there is the need to investigate the use of new high spectral resolution systems (imaging spectrometry) in estuarine studies. The National Land Cover Mapping from remote sensing is funded jointly by DTI, DoE and NERC. Further work, specifically in coastal systems, is being carried out as part of LOIS and also funded by the NRA.

### **5.3 Saltmarsh Fluxes**

Saltmarshes are the sites of major transformations in land-sea fluxes as well as acting as both sources and sinks of organic matter, mineral nutrients and pollutants. Experimental studies are being extended to a wider range of marshes to define their precise roles and the impact of different environmental factors. This work is being funded by the European Community and by NERC under its LOIS programme.

### **5.4 Biological Aspects of Erosion Control**

The effectiveness of the various plant species in trapping and binding sediments and resisting erosion, depends on the overall efficient functioning of the ecosystem. Of particular interest is the role of benthic organisms, principally microalgae and invertebrates, in biogenic accretion and sediment transformation and dynamics. Experimental work on the effects of pioneer

plant size and spacing, of hydrodynamics and sediment deposition is planned jointly with the Institute of Estuarine and Coastal Studies under a range of conditions. Aspects of these problems are also included in the EC saltmarsh studies, and other research planned under LOIS, but further research will be needed.

## **5.5 Environmental Impacts**

Saltmarsh ecosystem functioning can be greatly impaired by environmental impacts such as residues of herbicides and heavy metals in the sediments as well as sea level rise and inappropriate land use. Greenhouse and field experiments are needed to assess the sensitivity of key saltmarsh plant species to realistic levels of pollutants. Preliminary studies in this field are included in the planned EC research.

## **5.6 Saltmarsh Set Back**

In certain areas managed retreat may be the most cost-effective solution for coastal defence. This would involve the reconversion of agricultural soils to saline soils and the establishment of saltmarsh vegetation to stabilise the soil surface. Special techniques may have to be developed in order to achieve vegetation cover as quickly as possible. To tackle the problem effectively there has to be a combined approach involving small scale experimental studies of elevation, tidal submergence, residual nutrients, former land use, degree of warping, use of dredged soil and variation in propagule availability. Variation in species establishment requirements are being evaluated at a major set back project currently underway at Tollesbury on the Essex coast (funded by MAFF and English Nature).

## **5.7 Saltmarsh Modelling**

Predictive modelling of changes in marsh ecosystems is an important part of effective long term management. Models can be used to predict the establishment and successional processes of saltmarsh species. The development of niche models for some dominant plant species, initially using physical tide related parameters, has been funded by the Energy Technology Support Unit. Here the aim is to predict species ranges and distributions under tidal regimes altered by tidal-energy barrages. The key species *Spartina anglica* has been the main focus of this work.

Modelling is included in the LOIS studies and is being conducted in conjunction with the Plymouth Marine Laboratory (NERC) and IECS, Hull. Both saltmarsh process simulation models and the extension of finite element estuarine flow models, incorporating sediment and biological boundary conditions, are planned.

## **5.8 Saltmarsh Restoration**

The restoration of saltmarsh communities following major disturbances such as pipeline laying and causeway construction has been a long-standing interest. Centred mainly around Poole Harbour, where it is funded by BP, this work has included drawing up contractors specifications and post-operation monitoring, and has extended to sites in the Ythan Estuary and Morecambe Bay.

## **5.9 Saltmarsh Retreat**

The loss of saltmarsh under a combination of rising relative sea levels and *Spartina* dieback has a major impact, and the response of plant species to changing sedimentary dynamics and wave climates is an important area of research. Variation in rates of loss and species responses within and between estuaries with different tidal ranges and regimes is to be studied in future programmes (funded by BP and under LOIS) and is an area for which additional funding is sought.



## **6 EPSRC**

### **6.1 Overview**

The Engineering and Physical Sciences Research Council (EPSRC), successor body to the Science and Engineering Research Council (SERC), is responsible for postgraduate education and training through the provision of grants and studentships. The Council is currently in the process of developing a "Built Environment Programme" of research which is divided into 7 specific areas. One of these is the Coastal, Estuarine and Waterways Engineering Research Programme. This targeted programme of research involves collaboration with MAFF, NRA, DoE and HR Wallingford Ltd. Approximately £1.25 million per annum has been earmarked for high quality research projects, most of which involve consortia of several universities. Two large-scale research facilities are available at Wallingford, both of which were constructed jointly by the former Science and Engineering Research Council and HR Wallingford Ltd. The existing main themes of the programme are:

- river engineering
- coastal waves and currents
- coastal mixing processes
- coastal sediments
- coastal structures

It is intended to include estuarine engineering in the future. A scoping study of estuarine research requirements is being carried out with joint EPSRC, MAFF and NRA funding.

## **7 ENGLISH NATURE**

### **7.1 Overview**

English Nature inherited from the Nature Conservancy Council a programme of work on saltmarshes which had two main aims:

- to quantify the extent, diversity and distribution of saltmarsh in Great Britain;
- to review the pattern of changes to the saltmarsh resource and investigate the cause of significant losses.

Both of these lines of research have been progressed for England and it has been established that there is a pattern of widespread, continuing loss of saltmarsh in the south and south east of the country. This appears to be caused by a combination of land claim and marine erosion.

English Nature has now embarked upon a programme of research aimed at developing ways of maintaining or re-creating saltmarshes in situations where they have declined in recent years. It is recognised that there are many possible ways of doing this and English Nature are actively co-operating with trials of a variety of soft engineering and 'managed advance' techniques. As an organisation English Nature have chosen to concentrate their limited resources on the technique of managed retreat. Funding is also being provided to assist the support of a series of background studies and trials, details of which are set out below.

English Nature recognises that a full understanding of coastal processes is vital to any strategic programme of shoreline management and have commissioned a series of reviews of coastal processes within estuaries to underpin a major initiative on estuary management. They have also been active in commissioning a small 'pump-priming' review of the constructive uses of spoil from navigation dredging.

Reports for each of the completed contracts detailed below are available from the Communications and Grants Team, English Nature, Northminster House, Peterborough, PE1 1UA; telephone 01733 340345. A small charge may be made for printing costs.

### **7.2 The Saltmarsh Survey of Great Britain (Completed 1989)**

This work, commissioned and completed 'in-house' by the then NCC, describes the size, location and quality of the saltmarshes of the British coastline. It is based on field mapping, and includes figures for the total area of saltmarsh, by site, by county and by country. There are also area figures for each of the major saltmarsh vegetation communities which the survey identified and mapped.

**7.3 Erosion and Vegetation Change on the Saltmarshes of Essex and North Kent 1973 to 1988 (Completed 1991)**

This project re-mapped a series of saltmarshes whose extent and vegetation had first been mapped as part of a study of the potential impact of the Mappin Airport proposal. The maps were composed using a GIS and revealed a consistent pattern of significant erosional loss. Rates of loss of between 10% and 40% were recorded over the 15 year period. There were locally significant losses due to land claim and widespread reversion from mid to low marsh communities. The report did not investigate the causes of these losses in any depth but the pattern of loss suggests a link with relative sea level rise, though with other contributory factors such as navigation dredging.

**7.4 Targets for Coastal Habitat Recreation (Completed)**

This project summarises existing information on the extent and variability of all major coastal habitats, collates existing information on current and recent rates of habitat loss or gain, estimates current overall loss rates, predicts likely future rates of loss and provides targets for habitat recreation to offset these losses.

The section on saltmarshes confirms that there are widespread and continuing losses in South and South East England and sets a target for habitat recreation of at least 2,500 ha over the next 20 years.

**7.5 Review of Past Sea Wall Failure Sites (Completed 1995)**

A previous English Nature study to locate sites of past sea wall failure in Essex was completed in 1992 and identified a total of about 30 sites where failure had occurred at various dates between the mid 19th century and the 1953 storm surge. A subsequent, much larger, two-year study to review these sites in more detail has recently been completed. The aim of this review was to see what lessons could be learned about the design of future managed retreat schemes.

**7.6 Small-Scale Trial Managed Retreat. Northerly Island, Essex**

This ongoing small scale experiment involved the planned retreat of a length of sea wall to a new second line, with the twin aims of providing sustainable defences for the rest of this island and recreating an area of saltmarsh. The project was undertaken jointly with NRA and the National Trust. Prior to the retreat a detailed topographic survey was undertaken and tide gauging carried out. The optimal design for the breach was worked out and a means of re-profiling the old wall determined. After the retreat, sedimentation, the development of vegetation and physical changes to the site were monitored closely and this is continuing. The results are encouraging, with rapid colonisation by saltmarsh plants. The main limitation of this trial is its very small size; the total area is only 0.8ha. Various reports on this project are available.

## **7.7 Full Scale Trial Managed Retreat. Tollesbury, Essex**

This is a joint venture with MAFF. The site at Tollesbury is in excess of 20 ha and was purchased by English Nature to be used as an experimental saltmarsh habitat creation scheme. The benefits accruing from preserving the security of the flood defences are secondary. The overall aims of the project are:

- to investigate the feasibility of, and the practical problems associated with sea wall set back; and
- to investigate the effects of a set back site on saltmarsh vegetation in the adjacent estuary.

English Nature and the Institute of Terrestrial Ecology are conducting the majority of the research on the site, and, to date, have completed all arrangements with existing landowners, statutory authorities and others for managed retreat of the existing defences of the site to be carried out. An Environmental Assessment and an archeological survey of the site have been carried out by English Nature, and a contract has recently been let for the necessary drainage and counterwall works.

Other groups involved include: HR Wallingford who are undertaking modelling studies of various breach scenarios; Silsoe College who are looking at the changes in strength and stability of the soils; and the Institute of Estuarine and Coastal Studies who are undertaking hydrodynamic and sediment monitoring (jointly funded by the NRA).

## **7.8 Managed Retreat Guide (Completed May 1995)**

A practical guide on managed retreat has been prepared and is being distributed. This is based on the current understanding of managed retreat and will be developed as research results advance the understanding of the processes involved.

## **7.9 Pilot Study of the Potential Benefits to Nature Conservation of Retaining Dredging within the Active Coastal Zone (Completed 1992)**

This study combined a general review of the potential benefits and the potential problems of retaining dredging within the active coastal zone, with a case study which focused on Holes Bay in Poole Harbour, Dorset. The report concluded that there was considerable potential for using clean dredged material and the opportunities also exist to make some use of contaminated material. Coarse material is undoubtedly easier to use but there are opportunities for using fine materials as well. In relation to saltmarshes specifically, the coarser materials might be used to create sub-tidal features to protect saltmarshes from wave attack, whilst fines might be used to 'trickle charge' material onto the saltmarshes and adjacent mudflats.

## **7.10      Reviews of Coastal Processes to Inform the Production of Estuary Management Plans**

This contract was aimed at Supporting English Nature's Estuary Management Initiative. Reports have been produced for sixteen estuaries:

Solway Firth	Morecambe Bay
Ribble	Duddon
Mersey	Dee
Taw/Torridge	Fal
Salcombe/Kingsbridge	Poole Harbour
Medway	Thames
Blackwater	Stour/Orwell
Wash	Humber

Each of these reports describes the geomorphic and geological setting of the estuary, summarises the physical processes and present day sediment dynamics, reviews the Holocene evolution of the estuary and attempts to predict the impact of likely future changes. Recommendations are made for managing changes and what monitoring or research is likely to be needed.

## **8 ETSU**

### **8.1 Overview**

The Energy Technology Support Unit (ETSU) have previously commissioned research, on behalf of the Department of Trade and Industry (DTI), to answer specific questions associated with the possible environmental affects of tidal power barrages. Such environmental studies have always been run in parallel with site-specific investigations into the likely cost-effectiveness and technical feasibility of tidal power generation, which will be primary concerns of potential power barrage developers. The results of the latter studies have suggested that tidal generation is too expensive for commercial deployment in the near future.

Following a recent review of Government policy on Renewable Energy, published in Energy Paper 62, the DTI's Tidal Energy R & D Programme has been switched to a "Watching Brief" status. No further work will be commissioned, although existing projects will be completed. All outstanding projects on saltmarshes have been completed and published. There are three remaining projects within the programme which are examining the correlation between littoral sediments and migrating bird distributions. Details of these projects follow; the research projects described are expected to be completed by the end of 1995.

### **8.2 Sediment Prediction Model**

The aim of this project is to build a reliable database of sediment types within a number of estuaries in England, Wales and Scotland which have variable tidal ranges. Over 30 estuaries have been surveyed using aerial photography to map their recent sediment deposits based upon their reflectance characteristics. Each estuary has also been ground truthed to cross-check the photographic data. Contract Value : £133,600

### **8.3 Bird Intertidal Usage**

The aims of this project is to collate two winter seasons' of data on migratory bird populations on the same estuaries which have been mapped by aerial survey. Volunteer counters have provided data on the distribution of migratory bird populations within these estuaries, noting behavioural characteristics. The contractor, the British Trust for Ornithology (BTO), supervises the counters and checks data quality. Contract Value : £220,000.

### **8.4 Bird Prediction Model**

The final project links these two data sets together. By using statistical analysis it is anticipated that correlations can be identified between specific migratory bird populations and sediment type, principally distinguished on grain size and mud content. In future, if the sediment type is known the carrying capacity for a specific estuary could be determined. The work is being carried

out now while the contractors, the BTO and Institute of Terrestrial Ecology, still retain experience of tidal energy projects. If the programme is resurrected it is hoped that this expertise will provide a useful tool which could be used by future developers less familiar with current techniques and environmental issues related to tidal energy schemes. Contract Value : £60,000.

## **9 PROGRAMME DEVELOPMENT**

### **9.1 Introduction**

In determining an overall programme of saltmarsh research the timetables and objectives of all the funding organisations need to be taken into consideration. The programme development should also be done in conjunction with the timetables of current ongoing research and their anticipated finish dates (see Figures 9.1, 9.2 and 9.3). Thus the programme of any collaboration work has to be prepared in cognizance of the objectives of all the funding bodies, anticipated finish dates of existing projects and lead times for new projects.

### **9.2 NRA Priorities and Potential Areas of Collaboration**

The highest priority from the NRA's perspective was ascribed to the production of practical guidelines. This has direct benefits to the activities of the NRA and has itself identified further areas for research.

A comprehensive programme of research has been identified focussing on applied research. With specific aims and the development of practical techniques with application to scheme design, management and maintenance. In some instances this can build on more basic research conducted by MAFF, EPSRC, English Nature, etc. For example, the estuary morphology package is awaiting the outcome of the MAFF/EPSRC/NRA estuary scoping study. Opportunities for collaborative work with MAFF and English Nature at Tollesbury are being exploited to maximise the opportunity to study managed retreat.

### **9.3 MAFF Priorities and Potential Areas of Collaboration**

MAFF are already actively involved in funding saltmarsh related research projects as part of a much wider coastal research programme. They also recognise the requirement for close collaboration and liaison on a number of projects. As mentioned above, MAFF are jointly funding an estuarine morphology and processes scoping study with EPSRC and NRA (Commission G). They are also the main funding body, along with English Nature, for the Tollesbury Experimental Management Retreat Project. This is the main thrust of MAFF estuarine and saltmarsh research over the medium term.

### **9.4 NERC Priorities and Potential Areas of Collaboration**

NERC's priorities in saltmarsh research centre on increasing understanding of the impact of current changes, such as sea level rise, on the processes which influence saltmarsh growth and development. Thus, under LOIS, the role of saltmarshes in regulating biological-mediated fluxes of sediments, nutrients and contaminants is a key issue. In other science budget and commissioned research the impact of rising sea levels and of major estuarine development (eg tidal energy barrages, sea wall and port construction) is a priority area.



Research in the coastal zone must be developed through multidisciplinary projects. ITE is a major recipient of NERC funding and contributes expertise in remote sensing, GIS and coastal ecology. It is clear that NERC will maintain a substantial coastal research effort, particularly on the east coast, for the remainder of the decade. The challenge is to develop predictive process models linking marine processes, coastal geomorphology and saltmarsh ecology.

Collaboration with many agencies in both the public and private sectors continues to be a major feature of the Council's coastal research programme. Currently collaboration on coastal research in the UK is with the Universities of Hull, Oxford and with Plymouth Marine Lab.

#### **9.5 EPSRC Priorities and Potential Areas of Collaboration**

EPSRC are in the process of setting up their research programme which will be coordinated with MAFF, NRA, NERC and others. The present priority is the "Estuarine Morphology and Processes Scoping Study" which is jointly funded by NRA and MAFF.

#### **9.6 English Nature Priorities and Potential Areas of Collaboration**

English Nature has very limited funds available for coastal research. Their research programme, like MAFF's, is not specifically focused on saltmarshes but on the systems of which saltmarshes are an important component. English Nature has concentrated most of the resources which it has available on developing managed retreat as a practical, workable means of delivering both habitat recreation and sustainable flood defence. A full scale managed retreat trial is underway to achieve this goal through partnership with other bodies interested in funding work in this area.

#### **9.7 ETSU Priorities and Potential**

The DTI's Tidal Energy R & D Programme has been switched to a "Watching Brief" status so no new projects will be started. ETSU's priority is therefore to complete its existing projects.

#### **9.8 Communications**

To develop and maintain a useful dialogue between all the various research funding bodies and contractors, annual meetings/workshops should be held. The Saltmarsh Management Seminar held by the NRA was the first step in this communications process with the afternoon session devoted to disseminating information regarding the various funding bodies' aims. A second seminar is planned for the autumn to provide a forum for reporting progress and ideas on current and future research.

Figure 9.1 NRA Research Programme








Section	Package	1995	1996	1997	1998
3.2	1 Practical Guidelines				
3.3	2 Maintenance & Enhancement of Saltings				
3.4	3 Historic Changes in Saltmarshes				
3.5	4 Set-Back of Saltings				
	(1) Pollution of Managed Retreat				
	(2) Mathematical Modelling of Managed Retreat				
3.6	5 Estuary Morphology		Project not yet defined		
3.7	6 Saltmarsh Processes				
	(1) Sedimentation Processes of Managed Retreat				
3.1	Management				

Figure 9.2 NERC-ITE Research Programme

Section	Project	1995	1996	1997	1998	1999
5.2	Remote Sensing					
5.3	Saltmarsh Fluxes					
5.4	Biology and Erosion Control					
5.5	Saltmarsh Set Back					
5.6	Saltmarsh Modelling					
5.7	Saltmarsh Restoration					

Figure 9.3 English Nature Research Programme

Section	Project	1995	1996	1997	1998
7.6	Small scale trial managed retreat (Northey Island)	Post project monitoring and appraisal			
7.7	Full scale trial managed retreat (Tollesbury)	Monitoring and appraisal			
		Design and implementation			

This report has detailed the current research programmes and priorities of the main funding agencies who have an interest in saltmarsh related research. Each organisation has different objectives and defined programmes for research, so it is not appropriate to create a combined saltmarshes R & D programme. However, there are several ongoing collaborative projects and other opportunities for joint funding. This is particularly practical for capital intensive projects such as experimental set back where a higher level of funding enables larger trials to be conducted. However, it is hoped that this report may also encourage collaboration on smaller projects.

Links between the funding agencies, areas of research interest and research contractors have also been shown to establish the framework within which further research should fit. It is anticipated that this will be kept up to date as further projects are defined and therefore avoid duplication of work.

This framework report, therefore, is considered a working document, open to comment from each of the funding organisations and to be used when planning further work.