

# Final Project Report

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Project title	Suitability Criteria for Habitat Creation		
DEFRA project code	FD 1917		
Contractor organisation and location	CEFAS LOWESTOFT LABORATORY PAKEFIELD ROAD LOWESTOFT NR33 OHT		
Total DEFRA project costs	£ 65,600		
Project start date	06/01/03	Project end date	30/06/04

## Executive summary (maximum 2 sides A4)

This research project brings together the present scientific understanding of the physical, chemical and ecological factors controlling habitat creation (-saltmarsh, intertidal mudflat and eelgrass (*Zostera Marina*) beds) at coastal realignment sites. It also provides tools for engineers and managers to facilitate the selection of suitable sites within a given estuary or coastal location.

The specific purpose of this project is to produce electronic decision tools for users to assess the potential of specific sites for habitat creation schemes. These will be:

- at an estuary scale (screening tool) using a Geographical Information System (GIS);
- at a local scale using an influence diagram tool<sup>1</sup>.

The necessary site selection criteria and associated thresholds for different habitats were determined by:

- A review of the existing selection procedure and criteria for sites appropriate for habitat creation.
- A review of existing knowledge and understanding of the processes and parameters that influence the growth and functioning of natural saltmarsh and intertidal habitats.

Both of the reviews facilitated the identification of parameters and relevant limits (criteria) which can describe potential realignment sites with regard to habitat creation. This information provides a clear audit trail for incorporation into decision tools for policy makers and managers concerned with managed realignment and habitat creation or restoration.

The project outputs comprise two reports and the associated tools:

- 1) **Report I: Suitability Criteria for Habitat Creation: Reviews of present practises and scientific literature relevant to site selection criteria.**

<sup>1</sup> An influence diagram is a simple visual representation of a decision problem. It provides a way of carrying out calculations on screen and can identify and display the way essential elements in a decision process influence each other.

This review brings together the present scientific knowledge and associated criteria relating to the control of habitat creation at a given location. Not all the parameters reviewed were selected as suitable criteria for the decision tools.

## 2) Report II: Tools for Site Selection for Habitat Creation

This report integrates the main controlling criteria for habitat creation identified by the reviews into tools that will aid site selection in a screening mode (GIS) and on a site-by-site basis (influence diagram tool and software).

**This project is complementary to FD1918: Habitat Quality Measure and Monitoring Protocols and also with FD2413: Guidance On Design and Implementation of Managed Realignment (CIRIA, 2004: Design Issues for Managed Realignment) and the recent English Nature/Living with the Sea project: Coastal Habitat Restoration Guide**

([http://www.english-nature.org.uk/livingwiththesea/project\\_details/good\\_practice\\_guide/habitatcr/ENRestore/Habitats/Index.htm](http://www.english-nature.org.uk/livingwiththesea/project_details/good_practice_guide/habitatcr/ENRestore/Habitats/Index.htm))

**Scientific report (maximum 20 sides A4)**

Reference is made to the Technical Report associated with this project:

**Defra/Environment Agency  
Flood and Coastal Defence R&D Programme****Suitability Criteria for Habitat Creation – Report I: Reviews of present practises and scientific literature relevant to site selection criteria.**

R&D Technical Report FD1917

April 2004

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This report is summarised as follows:

**REVIEWS OF PRESENT PRACTISES AND SCIENTIFIC LITERATURE RELEVANT TO SITE SELECTION CRITERIA.**

This report provides detailed reviews of:

- The present approach to, and criteria used for, site selection for habitat creation.
- The physical, chemical and ecological criteria relevant to habitat creation.

Both detailed reviews appear in full in Appendices (I and II) and are summarised in the main body of this report.

The main findings of this report are:

- The relationship between the success of created habitat (in terms of establishment and continuing health of the created/restored ecosystems) and the physical, chemical and ecological conditions at the site before the habitat creation commenced is a key concern of estuary and coastal managers.
- The creation of managed realignment areas is considered to be a viable and cost effective alternative from a flood and coastal defence and habitat creation point of view. However, outcomes of such schemes are not always predictable and there is a clear need for a framework to make the site selection and decision process more transparent and with better prediction capabilities of the type of habitat which will emerge.
- The success of many schemes is well publicised but the failure of others highlights the need for the development of a more structured approach to site selection and assessment of interaction of the schemes with local and regional issues.
- Central to the suitability criteria in place at present are the differences in the need to create a habitat.
- Four main drivers have been identified, which, importantly, are not always mutually exclusive;

- Mitigation sites for a development where habitat will be lost.
- Compensation for natural habitat loss (potentially due to coastal squeeze/sea level rise)
- Compliance with EU Habitats or other directives for creation of habitat.
- Cost-effective flood defence strategy for a particular area.

Habitat creation as an objective may be particularly important for the first three and less relevant for the fourth, even though habitat creation is potentially an indirect benefit and aim. The relative importance of criteria (ecological, social, economic) in site selection will alter depending on the main drivers and stakeholders involved.

- Strategic plans give a large-scale approach, and sites may be selected according to a combination of criteria, of which habitat creation may only be one. The decision tools developed as part of this project need to sit within this strategic framework. However, approaches taken within and between agencies and end-users can vary and, therefore, an overview of the range of approaches taken at present is essential.
- Key factors affecting site selection for salt marsh or mudflat habitats are similar, and include the following:
  - Proximity to similar habitats (indicating potential for successful creation);
  - History of previous habitat at the site;
  - Site elevation and tidal inundation;
  - Site gradient;
  - Drainage;
  - Sediment supply and the ability to adjust to sea level rise;
  - Salinity;
  - Water quality.
- Key factors affecting site selection for eelgrass habitats include the following:
  - Proximity to similar habitats (indicating potential for successful creation);
  - Turbidity;
  - Degree of exposure to waves and currents;
  - Composition of the substrate;
  - Site elevation and tidal inundation;
  - Water quality;
  - Competition from invasive species.

A summary of the criteria and thresholds relevant to habitat creation as derived from the scientific reviews is given in Table A.

#### **Review of the Present Approach and Criteria used relevant to Site Selection for Habitat Creation.**

- This review assesses the current guidelines and procedures for site selection, the criteria used and how habitat creation features within this framework. The full review is given in Appendix 1.
- The protocols implemented by main stakeholders in site selection and the criteria used were reviewed by examination of relevant literature (site reports, monitoring reports, engineering reports, strategy documents, SMPs, CHaMPs<sup>2</sup> etc) and also meetings with representatives from stakeholder organisations.
- Between and within various agencies there are many initiatives concerned with identifying and selecting sites for potential managed realignment. These may be driven by different policies or strategies but generally the approaches and criteria employed have much in common.
- Many site selection processes involve a generic screening/coarse filtering/ primary matrix stage to create a short list of sites that are then examined with a more detailed approach (for example: Atkins, 2002; Binnie Black and Veatch, 2000; HESMP, 2000).
- The site selection approaches implemented have many criteria in common and are generic in nature covering all potential aspects of site selection, not only the environmental but also economic, social and political (HESMP, 2000). The criteria relevant to habitat creation identified from the present site selection overview are presented in Table B.

<sup>2</sup> SMPs (Shoreline Management Plans), CHaMPs (Coastal Habitat Management Plans)

- A number of the approaches involve the use of matrices or multi-criteria analysis to rank sites against the generic criteria (Halcrow/EA, 2003; ABPmer, 2002; Coutts and Roberts, 2003).
- In each case, although the criteria may be similar, the exact approach taken to give an overall ranking is different not only in the combination of scores but also in the methodology to derive those scores/thresholds. In many cases apart from elevation/tidal inundation the scores and thresholds are qualitative rather than quantitative (For example: Binnie Black and Veatch, 2000).
- The weighting/scoring of various criteria can vary depending on the main driver for site selection (mitigation/compensation, flood and coastal defence etc). For example, conservation agencies may weight the environmental criteria for habitat creation or bird usage more highly than stakeholders who are looking for sites for flood and coastal defence. In this way sites can be ranked differently depending on FCD/habitat creation priorities and also for their purpose.
- There is a benefit in bringing all these various approaches and ranking systems together in terms of common criteria, methodology and scoring so that for those schemes where habitat creation is a key consideration, the potential can be assessed in the light of all available knowledge and experience.
- However, at present the main controls on site selection are not only the type of habitat to be created, the emphasis of this project. Often, flood and coastal defence as well as habitat creation is the objective of many schemes. Site selection is, therefore a pragmatic process and other over-riding factors, such as land purchase or other socio-economic issues, may have higher priority than purely environmental or habitat creation concerns in the assessment of a sites viability.
- The GIS approach and Decision Tools (Report II) can be adapted to give a more generic screening tool in terms of other socio-economic factors as determined by the various matrix approaches implemented by different agencies and lead to standardisation of site selection. The approach adopted in this project, and the overview provided from the review of present site selection processes, gives a good starting point for a more generic selection tool, which could be applied by any end-user.

These reviews have provided an up to date assessment of scientific understanding of how habitat creation is related to site criteria. However, despite this information there are limits of the present understanding of the complex processes that interact to produce a given habitat. The outputs of this project will not necessarily provide predictions of habitat created in terms of quality, or help determine success of failure of a scheme, as this will vary depending on the site purpose and stakeholder priorities. However, the reviews and decision tools provide a procedure and auditable pathway to site selection and the decisions made.

## **Suitability criteria for habitat creation – Report II: Tools to aid site selection for habitat creation**

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Two approaches designed to facilitate site selection for habitat creation are presented in this report. These are:

- A demonstration of a GIS screening tool which is capable of identifying sites for habitat creation at a wider spatial scale and using readily accessible spatial data relevant to suitability criteria.
- A generic influence diagram model designed to assess each site within a short-list in more detail.

Both tools build on the findings of the comprehensive reviews detailed in Report I in terms of utilising the criteria and associated thresholds that were derived from the scientific reviews of the physical, chemical and ecological controls on habitat creation (FD1917 - Report I). In this way the tool(s) represent an attempt to unravel the complexity of interdependent processes and factors controlling habitat creation as discussed in Report I and incorporate them into a framework which will direct an end-user or site selector to the key issues (criteria) in a systematic way.

One of the main practical uses of the tools is to lead the end-user or site selector through the range of issues to consider. This process will include highlighting the factors amenable to predictive assessment, and also those that may be important but where the scientific understanding is not yet sufficient to allow incorporation into the tools.

The tools are designed to be applied in succession in terms of initial screening site selection using the larger scale, screening GIS tool and then application of the influence diagram tool to a short list on a site-by-site basis. Together the tools provide a framework that is user-friendly, accessible, and transparent and provide a good audit trail for decision-making and site selection.

At present there are still scientific limitations on understanding of key processes and controlling factors related to habitat creation and this has limited the quantitative predictive capability of the tools to some extent. Future research on more habitat creation sites, in particular focussing on site characteristics and controls on habitat establishment with time will lead to improved understanding of the cause and effect pathways, responses and outcomes relevant to site selection. This will enable improvement and development of tools such as these that are now in place.

A summary of the main points specific to the tools presented in section of this report appears below.

### ***GIS screening tool:***

GIS is increasingly being applied to coastal zone management situations either in terms of purely integrating relevant spatial information which facilitate site selection or in terms of applying GIS and models to help habitat predictions.

A demonstration of a GIS screening tool was developed for the Blackwater Estuary, Essex. GIS layers were developed for three of the criteria relevant to habitat creation (elevation, slope and proximity to existing habitat) and filtered using thresholds to provide suitability maps at estuary and site scales. These layers were combined by various methods to give maps of potentially suitable sites for saltmarsh and also some estimates of relative suitability. Some of the predicted sites were compared to existing managed realignment sites (Tollesbury, Abbots Hall) to see how the tool compared. For the demonstrated example of saltmarsh habitat the tool predictions compared well to the actual habitat creation sites.

The GIS screening tool is capable of providing a rapid overview of potential sites for habitat creation (saltmarsh in this case). These sites can either, be identified as suitable or not depending on whether they satisfy a range of criteria, or can be ranked in relation to their mean suitability (derivative mapping) against the same criteria. Either method provides a short-list of sites to be tested using the influence diagram tool on a site-by-site basis.

The GIS application performed was limited to some extent by the lack of scientific information which could define the habitat/ criteria / threshold relationships and also by available spatial digital data. As knowledge of the controlling factors on habitat creation and availability of data improves this can be taken further.

Application of this procedure in other geographical areas will require some adaptation of criteria and thresholds in relation to local habitat data but also tidal level information to Chart Datum (CD) or Ordnance Datum (OD). An end-user can therefore tailor the approach presented here to a specific area using local data or site selection aims.

Use of GIS needs to be critically applied and the reasons for selection or deselection of sites must be transparent. The accuracy and uncertainty of each layer needs to be understood so weighting can be appropriately applied.

The criteria used in the GIS overview were specifically targeted towards the physical, chemical and ecological controlling factors of habitat creation. However, other socio-economic, political or logistical constraints may also impact site selection. The GIS framework is flexible enough that given site selection on this basis it is possible to add further layers which can aid filtering from other perspectives such as, grade of coastal defence, Ordnance Survey spatial data (roads, footpaths), agricultural land grade, land availability, strategic plans, conservation restrictions i.e. SSSIs, SACs etc. Within a GIS framework the bigger picture is important not only in terms of scale but to also fit within strategic coastal plans. It is important to look at this large scale as an initial process of identifying potential sites within the context of long-term development of an estuarine or coastal system.

### ***Influence diagram model:***

The generic influence diagram model is designed to assess each site within a short-list identified by the GIS screening tool, in more detail. The model is intended to act as a guide to assessing a site for potential suitability for habitat creation. It has been developed from the outputs of 'Suitability criteria for habitat creation – Report 1' (R&D Technical Report: FD1917). This report facilitated the identification of physical, chemical and ecological parameters (criteria) and relevant limits, which describe potential realignment sites with regard to habitat creation. These outputs provide the basis for the influence diagram's habitat area and suitability calculations.

The model helps steer the user towards the type of data needed to meaningfully investigate a potential site and to identify the most important factors in generating new saltmarsh, intertidal flats or eelgrass (*Zostera marina*) habitat. Although generic the model has the potential to be adapted to individual sites, and to be expanded and developed as criteria are more accurately parameterised with future research.

The influence diagram model is run using *Analytica* software that is freely available through the Lumina website and the model can be both browsed and edited for 30 days. After this period the software allows only the browse mode to be used.

A guide to entering data and using the model is provided. The physical site parameters and suitability criteria of the model are described and defined, with units and threshold information supplied where appropriate. Frieston, The Wash is used as an example of a managed realignment site and the model's predicted habitat area is shown to correspond with the actual area of saltmarsh created on the site.

Guidance and information on weighting criteria and on calculating confidence are provided to help make the model more sensitive to specific sites.

The model has been tested against data for a range of sites with differing locations and purposes; e.g. coastal realignment, estuarine realignment, recharge sites. A strong correlation exists between the model's predicted habitat areas for each site and the area of habitat that actually created following inundation. The model will also be tested against data for sites which failed to create habitat. This will further examine the sensitivity of the model's predicted suitability calculations.

The model can be adapted and expanded once users are familiar with the structure of Analytica's software and have site-specific information available to incorporate into the model's calculations. In this way it acts as an effective audit trail for decisions on final site selection.

### **Conclusions:**

This report covers the demonstration of two tools to aid site selection in terms of habitat creation; a GIS screening tool and a site-specific model. Both use the combination of physical, chemical and ecological controlling factors identified in Report I. These tools are flexible and can be adapted, refined and expanded, to provide greater accuracy and site-specific results. As knowledge improves and criteria are more precisely quantified the tools will become more sensitive and accurate in their prediction of suitability. Together they act as an effective audit trail for decision-making and site selection.

The outputs from this project together with the monitoring guidance provided by DEFRA/EA-FD1918 (2004) and CIRIA (2004) provide a continuum of site evolution and a mechanism for improved understanding of habitat creation in terms of site selection, site design and site monitoring over various timescales. These tools provide a user friendly and auditable framework to encapsulate present day understanding of habitat creation, but they do not deal with all issues related to site selection and are limited to some extent by scientific understanding to date and also variability observed at present example habitat creation sites. The tools are a good starting point to help guide site-selectors through the key issues but a more fundamental study is required to develop increasingly robust tools for future site selection applications.