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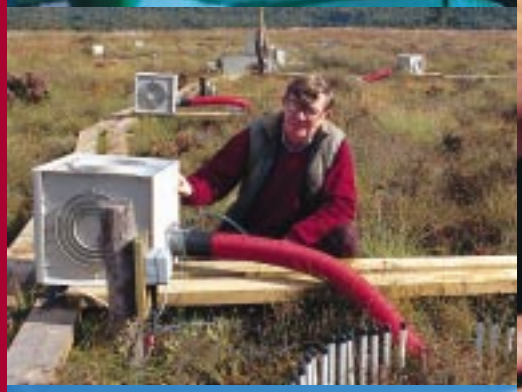
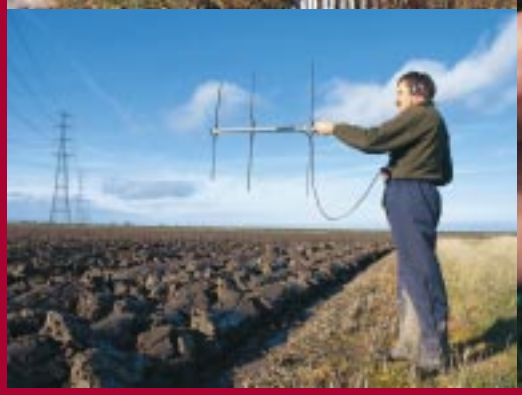
Flood defence standards for designated sites

English Nature Research Reports





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Number 629

Flood defence standards for designated sites

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Cover note

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Contents

1 Introduction

Within the course of a single night (December 31st 1921) the sea, which man for generations has been striving to keep at bay, by shattering a concrete wall has once again placed under natural conditions acres of reclaimed marshland in this district, which have thus reverted to the ideal breeding ground they once were when the avocet, ruff and numerous species of seabirds resorted to them as a nesting area.[1]

1.1 Background

Responsibility for the provision of coastal defences, to reduce risk the built and natural environment from tidal flooding and/or erosion, rests with the Environment Agency (the Agency) for flood defence and the local authority for erosion prevention. In all cases, any works have to comply with the requirements of legislation and Government policy.

In England and Wales almost all works associated with coastal defence are funded out of general taxation. It is therefore important that all projects show 'value for money'. To assist the decision-maker in choosing the most appropriate option, an economic appraisal is undertaken which compares the overall benefits and costs of alternative solutions. Guidelines for such appraisals are set out in the Treasury Green Book and Defra's Project Appraisal Guidance series (MAFF 1999-2001).

In July 1998 Defra (then MAFF) confirmed that it accepted that government had a responsibility to provide flood management measures for Natura 2000 and Ramsar sites where it was sustainable to do so; this responsibility has been embraced in subsequent guidance. Defra, in FCDPAG3 (Flood and Coastal Defence Project Appraisal Guidance, Economic Appraisal)[2], Section 4 on Benefit Assessment, states that: *Under the Habitats and Birds Directives there is a legal obligation to prevent damage or loss of integrity to Special Protection Areas (SPAs) and Special Areas of Conservation (SACs). If one or more of the designated habitats under threat in such a site are considered not to be re-creatable, then valuation will normally need to be derived from the least cost method of achieving an appropriate level of protection.*

However, to assess the impacts in the manner described above there needs to be an understanding of what an 'appropriate level of protection' means. Some guidance is given in FCDPAG3 in Table 6.2 where land use band B is described as: *Typically less intensive urban areas with some high grade agricultural land and/or environmental assets of international importance requiring protection.* The indicative standards of protection given in FCDPAG3 for coastal areas and land use band B are a return period of 50-200 years (an annual probability of failure of 0.005-0.02) for Natura 2000 and Ramsar sites.

Clearly all sites are unique and it is not possible to provide a fixed standard of protection that covers them all. Therefore, in the case of nature conservation sites the above guidance, if used, may lead to an enhanced or reduced standard to that actually required to maintain the

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1 Transactions of the Norfolk and Norwich Naturalists Society Volume XI: Wild Bird Protection in Norfolk in 1922 – Salthouse Broad.

2 Defra (1999): **Flood and Coastal Defence Project Appraisal Guidance Economic Appraisal**, FCDPAG3, December 1999.

integrity of the site. What is required is an understanding of what would be considered an appropriate standard of protection for a particular site.

English Nature is concerned that the current indicative standard of defence for International Sites (i.e. sites with an International Designation such as SPAs, SACs and Ramsar sites) has major implications not only for the costs of the scheme but the appropriateness of the standard for the area under consideration. For example, a 1 in 100 year standard of defence to a site that has been inundated with salt water on average every five years may be totally inappropriate and actually damage the site rather than protect it. In addition it is clear that some sites actually *require* occasional inundation in order to sustain their conservation interest.

English Nature therefore needs to be in a position to advise on appropriate standards of defence for protected sites on the coast and tidal rivers. To date there is very little information relating to 'what may be appropriate' although there is a general feeling that from limited information available some of the defence projects currently being promoted are providing a standard of protection somewhat higher than may be 'appropriate'.

1.2 Aims and objectives

The primary objective is to provide English Nature with guidance to assist staff in making informed decisions regarding appropriate standards of defence for coastal and tidal sites which have an International Designation (SPA, SAC and/or Ramsar). To meet this objective the following actions were agreed:

- produce a research report that will provide information to assist in making decisions on appropriate standards of flood defence for coastal sites;
- provide EN with information to produce a guidance note for staff;
- disseminate the findings through a paper to be presented at a coastal conference; and
- identify the need for future research.

1.3 Organisation of the report

Apart from the dissemination of findings through a conference paper which will be undertaken as the opportunity arises, this report covers the above actions within the following sections:

- Section 2 introduces standards of defence in coastal defence and reviews 'appropriate' standards for conservation sites;
- Section 3 provides generic guidance to the decision process;
- Section 4: describes the case studies;
- Section 5: develops the draft guidance note; and
- Section 6: discusses suggested further studies required.

A literature review has also been undertaken but little information of relevance was found.

2 Standards of defence

2.1 The historical context

The defence of land against flooding and actions taken to improve drainage of land have been an integral part of coastal land management for hundreds of years. Initially it was used to maximise agricultural production (grazing and arable) on fertile land which was also close to transport routes of rivers or the sea. The provision of defences was initially carried out by local landowners very much on a 'piecemeal' basis with areas of land not just protected from the sea but also reclaimed.

Over the years, the Government gradually took an interest in flooding and land drainage issues as it was seen as a benefit to the nation. The earliest Crown authority for flood defence/land drainage purposes was the appointment of the Lords, bailiffs and jurats of the Romney Marsh in the early 13th Century. In 1427, Henry VI appointed Commissioners of Sewers (for a period of ten years) who were sent to all parts of the realm with powers to survey sea defences, flood alleviation in rivers, to maintain and repair those flood defences and take action against people who might damage the defences. They were also given powers to levy rates for any payment or expenses occurred (Purnell, 1993 [3]).

These commissions became more or less permanent under the Bill of 1531 which provided that Commissioners of Sewers could be set up at any time and without limit to their jurisdiction. Many of these commissions existed up until the time of the 1927 Royal Commission.

In parallel with the establishment of the Commissioners of Sewers, a large number of drainage authorities were set up primarily as a response to the agricultural reform. The most famous is perhaps the Conservators of the Great level of the Fens (the Bedford Level Corporation) set up by Act of Parliament in 1661 to control the large area of the fens which had been previously reclaimed.

In the 1920s it was recognised that the UK was not producing enough foodstuffs and in 1927 Lord Bledisloe was appointed to inquire into the present law relating to land drainage. The brief of this 1927 Royal Commission was to consider the administration of land drainage and consider if an amendment of the law was needed to secure an efficient system of drainage. The conclusions were far reaching and stated "It will be apparent from the foregoing summary that the administration of the arterial drainage is conducted by a confused tangle of authorities, established by the piecemeal legislation of 500 years and exercising a great variety of powers and functions. There is no uniformity of method of powers or of liability, many drainage authorities are doing admirable work, others are doing none. The efforts of some authorities are rendered ineffective by the lack of co-operation of their neighbours and by the fact that the drainage of adjoining land is under no control whatever. Liability for works is regulated by no common or uniform system and is frequently obsolete and obscure". As a result the 1930 Land Drainage Act was passed, repealing all previous Acts. The Act established Catchment Boards who derived income from not just those who benefited directly

[3] Purnell RG (1993): *Flood Defence Legislation and Management*, paper presented at the UK – Hungarian Workshop on Flood Alleviation.

but also by precepting other authorities, primarily the County Councils and Drainage Boards (if they existed in their area).

One conclusion of the 1927 Royal Commission is of particular interest "…originally the lowlands were in many cases swamps, receptacles for upland waters. The ingenuity of the low lander has reclaimed them and from being vast unhealthy wastes, they have in many instances been converted into some of the richest and most valuable land in the kingdom". (Defra's Chief Engineer commented in a paper on Flood Alleviation in 1993 "these days there are many who will dispute whether these converted unhealthy wastelands are more valuable than the ecologically rich swamps that previously existed".)

The River Board Act of 1948 made considerable changes to the Land Drainage Act, which up to that time was primarily for the maintenance and improvement of drainage and flood defences for the benefits of agricultural production. It set up Catchment Boards which superseded River Boards, covered the whole of the catchment of all major rivers and gave powers for fisheries and pollution control.

The devastating floods of 1947 and 1953 graphically demonstrated the reliance of low lying land on effective defences to reduce flooding and hence the loss of agricultural production and loss of life.

The Report of the Departmental Committee on Coastal Flooding (The Waverley Report[4]), dated May 1954, appears to be the first reference to standards of defence. Section 11 states that: "the maximum standard of protection to be afforded by public authorities against flooding should in general be that sufficient to withstand the flood of January 1953, and this should be provided where flooding would affect large areas of agricultural land, or would lead to serious damage to property of high value such as valuable industrial premises or compact residential areas. Elsewhere, the defences should be at a standard which would reasonably have been thought adequate before the flood of January 1953. In certain circumstances, higher and lower standards may be appropriate. Anyone requiring such a high standard should pay for it himself".

The guidance given on standards of protection by the Waverley Report were generally implemented, especially on the East and South Coasts during the 1950's and 1960's with tidal defences being raised and strengthened to a nominal 1 in 100 year standard (the estimated return period of the 1953 flood). The exception to this was the London tidal defences which provide protection to the capital against a 1 in 1000 year event.

Subsequent Land Drainage Acts, Water Resource Acts and Water Acts whilst not changing the essence of the original Act, added powers and responsibilities to change the emphasis from the protection of agricultural land towards the need to protect property and life.

The provision of this nominal standard of defence in some areas may have been well in excess of the standard previously provided. Consequently, the reduced flooding may have resulted in some changes to the ecology of the protected area.

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[4] Home Office (1954): **Report of the Departmental Committee on Coastal Flooding** (The Waverley Report), HMSO: London.

The environmental damage caused by improved drainage and flood defence measures to low lying areas (the 'unhealthy wastes' of 1927) began to be realised during the 1970s and a number of Acts and regulations have sought to provide a more balanced approach which recognises the environmental 'value' of these low land areas. The requirement for environmental impact assessments and statements, openly advertising flood defence schemes, and greater stakeholder participation in the decision process have all played their part in reducing environmental damage and possibly reversing some of the changes that have taken place under previous policies to produce more food.

There are now indicative standards set for different types of land use (see Section 2.3). However, for areas of high conservation value, which have been developing over many hundreds of years and with different and comparatively low standards of defence, the setting of one standard to suit all types of habitat is not appropriate. The purpose of this study is to provide answers for the following two questions:

- what is an appropriate standard? and,
- how it is arrived at?

2.2 Standards of defence

2.2.1 Flood defence standard

A flood defence standard specifies the protection offered to a specific area from flooding from the sea or rivers. It is usually associated with a man made defence on the coast or in estuaries, with land that has been 'claimed' from the sea (often many centuries ago).

There are also cases where a natural defence, such as a sand dune or shingle bank, is managed to provide an increased standard of protection to the hinterland.

Defences are provided to reduce the risk of flooding from the sea or river and within the flood and coastal defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100 year standard of protection. This, in its simplistic form, means that over time, the defence will fail once every one hundred years. More recently the concept of annual probability of flooding is also referred to and a 1% probability is equivalent to 1 in 100 year return period.

However, failure of the defence (and this could be described in different ways) may not necessarily damage the area being protected. The damage (impact) to the protected area will depend on many factors such as salinity levels, depth of flooding, duration of flooding, time of year of the event, etc. arising from the flood event.

It is therefore usual to address the issues associated with flooding using risk based methods which take both the probability (likelihood) and impact (consequence) into account.

2.2.2 Defence failure

The previous section described a standard of protection provided by a defence on the basis of a return period. For example, a 1 in 100 year defence would not defend against a 1 in 150 year event and flooding would take place. But again it is not easy to define the physical

parameters of the 1 in 100 or the 1 in 150 year storm event[5]. The return period could represent the still water level associated with a combined tide and tidal surge, or it could be a large tide with severe wave action with a joint probability of occurring once every 100 or 150 years on average.

The mode of flooding could also be used to indicate failure. Under wave attack the defence may not breach[6] but significant overtopping[7] would lead to flooding. Another form of failure could arise from increased seepage through a permeable defence (such as a shingle bank) where this also gives rise to flooding.

As can be seen, the definition of 'failure' is not straightforward and an understanding of the forcing conditions (tides, waves, etc.) and mechanisms for flooding both play a part. For the purposes of this project three modes of failure are considered.

- failure by breaching;
- failure by overtopping; and
- failure by seepage.

Failure may also occur from a combination of overtopping and seepage.

Failure of the defence is therefore related not just to the external conditions but also the specific impacts (damage) caused by water entering the site. Defence standard therefore refers to the number of times over a specific timescale that water could enter the site either through or over the defence **and** cause damage.

2.2.3 Impacts

The impacts on a site describe the consequences of flooding on the habitat and/or species. Each site is unique and therefore a good understanding of what is on the site and how it will be affected by a change in conditions under a flood scenario is a prime requirement. The components of the flood conditions that could damage the site can be categorised as follows:

- water quality (salinity, nutrient content, etc.);
- velocity;
- depth; and
- length of time flooded.

In addition, the impacts will also be influenced by other factors such as:

- tolerance of habitat to floods (e.g. salt tolerant grasses?);

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5 The 1 in 100 or 1 in 150 year storm event is defined as an event which would occur, on average, once every 100 or 150 years.

6 A breach within the context of this report is when the man made defence is damaged and fails, allowing the uncontrolled ingress of water.

7 Overtopping is when during a storm event the defence remains intact and water flows over the defence.

- season flooding takes place (e.g. plants dormant, breeding birds, etc.);
- drainage on site to evacuate water;
- compartmentalisation of site to restrict flooding;
- rainfall (to dilute saline conditions); and
- freshwater flows to 'flush' the site.

The risk of damage to a site is a function of the conditions causing flooding, the type of failure of the defence and the actual impact (damage) to the site. This can be addressed in terms of:

Source>>>>Pathway>>>>Receptor

Within this project we are primarily concerned with the pathway (the defence and mechanism for flooding) and the receptor (the site under consideration) although the source, especially in respect of salinity (estuary or open sea site for example) may also be a consideration.

2.3 'Appropriate' standards

2.3.1 Standards of protection up to 1993

As mentioned in Section 2.1, following the 1953 flood many defences were raised to a comparatively high standard (to withstand the 1953 flood conditions) as recommended by the Waverley Report. Many Regional Flood Defence Committees had their own guidance relating to standards. For example, the following design criteria were in force in 1989 in the National Rivers Authority (NRA) Unit of Anglian Water.

In addition to the design standards based on still water levels, as given in Table 2.1, there were also allowances for sea level rise (variable from 3mm to 6mm/year) and for freeboard[8] (variable across the LFDCs).

Table 2.1: Design Standards in NRA Region of Anglian Water, 1989

LFDC[1]	Land protected	Frontage type	Still water level
Essex	Urban	All	Optimum cost effective (1in 200 to 1 in 1000)
	Rural		1 in 100
Norfolk & Suffolk	Urban	Exposed coast	1953 level
		River/estuary	1 in 100 to 1953 level (river)
	Rural	Exposed coast	1953 level
		River/estuary	Min 1 in 5 year; max 1 in 25 year
Great Ouse	Urban & Rural	All	1 in 100
Welland & Nene	Urban & Rural	All	1 in 100
Lincolnshire	Urban & Rural	All	1 in 100

Notes: [1] LFDC is Local Flood Defence Committee.

[8] Freeboard is an allowance by which the top of a defence is raised to take account of uncertainties in the assumptions made in the design and can be compared to a safety factor.

2.3.2 MAFF guidance 1993

The guidance on appropriate standards was replaced in 1993 by MAFF with the publication of their Project Appraisal Guidance Notes (PAGN). The guidance given in PAGN included not only indicative standards but also a decision rule to be followed when choosing the most (economically) efficient option.

The indicative standards were classified by land use as presented in Table 2.2, taken from PAGN.

Table 2.2: Indicative standards from PAGN (1993)

Current Land Use	Indicative standard of protection (return period in years)	
	Tidal	Non-tidal
High density urban containing significant amount of both residential and non-residential properties.	200	100
Medium density urban. Lower density than above, may also include some agricultural land.	150	75
Low density or rural communities with limited properties at risk. Highly productive agricultural land.	50	25
Generally arable farming with isolated properties. Medium productivity agricultural land.	20	10
Predominantly extensive grass with very few properties at risk. Low productivity agricultural land.	5	1

Notes:

Within the context of project appraisal it is expected that the authorities will use the indicative standards to help establish the range of options to be considered. The Ministry will expect a full range of options to be considered including some which do not meet the indicative standard.

The above indicative standards do not represent an entitlement to protection or a minimum level to be aimed at.

In deciding which option to proceed with an authority should follow the decision rule.

The decision rule was introduced to maximise the economic return of the project by choosing the option that was the most economically efficient as set out in Box 2.1.

Box 2.1: The decision rule

The steps set out below take maximisation of the benefit-cost ratio as their starting point. It is expected that, under most circumstances, the option with the greatest average benefit-cost ratio will represent the final choice. In some circumstances this option may fall short of the indicative standard of protection. If it does, the rule then goes on to examine whether an option which would more closely approach the indicative standard of protection would be justified. The justification depends on the additional benefits purchased by the additional costs of increasing the scale of the project, i.e. the incremental benefit-cost ratio. Provided this additional investment is robustly worthwhile in its own right, i.e. the incremental benefit-cost ratio comfortably exceeds unity, an increase in scale for standards of protection reasons is justified.

I Examine the average benefit-cost ratio of all options. If none is at least unity, reconsider scope of options or abandon proposal.

II Identify the option with the greatest average benefit-cost ratio that is at least unity. If this option meets or exceeds the indicative standard, it is the final choice. If not proceed to III.

III In order to determine whether an increase in scale would be economically efficient, examine the next option with a higher standard of protection than that identified at II. Provided its average benefit-cost ratio remains at least unity, consider switching to this option if its incremental benefit-cost ratio comfortably exceeds unity under plausible values for main variables. If this option meets these conditions and meets or exceeds the indicative standard, it is the final choice.

IV However, if the choice under II or III falls short of the indicative standard, choose the option that most closely approaches the indicative standard **provided** the average benefit-cost ratio of that option is at least unity and its incremental benefit-cost ratio comfortably exceeds unity, and both ratios are robust to likely variations in key variables.

It is recognised in PAGN that "cost-benefit analysis is not a decision making tool in itself, it is merely a powerful aid to decision making". It goes on to add that if the operating authority considers that justification exists for proceeding with a scheme other than that given by the decision rule, the case must be put to the Ministry. The case would need to include the reasons behind the choice and for departing from the solution identified by the decision rule. Reasons given in PAGN could include:

- significantly higher sensitivity (than a competing option) to an uncertain and important variable but only if such sensitivity has not already been incorporated into expected values;
- environmental impacts or opportunities not given monetary values but which favour another option (the Environmental Statement and/or the views of environmental consultees will have an important role in this instance); or
- planning constraints which cannot be amended.

As can be seen from the above, the treatment of environmental sites is not explicitly covered by the indicative standards or the decision rule and would therefore be left to discussions between operating authorities and English Nature. Although with the inclusion of extensive grassland in the land-use categories, standards at the lower end of the range would appear to be most appropriate for many of the coastal and estuary grazing marshes unless properties and high grade agricultural land was also present.

2.3.3 MAFF guidance FCDPAG3

In 1999 MAFF published Flood and Coastal Defence Appraisal Guidance – Economic Appraisal (FCDPAG3) as a revision of PAGN to include clarification of a number of areas that had "caused problems" and subsequent developments. The main changes, apart from more guidance on the valuation of benefits, were to indicative standards and a revised decision rule. The indicative standard, rather than being a single value was changed to a range and the land use bands included explicit reference to environmental assets of international importance requiring protection.

The revised indicative standards are shown in Table 2.3, taken from FCDPAG3.

Table 2.3: Indicative Standards from FCDPAG3 (1999)

Land use band	Description	Indicative standards of protection (return period in years)	
		Coastal/saline	Fluvial
A	Typically intensively developed urban areas at risk from flooding and/or erosion.	100 - 300	50 - 200
B	Typically less intensive urban areas with some high-grade agricultural land and/or environmental assets of international importance requiring protection.	50 - 200	25 - 100
C	Typically large areas of high-grade agricultural and and/or environmental assets of national significance requiring protection with some properties also at risk, including caravans and temporary structures	10 - 100	5 - 50
D	Typically mixed agricultural land with occasional, often agriculturally related properties at risk. Agricultural land may be prone to flooding, water logging or coastal erosion. May also apply to environmental assets of local significance.	2.5 - 20	1.25 - 10
E	Typically low-grade agricultural land, often grass, at risk from flooding, impeded land drainage or coastal erosion, with isolated agricultural or seasonally occupied properties at risk, environmental assets at little risk from frequent inundation	>5	>2.5

The decision rule also changed in that once the lower end of the indicative standard had been reached it is only possible to provide a higher standard if the incremental benefit-cost ratio is greater than 3 (the median of all nationally funded schemes in 1998). Below the indicative standard, the incremental benefit-cost ratio must be robustly greater than unity to move to the next, higher, option. FCDPAG3 also defined the need for a more robust incremental benefit-cost ratio, as being in excess of 1.5. A flow chart is also included within FCDPAG3 for ease of use. Again FCDPAG3 recognises that benefit-cost analysis is only one tool available to the decision maker and an alternative option could be chosen if there were exception factors. These factors could include:

- uncertainty regarding the economic outcomes of a particular option which it has not been possible to incorporate adequately into the analysis;

- environmental considerations for which it has not been possible to assign monetary values;
- irrevocable planning constraints; and
- availability of funds (affordability).

2.4 Discussion

The provision of defences delivering protection to low-lying areas of land adjoining the coast or rivers has been agriculturally led for many centuries. Initially the land would have been used for summer grazing but with improved construction techniques, the introduction of powered earthmoving machinery and the means of evacuating water effectively, through pumps it has been possible to convert these areas to arable cropping. If conditions were not suitable for arable crops it was still possible to provide intensive rather than extensive grazing and increase stocking rates and the length of the grazing season.

It is also worth bearing in mind that during and immediately after the World War II the need to grow food led in many cases to grazing marsh (and other land) being turned to arable production.

With the loss of life in the 1953 floods the importance of reducing risks to people and property was given greater emphasis and since 1977 much research has been carried out to value damages caused by flooding to the built environment and agriculture. This has been and is being used to economically justify investment in flood protection (much of the work has been carried out by Middlesex University Flood Hazard Research Centre and Silsoe College). As can be seen from the previous sections, at present economic criteria drive the selection of the preferred option and this relies heavily on being able to value the impacts/damages. For those areas where valuing impacts is more difficult, such as social and environmental issues, these are dealt with outside of the decision rule but there is no formalised way of doing so, which can result in their relegation to issues of secondary importance unless the site has an international designation.

Whereas when assessing damages to property and people and to agriculture the losses from flooding can relatively easily be calculated (using standard depth damage data) the impacts to conservation sites are not so straightforward. There are a number of factors relating to not just the species but also the habitats, that have to be understood before a decision on what is being impacted can be taken. For example, the habitat will often have developed over many centuries and been influenced by natural events such as rainfall, and changes in frequency of flooding if defences have been provided. No defence can exclude all flood events and it is likely that prior to the 1940s defence standards were lower and therefore the defended areas were subjected to flooding on a more regular basis. The species inhabiting the protected area may have built up or become tolerant of conditions arising from characteristics of the flood events. Some species may even benefit from occasionally inundation.

The guidance given in FCDPAG3 states a range of indicative standards appropriate for different levels of statutory designation (from international to local designations) but apart from "environmental assets at little risk from frequent inundation" in land use band E there is no link to the type of habitat, just to its designation. FCDPAG5 recommends, therefore, that English Nature be consulted to obtain case-by-case advice on standards. In order to make informed decisions on the appropriate standard of protection each site must be considered

individually. The resulting standard can then be used together with other impacts to the build environment to assist the decision makers in choosing the preferred option. The approach to doing this is considered in the next Section - Generic Guidance.

3 Generic guidance

3.1 Factors to be taken into account

The previous sections have provided the background on the development of flood defences over the years, introduced the term standards of protection and discussed the decision-making process within the flood and coastal defence system. When assessing the impact of floods on a particular site it is not easy to make generalisations as every site is unique. Also, it may be necessary to look at the site within the context, not just of the site itself, but also its proximity to other sites, its location with regard to options for rolling back the site (or migration of the conservation interest) and how this sits within the overall coastal ecosystem in the general area.

Project appraisal for flood and coastal defence projects uses the do-nothing option as the baseline case against which all other options are compared. The do-nothing scenario is one where there is no intervention and any defences are allowed to deteriorate and if damaged, they are not repaired. There are usually no costs associated with this option.

The generic guidance presented here also takes the do-nothing scenario as the baseline. If this is expected to cause impacts that are not acceptable then the appropriate standard of protection is identified and assessed within the decision framework as set out in FCDPAG3.

The following information is required to be able to make a decision on the appropriate standard of protection:

- description of conservation designation and citations;
- key features, habitats and species;
- flood history of the site;
- site objectives and conservation objectives for the area;
- description of flood risk management (past and present);
- future changes to the site (e.g. climate change);
- impacts of do-nothing (no active intervention); and
- impacts associated with different standards of protection.

It is anticipated that the decision process will require input from a number of EN staff members with different specialisms (and others with specialist knowledge of the site) to provide information on the impacts across the range of flora and fauna present. They will also need to be involved in the decision making to discuss possible trade-offs when selecting the appropriate standard.

3.2 Overview of the approach

The decision process is shown in the form of a flow chart, Figure 3.1. The flow chart identifies the type of issues and impacts that will need to be considered when making a decision for a particular site.

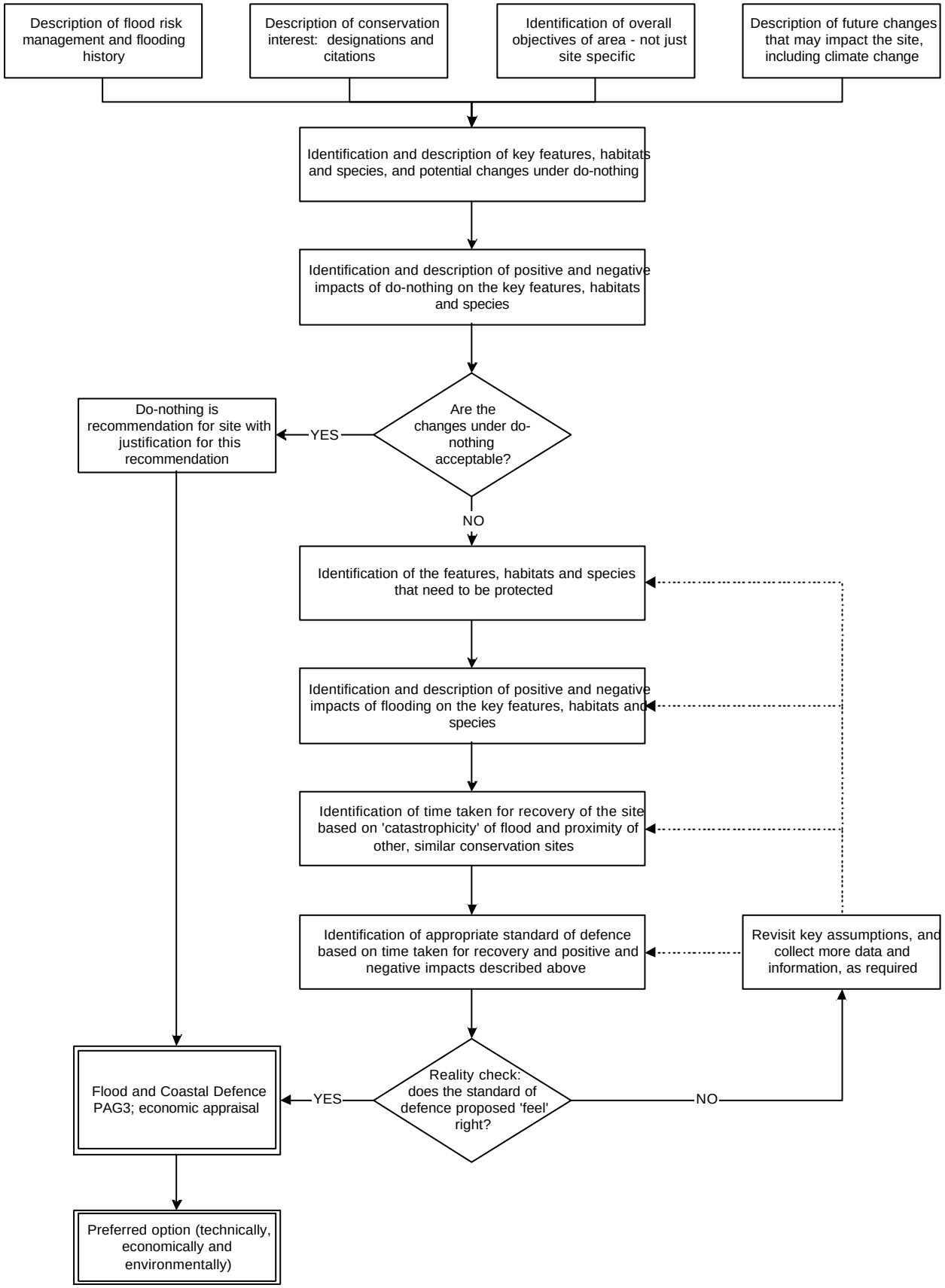

Figure 3.1: Decision process – generic guidance

The approach is designed to take the form of a high level assessment, focusing mainly on features and habitats. However, there is also scope to include specific impacts on species where these are not seen to be adequately included under the description of impacts on features and habitats. In this way, the methodology can be tailored to the level of detail that is considered necessary to make the 'best' decision possible.

The methodology is used to set out, explicitly, all of the available information and the inferences drawn from it. Thus, an audit trail is provided of the assumptions and reasoning behind the decision.

There are two points at which a decision can be made about the site. The first follows the description of what is expected to occur if the do-nothing option is implemented. Here, it is necessary to decide if the impacts under do-nothing are acceptable (or not). If it is decided that do-nothing is the most appropriate action for the site, justification is provided and the assessment stops. If not, the assessment moves onto the second part of the methodology where the appropriate standard of defence is to be determined. This requires consideration of the time that would be required for the current (i.e. pre-flood) conservation interest of the site to recover. This information is then used to decide what the appropriate standard of defence should be (usually given as a range to reflect uncertainty).

Identification of impacts under the do-nothing option requires information to be collected and predictions made of the changes that may occur to the features, habitats and/or species present on the site if no work is undertaken on the defences. The key issue in the decision relates to the predicted changes to features and habitats and whether these will be replaced by other features and habitats of equal, greater or lower conservation interest and whether this is acceptable.

Identifying the appropriate standard of defence (where the do-nothing option is not considered acceptable), involves an assessment of the flood conditions and the impacts of these on the conservation interest of the site. This is termed the 'catastrophicity' as it relates to the impacts of floodwater velocity, area inundated, depth of floodwater, quality of floodwater and time required before the floodwaters are evacuated from the site. These five factors are used to give an indication of the immediate effects on the site. From this, an estimate can be made of the time required before the site returns to the same level of conservation interest as before the flood. It is important to note that the methodology concerns itself more with level of conservation interest, or biodiversity, and does not require a site to be re-created in the same form as prior to flooding. In this way, natural changes and sustainability can be included and should help encourage a move away from 'preservation' towards 'conservation'.

Application of the generic approach and its development to a proforma based methodology has been undertaken using a series of case studies. This is described in detail in Section 4.

4 Summary of the results of the case studies

4.1 Introduction

The aims of the case studies are twofold:

- firstly, to aid in the development of the methodology; and
- secondly, to illustrate use of the methodology.

This Section describes how the case studies have been identified, how they have been used to help in developing the methodology and to summarise the findings of the case studies.

4.2 Selecting the case studies

A long-list of potential case studies was developed through consideration of projects that RPA has been involved in and from discussions with English Nature staff. A long-list of some 25 case studies was drawn up and is given in Table 4.1.

Table 4.1: Long-list of potential case study sites

Site name	Area/region
Arun Valley (Waltham Brooks, Amberley Wildbrooks, Pulborough Brooks)	Sussex
Arundel Park SSSI and Arun Banks SSSI	Sussex
Blakeney Freshes	North Norfolk
Brancaster	North Norfolk
Bridgwater Bay	Severn Estuary
Burnham Overy Marshes	North Norfolk
Cantley Marshes	Norfolk Broads
Clayrack Marshes	Norfolk Broads
Cley-Salthouse	North Norfolk
Dawlish Warren	Devon
Hardley Flood	South Norfolk
Hazlewood Marshes	Suffolk
Humber Estuary	Humber
Isle of Sheppey	North Kent
Lewes Brooks SSSI	Sussex
Old Hall Marshes/Tollesbury Wicks	Essex
Pett Level SPA	East Sussex
Pevensey Bay Ramsar site	Sussex
Porlock Marsh	Somerset
Seaford to Beachy Head SSSI	Sussex
Selsey to Bracklesham	West Sussex
Slapton Ley	South Devon
Slaughden	Suffolk
The Wash	Lincolnshire/Norfolk
Tinkers Marsh	Suffolk

Selection of sites was made based mainly on the availability of information. Care was taken to ensure that the case studies covered different areas of the country and comprised a range of

issues, including different flooding scenarios (erosion, breaching), different site types (freshwater to brackish) and different habitats and species (birds, invertebrates, aquatic flora). In this way, the methodology could be tested as widely as possible.

The final case studies selected and assessed are given in Table 4.2. The case study number is used as the reference in the completed assessments. A full set of completed proformas are provided in Annex 1.

Table 4.2: Short-list of case studies assessed	
Number	**Case study name**
1	Blakeney Freshes, North Norfolk
	Cley-Salthouse, North Norfolk (combined with Blakeney Freshes)
2	Lewes Brooks SSSI, Sussex
3	Tinkers Marsh, Suffolk
4	Cantley Marshes, Norfolk Broads
5	Selsey to Bracklesham, West Sussex
6	Pett Level SPA, East Sussex
7	Brancaster, North Norfolk
8	Old Hall Marshes/Tollesbury Wicks, Essex
9	Burnham Overy Marshes, North Norfolk
10	Slapton Ley, South Devon

4.3 Assessment of the case studies

4.3.1 Using the case studies to develop the methodology

Each case study has been assessed using the same approach. This approach is based on a series of proformas developed while undertaking the assessment of Blakeney Freshes. The assessment of subsequent case studies highlighted where changes needed to be made to the proformas, particularly in terms of making the terminology used more general such that it can apply to a wide range of conditions. After assessing the first four case studies, the methodology had been refined sufficiently that no significant changes were made following the assessment of the remaining six case studies. This illustrates that the approach should be applicable to almost all situations that may be faced when determining the appropriate standard of defence for coastal sites. The use of general terminology and application to sites such as Cantley Marshes should also make the methodology generally applicable to river flooding (although some changes may need to be made to some of the terminology, such as in Proforma C – predicted future changes).

4.3.2 The Results of the Assessments

The main output of an assessment is to identify whether the do-nothing option is considered appropriate and, if not, to identify what standard of defence (or range of standards of defence) may be required at the site. Table 4.3 presents the results of each case study assessment as undertaken by RPA, together with a summary of the justification given for making that decision[9].

[9] The case studies have been undertaken by a number of different RPA staff to assess whether the approach is easy to follow and whether an assessment can be completed without detailed knowledge of the site and/or specific ecological/botanical expertise. This means that the case study assessments are only based on information that was readily available from reports, surveys and strategies for each site.

Table 4.3: Summary of results of the case study assessments		
Number	**Case study name**	**Decision made and justification**
1	Blakeney Freshes, North Norfolk Cley-Salthouse, North Norfolk (combined with Blakeney Freshes)	**Protect to 1 in 3 to 1 in 10 standard**. This is an important freshwater site and it would be of benefit to protect it in the short term to allow a gradual change to a more saline and then saltmarsh environment. This would provide time for migration of species to nearby sites. Protection in the longer term is unlikely to be sustainable or cost-effective as the costs of providing defences would become increasingly prohibitive. Protection to a higher standard may also mean that the site becomes too low lying for saltmarsh to develop.
2	Lewes Brooks SSSI, Sussex	**Do-nothing.** Although there would be some loss of freshwater and brackish water habitats, the conservation status of the area has deteriorated due to the amount of drainage that has been undertaken. The change to saltmarsh/mudflat habitat would greatly increase the extent of intertidal areas and could provide some flood defence benefits to the town of Lewes (upstream).
3	Tinkers Marsh, Suffolk	**Do-nothing is not acceptable due to uncertainty as to what habitats would be created (if any). Research needs to be undertaken to determine whether saltmarsh could be created on site.** The potential for creation of saltmarsh/mudflat habitats as replacement for the grazing marsh, etc. is highly uncertain. Without the creation of new saltmarsh areas, the area could be inundated for prolonged periods and may result in a net loss of habitats and feeding grounds. If saltmarsh could develop over time and suitable alternative habitats are available for bitterns and marsh harriers, do-nothing would become the acceptable option.
4	Cantley Marshes, Norfolk Broads	**Do-nothing is not acceptable. Protect to 1 in 3 to 1 in 10 standard (short-term).** Potential loss of botanically valuable aquatic flora may not be compensated elsewhere and biodiversity would be reduced. Protection will allow other sites to be found for the botanically valuable species. Over time, the site is not sustainable as salinity levels and nutrient levels are both increasing. Therefore, protection of the site to a higher standard is unlikely to protect the valuable species currently present on the site.
5	Selsey to Bracklesham, West Sussex	**Do-nothing.** Although there would be a loss of shingle and the species poor grassland habitat this would be compensated by an increase in saltmarsh and associated species. The shingle habitat is also poor as it is heavily managed. The present standard of protection to the grassland is 1 in 1 year and is unsustainable in that it relies on importing shingle on an annual basis (at significant cost).
6	Pett Level SPA, East Sussex	**Do-nothing is not acceptable. The recommendation is to maintain the beach and seawall but to allow gradual reduction in standard of protection provided (due to sea level rise).** This approach will give species requiring freshwater or brackish conditions time to relocate to other sites. Repairing breaches to a low standard should allow the development of a new salinity gradient across the site. Breeding and roosting sites should be maintained.

Table 4.3: Summary of results of the case study assessments		
Number	**Case study name**	**Decision made and justification**
7	Brancaster, North Norfolk	**Partial realignment.** Net benefit to the habitats for which the cSAC was designated. May result in very limited long-term negative impacts to some of the bird species for which the SPA was designated (e.g. oystercatcher and redshank). However, management of the remaining freshwater habitats are likely to be of benefit to these and other SPA species.
8	Old Hall Marshes/Tollesbury Wicks, Essex	**Protect to 1 in 10 standard.** Although data on recovery of species would suggest that grassland species can recover within 3 years, it is estimated that by 2046 the existing sea wall would provide only defences to a 1 in 6 year standard (as opposed to the current 1 in 24 year standard). Essex Wildlife Trust suggests this represents a significant increased risk of flooding which would destroy the habitat. Therefore a higher standard of defence than 1 in 6 is required, and 1 in 10 would suggest that species would have time to recover between flooding events.
9	Burnham Overy Marshes, North Norfolk	**Protect (short-term) but allow sea level rise to result in reduction in standard of protection over time.** More information is required as to the potential impacts of breaching on the site. Previous flood events suggest the site can recover quickly following flooding. With regular flooding, however, it is likely that the site would revert to saline habitats. Breeding habitats could be protected by providing protection against flood events during the breeding season, which would require a low standard of protection.
10	Slapton Ley, South Devon	**Do-nothing.** Natural development of the shingle ridge is restricted due to the road on top of it and its protection from the advancing sea. The beach and shingle ridge have been evolving in response to rising sea levels. Furthermore, the freshwater lagoon that is located behind them is, by nature, a temporary feature in the coast, and although a rare element, it is not sustainable to preserve it in a stagnant/museum like state. Recent surveys show that some features at Slapton Ley SSSI already have an unfavourable status of conservation, some of which is caused by the restricted natural development of the shingle ridge.
Note: It is important to recognise that the case study assessments have been undertaken by RPA and do not represent the views of English Nature as to the flood defence requirements of any of the above sites. Neither do the above results provide any recommendations for future flood defence standards at the case study sites.		

Table 4.3 shows that the results of the assessment vary considerably according to the specific conditions of each site. This shows that the methodology has been fully tested by the case studies and that a wide range of different recommendations can be obtained. This is important for any methodology that is to be used to assess conservation sites since all sites are different and such differences have to be taken into account in decision-making.

5 Guidance for English Nature staff when selecting appropriate standard of defence

5.1 The approach

The key part of the assessment is to identify the key factors that affect the decision. To do this it is necessary to:

- identify the baseline (current situation)[Error! Bookmark not defined.];
- what will happen from that baseline if nothing is done (i.e. equivalent of the do-nothing option);
- is "do-nothing" acceptable (including consideration of whether doing so meets legal obligations)?
- if not, describe the key factors that affect what standard of protection is required (important to discuss minimum and maximum standards).

The guidance note set out below is designed to help an assessor complete the proformas and, in so doing, to set out the key information and provide a record of the decision-making processes. As the note is aimed at the person undertaking the assessment, it refers to the assessor as 'you'.

5.2 The guidance

5.2.1 Overview

The Guidance is organised as a series of proformas which are designed to help you set out and record the key issues, and to lead you through the decision-making process. Once you have completed the proformas, you should review the information you have recorded to help you make a decision as to whether you need to defend the site and, if so, what level of protection may be required as a minimum or should not be exceeded as a maximum.

Where necessary, details are given on what sort of information to include in each box and, wherever possible, the sources of information that may be available to help you when completing the proformas is provided.

The proformas are organised alphabetically. There are six different proformas, each comprising a number of parts:

- Proforma A: used to record administrative details and the site being assessed;
- Proforma B: used to describe the current situation on the site and the key factors that make the conservation site important;
- Proforma C: used to describe potential future changes that may affect the site;
- Proforma D: used to provide a record of the impacts that are expected/predicted under the do-nothing option';

- Proforma E: used to describe the impacts of a flood on the site, where the do-nothing option is not considered appropriate for the site; and
- Proforma F: used to detail the decision that has been made and the justification behind it.

All of the proformas are set out in the same way, with 'orange' boxes containing the name of the box and/or describing the information that should be added into the 'white' boxes.

5.2.2 Proforma A: Identification of site

Proforma A is used to record the administrative details such as site name and location, any identification numbers applied to the site or project, the name of the assessor(s), etc. The proforma also provides space for recording information/data sources. This could include reports, journal articles or other printed matter, but also discussions and consultations with other EN staff or external contacts. In this way, the whole process is recorded in one place and will provide a record of how the assessment has been undertaken as well as the decision coming out of it.

Proforma A: Identification of site and administrative details	
Site name and location	
Site/project identification number	
Assessor	
Date assessment started	
Data sources	

5.2.3 Proforma B: The current situation

Proforma B is used to set out the key issues relating to the site in its current condition. This includes management, conservation and other key factors. The 'key features', 'key habitats' and 'key species' boxes are where the specific conservation interest of the area can be recorded. To minimise repetition and reduce the amount of time required to complete an assessment, it is recommended that you start with key features. Only where the impacts on a specific habitat or species cannot be fully described under the key features should you separate it out. However, there will be many cases where impacts on a specific habitat and/or species cannot be described satisfactorily under 'key features' and the 'key habitats' and 'key species' boxes provide an opportunity for recording more detailed information.

To complete Proforma B, you may find it useful to have the following information available:

- documents relating to the flood defences of the area. This may include:
  - Shoreline Management Plan (SMP);
  - Flood Defence Strategy (available from Defra, the Environment Agency and/or local authorities);
  - Futurecoast;
  - Coastal Habitat Management Plan (CHaMP); and
  - Strategic Environmental Assessment (if applicable), or other environmental reports that may have been prepared.
- maps of the area (Ordnance Survey 1:50,000 may be sufficient in most cases);

- citations (if applicable) as these will help guide you as to what are the key features, habitats and species;
- reports on current conservation objectives and management of the site; and
- any surveys that may have been carried out on the site, such as bird counts, baseline ecological surveys or annual reports from wardens, etc.

Proforma B: The current situation		
Criteria	**Factor**	**Description**
Management	Flood history	
	Current situation	
	Management for flood defence	
Conservation interest	Designations	
	Key features	
	Key habitats	
	Key species	
	Management for conservation	
Other key factors	Historic environment	
	Recreation	
	Economic factors	
	Social factors	

5.2.4 Proforma C: Predicted future changes

Proforma C is used to record the expected/predicted changes that may occur over the next 100 (or so) years. Such changes may often be uncertain such that you may need to record possible ranges or consider a number of possible end results. The description of future changes is important as these are likely to place constraints on what is sustainable at many coastal conservation sites.

The documents used to complete Proforma B may also include some of this information.

Proforma C: Predicted future changes		
Criteria	**Factor**	**Description**
Climate change	Sea level rise	
	Extreme water levels	
	Tidal currents	
	Wave direction	
	Geomorphology	
Other changes	Water quality	

5.2.5 Proforma D: Do-nothing

Proforma D is used to describe the changes that may occur if the site is left and no further flood defence management is undertaken. This is assumed to be the equivalent of the do-nothing baseline that is used in project appraisal. It is important that the do-nothing option is used as a baseline as it (i) provides the likely situation if no further defence works are undertaken and (ii) is consistent with the approaches that will be taken in the economic appraisal of flood protection works. This will mean that the results of your assessment can be

used to provide the implications for the environment and, hence, feed into the wider decision-making when the flood defence policy, strategy or scheme for the area is being undertaken.

The aim of Proforma D is to identify the predicted impacts of do-nothing on the key features, habitats and species identified in Proforma B. The first part of Proforma D (D1) involves screening out those features, habitats and features that would not be affected and screening in those that would or could be affected. The aim of this proforma is not to describe all of the expected impacts, but rather to describe why a particular feature, habitat or species will (or will not) be considered further in the assessment.

Proforma D1: The impacts of do-nothing			
Criteria	**Feature/habitat/species**	**Description**	**Impact expected (Y/N/unsure)**
Key features (from proforma B)			
Key habitats (from proforma B)			
Key species (from proforma B)			

It is often quite difficult to screen features, habitats or species out at this stage, since there are likely to be at least some impacts on all of them. You need to make sure that you focus on the most important impacts, i.e. those that affect the overall conservation interest of the site and the surrounding area. You also need to consider how much time is available for completing the assessment when deciding which features, habitats and species to screen in and which to screen out. Those habitats that may benefit from do-nothing (e.g. where the area covered would increase) can be screened out at this stage, although you will need to include the size of the expected increase in the summary Proforma D5.

Information sources for this type of information are again similar to those used when completing Proforma B. A flood defence strategy (if available) should provide a detailed description of what may happen under the do-nothing option in terms of potential flooding of the area. This may provide a useful indication of which features could be affected.

Proforma D2 is used to describe the impacts on those features that could be affected, with Proformas D3 and D4 related to habitats and species that could be affected. You will need one proforma D2, D3 or D4 for each feature, habitat and species that has been 'screened in' in Proforma D1.

Proforma D2: The impacts of do-nothing on key features	
Key feature:	
Question	**Description**
Would the feature be replaced by another feature?	
How close is the nearest similar feature?	
Could the original feature return over time?	

Proforma D3: The impacts of do-nothing on key habitats	
Key habitat:	
Question	**Description**
Would the habitat be replaced by another habitat?	
How close is the nearest similar habitat?	
Could the original habitat return over time?	

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	
Question	**Description**
Could the species relocate?	
How would this affect species distribution?	
Would other species move onto the site?	

To complete Proformas D2, D3 and D4 you will find it useful to have the following information:

- possible changes to the site in terms of the features, habitats and species that can inhabit it;
- proximity to other similar features, habitats and species that could provide alternatives to those affected (naturally or by re-creation); and
- whether you would expect the features, habitats and species to return over time or whether the nature of the site would be changed.

Additional information sources that may be helpful when completing Proformas D2, D3 and D4 includes:

- locations of nearby sites of conservation interest (both designated and non-designated, including any corridors along which species may migrate) from maps or reports collected for Proforma B;
- citations or descriptions of nearby sites;
- historical data such as journal articles or reports on changes in types of habitats/species present before, during and after floods. Useful sources may include:

- Environment Agency reports such as Baseline Ecological Surveys;
- Strategic Environment Assessments or Environmental Impact Assessments;
- articles/reports from local wildlife trusts, National Trust, etc.;
- transactions/proceedings of local Naturalists' Societies;
- reports/articles from local interest groups (birds, butterflies, botanists, etc.);
- anecdotal evidence from wardens or from discussions with people living in the area under consideration;

- species information provided in Annex 2 of this report; and
- similar cases that English Nature have already advised on.

It is important to remember when completing Proformas D2, D3 and D4 that, while sites may change, many of the current features, habitats and species may be able to adapt, may be able to move to other sites or may be replaced by other features, habitats and species. What you are looking to assess here is whether the expected changes are acceptable or not from a conservation viewpoint.

Proforma D5 is used as a summary of the results of Proformas D1 to D4 and should be used to record where and how much changes are expected. This proforma can be used to place in context the different scale of changes that are expected (e.g. record whether the key features, habitats and species highlighted as being impacted would face a large/small loss or gain). Only two boxes are given (large loss/gain and small loss/gain). This is because it is relatively easy to decide if a large (or total) loss is likely to occur compared with a small (or partial) loss, while deciding between different grades of losses would be very difficult, if not impossible at this stage.

Proforma D5: Summary of expected changes under do-nothing				
Large loss	**Small loss**	**No change (or insignificant)**	**Small gain**	**Large gain**

Finally, it is necessary to make a decision as to whether do-nothing is acceptable in terms of the conservation importance of the site. To decide, it will be necessary to weigh up what the changes mean in terms of conservation interest. You may wish to consider:

- whether biodiversity increases or decreases;
- whether the site is only viable in its current location, or whether it could be relocated elsewhere (either through natural migration, assisted migration or re-creation);
- whether new habitats would be created that are of greater conservation interest;
- whether the current features, habitats and species could adapt to the new conditions; and/or
- whether the current site is sustainable in its current location and/or whether changes are likely to occur that may reduce conservation interest over time even if the site is protected.

If the decision is 'yes' (the do-nothing option is acceptable from a conservation viewpoint), it is assumed that no flood defences are required and that do-nothing is the preferred option. If the answer is 'no', it is necessary to move onto Proforma E to identify what the appropriate

standard of defence may be. The decision and justification for it are recorded in Proforma D6.

Proforma D6: Is do-nothing acceptable?	
Is the do-nothing option acceptable?	
Justification	

When giving the justification, you may want to describe what the changes may be and why these are or are not acceptable. Sufficient information needs to be given that somebody else who is reading your assessment can understand why you have made that decision. This does not mean that everyone will necessarily agree with your decision, but you need to make sure that your argument is fully justified.

5.2.6 Proforma E: The appropriate standard of defence

Proforma E is used to assess what is the appropriate standard of defence. It is divided into a number of parts. The aim of the first part of Proforma E is to highlight those features, habitats and species that need to be protected. It is these features, habitats and species that will then be used to examine what the appropriate standard of defence may be.

Proforma E1 is based on the results of Proforma D5 as it requires identification of those features, habitats and species that need to be protected and should also be linked to the decision that the do-nothing option is not considered acceptable. Proforma E1 provides an option for protection in the long-term (i.e. where loss of the feature, habitat or species needs to be avoided wherever possible) and in the short-term (i.e. where gradual change to the new features, habitats and species is acceptable as sea level rises or the condition of the defences changes). You can also record any changes that may occur to features, habitats or species that do not necessarily need to be protected.

Proforma E1: Summary of features, habitats and species that need to be protected		
Need to be protected (long-term)	**Need to be protected (short-term)**	**Would be offset by changes to other features/habitats/species**
If all sites 'need to be protected (short-term)', does work need to be carried out on site? (If yes, complete proformas E2 to E6)		

If all of the habitats or species are included under 'need to be protected (short-term)' or 'would be offset by changes to other habitats or species', then it may not be necessary to continue the assessment. This is because sea level rise will result in a reduction in the standard of defence and, consequently, a gradual change to new features, habitats and species. If, however, the current defences need renewing and managed realignment is not considered acceptable now, you may need to consider what standard of defence may be appropriate in the short-term.

The final box in Proforma E1 can be used to record any additional survey or research work that may be required in order that a robust decision can be taken. This may include the need to survey land heights to assess if saltmarsh may be created or to look for the continued presence of a particular species of conservation importance in the area.

The next step is to consider the potential for flooding, how this would occur and how long the site may take to recover after a flood. There are five key factors in determining how catastrophic a flood is in terms of impacts upon the habitats. These factors are:

- floodwater velocity;
- area inundated;
- depth of floodwater;
- salinity of floodwater; and
- evacuation of floodwater.
- toxic contamination;
- nutrient enrichment.

Proforma E2 is used to record the expected 'catastrophicity' of a flood on the site. You will need to consider what you expect the effects of the flood to be by describing impacts across the five key factors. Information sources such as those listed for Proforma B and/or D2 are also likely to be useful here.

Proforma E2: The expected effects of a flood	
Five key factors	**Description of impacts**
Floodwater velocity	
Area inundated	
Depth of floodwater	
Quality of floodwater	
Evacuation of floodwater	

The next step is to consider what the expected 'catastrophicity' would mean in terms of the changes and time to recovery for the key features, habitats and species that would be affected. The features, habitats and species to consider are those that were highlighted as needing to be protected in the long or short term in Proforma E1. A description of the expected changes and an estimate of the time required for recovery should be recorded in Proforma E3. You will need to complete one Proforma E3 for each feature, habitat or species affected.

Proforma E3: The impacts of flooding			
Feature/habitat/species (from proforma E1)	**Factor**	**Description of expected changes**	**Time required for recovery**
	Floodwater velocity		
	Area inundated		
	Depth of floodwater		
	Quality of floodwater		
	Evacuation of floodwater		
Scale for qualitative descriptors of time required for recovery:			

When determining what timescale is appropriate, you should consider:

- changes in the physical and chemical conditions that could affect the suitability of the site as a habitat;
- the degree of connectivity with similar features/habitats that could provide sources of seeds or from which individuals could move onto the site; and
- the succession of plants, animals, etc. that would be required before a specific species could recolonise the site (e.g. is there a food source?).

The time required for recovery can be recorded as an approximate estimate in years if data are available or as 'short', 'medium' or 'long' to reflect time periods of (for example) less than 10 years, between 20 and 50 years, or around 100 years. It is important that you note what your timescale relates to if you use a qualitative descriptor (space is given for this in Proforma E3 – one timescale should be used for all features/habitats/species).

Useful data sources that may provide an indication of this type of information can often be found in 'local' literature. Transactions of local naturalists societies may be particularly useful and can usually be found in local libraries (particularly universities). Specific articles may also be available from the British Library, although you will need to know the dates of floods and whether any articles have been written following these floods. Annex 2 to this report provides a summary of information, including that taken from a number of sources including the Transactions of the Norfolk and Norwich Naturalists Society following a major flood in 1938 and articles on 'Wild Bird Protection in Norfolk' following floods in 1921, 1938, 1943 and 1949. While these articles provide an indication of the type of information that may be available, they also illustrate the time taken for a number of different species of flora and fauna to return after floods of different depths, and time before evacuation of floodwaters.

Proforma E4 considers whether there is a maximum standard of protection that may be required. This may occur where, for example, the site needs to be periodically flooded in order to maintain the features, habitats and species that are currently present. If this is the case, it is important to note in Proforma E4, otherwise, the site may be damaged by not being flooded often enough. You should also consider the five key factors described in Proformas E2 and E3 when completing Proforma E4. You may be able to obtain this information by considering the flood history of the site, the current status (whether favourable or not) and/or by comparing features, habitats and species present with those described in historical articles and reports (care should be taken when doing this, however, as much historical information can be anecdotal).

Proforma E4: Flooding requirements of site		
Feature/habitat/species (from proforma E1)	**Does site require periodic flooding?**	**If yes, what is maximum time between floods to maintain conservation value of site?**

Proforma E5 is then used to bring together the results of the assessment of the appropriate standard of defence. You should identify (i) the minimum estimated time to recovery and (ii) the maximum estimated time to recovery as described in Proforma E3 for each affected feature, habitat and species. At this point, you should also consider uncertainty in the estimated time for recovery. This may simply reflect a range applied to the time required for

recovery or the maximum time between floods, or could include consideration of the impact of uncertainty in the five key factors as described in Proformas E2 and E3.

Proforma E5: Summary of results				
Feature/habitat/species (from proforma E3)	**Minimum estimated time for recovery**	**Uncertainty (range of time for recovery)**	**Maximum estimated time for recovery (or time between floods)**	**Uncertainty (range of time for recovery)**

The final part of Proforma E is to consider which of the features, habitats and species are most important in determining the minimum and maximum time to recover (or time between floods). This gives an indication of what the appropriate standard of protection for the site may be. The results should be recorded in Proforma E6. Also included in Proforma E6 is a 'reality check'. This is where you have to ask yourself is this 'feels right' for the site. If not, you may need to go back to some of the assumptions made during the assessment and/or obtain additional information on the site that may help give you a result that does 'feel right'.

Proforma E6: Identifying the appropriate standard of defence			
Most important feature(s)/habitat(s)/ species	**Time (years) for recovery or between floods**		**Does this 'feel right' for the site having completed the assessment?**
	Minimum	**Maximum**	

5.2.7 Proforma F: The decision

Proforma F is used to provide a summary of the assessment and to highlight the decision that has been made. Although the question in Proforma F asks 'what is the recommended appropriate standard of defence for the site?', in most cases you will probably have a range taken from the minimum and maximum time for recovery given in Proforma E6. In almost all cases, a range would be most useful since it highlights uncertainty in the standard of defence that is considered appropriate and, therefore, is not too prescriptive in the recommendations.

Proforma F: What decision has been made?	
What is the recommended appropriate standard of defence for the site?	
Justification	

Like Proforma D6, detailed justification is required explaining why a particular decision has been taken. This is to ensure that anybody who is reviewing the assessment can understand the thought processes behind the decision. The key issue to remember when completing Proforma F is that your justification explains clearly why you have taken the decision and is backed up by the information included in Proformas A to E. Any uncertainties such as lack of data on particular issues can also be recorded here. This is important where decisions may be reviewed in the future, such that additional data that may have been collected can then be introduced to the assessment.

5.3 Worked examples

A series of case studies have been undertaken to aid the development of the approach and to test the methodology and guidance. The results of the case studies are described in Section 4. The completed proformas for each case study are provided in Annex 1 to this report. The case studies illustrate how the proformas can be used and highlight the flexibility that is inherent within them.

6 Suggested further studies

6.1 Introduction

To allow the assessments to be undertaken in an informed manner, it is necessary to collect a significant amount of information. Much of this information should be readily available, such as citations for sites, management history and relevant reports, particularly where flood defence strategies/schemes are being undertaken. Where possible, the Guidance Note includes reference to potential sources of information. However, not all information will be readily available at all times. This Section of the report highlights those areas where further studies may be required such that as much as possible of the required information is made available and the assessments made as robust as possible.

6.2 Further studies required

6.2.1 Undertaking the assessments

The first issue relates to how the assessments are to be undertaken. There are two possible approaches:

- assessment undertaken by one key person who then obtains comments on specific points, impacts and habitats/species from the relevant experts within English Nature (and potentially wider); or
- a team of experts is assembled to go through the assessment together.

There are advantages to both approaches. For example, one person assessing a site would be able to obtain information as they needed it and undertaken the assessment as and when the required data become available. They would then obtain comments on specific points such that the resources and elapsed time required to complete the assessment may be reduced. However, obtaining comments from experts independently may result in conflicts arising that cannot be resolved by the one person responsible for the overall assessment.

A team approach would allow direct discussion of conflicts and would help to resolve them by making the whole team aware of the wider issues. However, this approach is resource intensive, requires all of the required data to be available in advance and may present logistical difficulties.

At a workshop held in March 2004, the team approach worked well for the case study.

6.2.2 Assessing time to recovery

Annex 2 presents an initial indication of the type of information that may be available on the recovery of habitats and species after flood events. The Annex is not comprehensive nor is it searchable other than by the general or species names used to sort the list alphabetically. The type of information given in Annex 2 may be key data for use in deciding what the appropriate standard of defence may be for a particular site. In order to make this type of information more available and workable, three studies may be required:

- firstly, conversion of Annex 2 to a database system that can be made searchable by species name (common and scientific), more general terms (such as tree) and type of flooding incident. A database system would be particularly useful as it could be updated and improved as more data become available;
- secondly, a thorough trawl of the literature could provide additional data to populate the database. This may either take the form of a detailed literature review that would involve a search of as much as possible of published (and grey) literature. This may be expensive, however, in both time and resources. An alternative may be to populate the data as assessments are undertaken and new information unearthed. This will require (at least) the initial assessments delving into historical data sources; and
- thirdly, undertaking monitoring and survey work of areas that are flooded in the future would provide key information for the assessments. As well as areas that are flooded by extreme events, monitoring of realignment sites will also provide important data on the amount of time taken for saltmarsh to colonise and for conservation interest/biodiversity to increase. The impacts of flooding on the features, habitats and species present before realignment may also provide important data on the potential for natural or assisted migration.

6.2.3 Addressing uncertainty

The current approach is based on qualitative descriptions of impacts, supported by quantitative information, where available. One of the key aspects when estimating the appropriate standard of defence is the 'catastrophicity' of a flood. At present, the methodology requires five factors that determine 'catastrophicity' to be considered:

- floodwater velocity;
- area inundated;
- depth of floodwater;
- quality of floodwater; and
- time required for evacuation of floodwater.

The first three of these factors (velocity, area inundated and depth) are directly related to the size and location of a breach, or the volume of water entering the site as a result of overtopping and relates to the integrity of the defence to withstand a specific event. The size and location of a breach and/or overtopping can be presented in terms of risk, which itself incorporates both probability and consequence. Estimating the time required for recovery due to different types of floods could, therefore, be expressed in terms of risk and should make the assessment more rigorous, resulting in potential reductions in uncertainty.

A risk-based approach to identifying the 'catastrophicity' of a flood could be used to bring all five factors into account. This would involve estimation of the probability of a flood (through breaching and/or overtopping), plus additional categories to cover the change in quality of water and drainage of the site. Such an approach could use spreadsheet-based decision-trees to provide a simple model of the site and, thus, to generate a site-specific, risk-based estimate of 'catastrophicity' that would convert qualitative descriptions into quantitative data that would follow a consistent approach for all assessments.

6.2.4 Presenting and storing the results

The process of identifying appropriate standards is likely to develop over time as the methodology becomes more familiar and as the data required become more readily available. In the meantime, it will be important that assessments undertaken by EN staff are available to other staff as worked examples or EN case studies. The case studies undertaken by RPA (provided in Annex 1 to this report) illustrate the process and do not replicate the decisions that may be taken by EN. Thus, there is likely to be a need to make assessments completed internally available.

The best method for doing this may be to convert the proformas (currently in Word format) to Access where they can be completed and stored as a database. Such an approach will also make it easy to check for consistency of assessment. This, in turn, will improve the quality of the assessments and can be used as a basis for presentation of results to external parties and, potentially, for stakeholder involvement.

Annex 1: Completed assessments for each case study

A1.1 Case Study 1: Blakeney Freshes and Cley-Salthouse, North Norfolk

Proforma A: Identification of site and administrative details	
Site Name and Location	Blakeney Freshes and Cley-Salthouse, North Norfolk coast
Site/Project Identification Number	Case Study 1
Assessor	TF
Date Assessment Started	14-10-03
Data Sources	Halcrow (2002): **Blakeney Freshes Scoping Report.** Harris J & Driscoll R (2002): **Blakeney Freshes Flood Defences: Baseline Ecological Surveys: Aquatic Invertebrates.** Harris J (2002): **Blakeney Freshes Flood Defences: Baseline Ecological Surveys: Water Vole and Otter.** National Trust (nd): **Biological Survey – Blakeney Freshes, Norfolk.** University of Cambridge (1997): **North Norfolk Sea Defences: Cley to Kelling Environmental Investigation**, report to Environment Agency. English Nature (2002): **Cley-Salthouse Flood Management Scheme** , English Nature advice on Environmental Requirements. Environment Agency (2002): **Salthouse Flood Protection Flood Defence Option Review**, October 2002.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	Blockage of the tidal channel by movement of Blakeney Spit has occurred previously in 1953, 1978, 1991 and 1996. The 1996 event caused a near-complete blockage of the Glaven channel resulting in the Cley-Salthouse marshes being unable to drain the saline floodwaters that had occurred due to a breach of the frontline defences. The waters did not drain off the marshes for 3 to 4 weeks and the depth of flooding was up to 2m in some places. No significant fluvial flooding in the lower Glaven valley upstream of the tidal sluices occurred during the three weeks that the tidal channel was blocked.
	Current situation	Blakeney Spit is moving landwards at an average rate of 1m/year causing the shingle material to threaten to block the tidal River Glaven channel. If the channel becomes blocked, drainage of the Cley-Salthouse marshes and the fluvial River Glaven would be impeded causing flooding of the marshes and subsequent fluvial flooding upstream to property and infrastructure in the villages of Cley and Wiveton.
	Management for flood defence	Current management by the Environment Agency involves dredging the channel and reprofiling the shingle on Blakeney Spit following storm events.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Conservation Interest	Designations	Much of the freshwater marshes were reclaimed in the 17th century and now comprise freshwater meadows, small areas of reedbed and are dissected by a network of drainage ditches. They are protected from tidal inundation by earth embankments to the north, east and west and higher ground to the south. The whole area is part of the North Norfolk Coast SPA, North Norfolk Coast cSAC, North Norfolk Coast Ramsar site, North Norfolk Coast SSSI, Blakeney National Nature Reserve, North Norfolk Coast Biosphere Reserve and the Wash and North Norfolk Coast World Heritage Site (potential). The North Norfolk Coast is also designated as an Area of Outstanding Natural Beauty, Heritage Coast and Character Area.
	Key features	The following features qualify Blakeney Freshes for the North Norfolk Coast SSSI: rich diversity of aquatic and emergent plant communities; ditches of zoological interest with two nationally scarce plants; nationally important pastures for wintering and breeding birds; and birds of national interest in reedbed. The key features for Cley-Salthouse are: saltwater and freshwater marsh; large areas of reedbed; and grazing marsh with a variety of pools and scrapes. There is a general salinity gradient across the site.
	Key habitats	Freshwater grazing marsh, small wildfowling flight ponds, small area of brackish open water, areas of *Phragmites* reedbed, Other BAP habitats on the site: sea grass (*Zostera*) beds, shingle, saltmarsh, sand dune.
	Key species	Breeding populations of avocet, bittern, marsh harrier Other BAP species recorded on the site: skylark, reed bunting, linnet, grey partridge, otter, water vole Nationally scarce aquatic invertebrates: *Dysticus circumflexus* and *Helochares lividus*
	Management for conservation	Careful management of the site by the National Trust means that it currently holds favourable conservation status.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Other Key Factors	Historic environment	Blakeney Point is Geological Conservation Review site Blakeney Chapel SAM Black Joy Fort (possible site of star fort, built in 16th century – requires further investigation)
	Recreation	Blakeney & District Wildfowlers Association shoot over the Freshes both recreationally and commercially; Peddars Way and Norfolk Coast Path National Trail; Right of Way from north to south in western area of Blakeney Freshes; sailing clubs at Blakeney and Cley; Glaven Estuary used for swimming, sailing, motorboating, canoeing, angling, commercial boat trips.
	Economic factors	Blakeney Harbour Mussel Society holds a Severals Order for rights to mussel fishing in Blakeney Harbour. Grazing marshes are Grade 4 agricultural land Tourism
	Social factors	Property and roads within fluvial floodplain of River Glaven

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	260-280mm increase by 2080 for south-east England
	Extreme water levels	Extreme water levels with a 2% probability of occurrence predicted to increase to a 33% probability of occurrence by 2080 (medium to high greenhouse gas emission scenario).
	Tidal currents	May change due to change in bathymetry
	Wave direction	May change due to change in bathymetry
	Geomorphology	Altered wave patterns may alter areas of accretion and erosion with resultant adjustments to structure and distribution of coastal habitats
Other changes	Water quality	N/a

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)	Rich diversity of aquatic and emergent plant communities	Change from freshwater to intertidal saline habitats	Y
	Ditches of zoological interest with two nationally scarce plants	Change from freshwater to intertidal saline habitats with loss of soft hornwort (*Ceratophyllum submersum*) and brackish water crowfoot (*Ranunculus baudotii*)	Y
	Nationally important pastures for wintering and breeding birds	Change from freshwater to intertidal saline habitats; increased freshwater flooding through Blakeney Freshes may reduce feeding/breeding areas	Y
	Birds of national interest in reedbed	Considered under habitats (*Phragmites* reedbed)	-
Key habitats (from Proforma B)	Freshwater grazing marsh	Change from freshwater to intertidal saline habitats; impeded drainage in Glaven valley may increase area of freshwater marsh vegetation	Y
	Small wildfowling flight ponds	Considered under features (pastures)	-
	Small area of brackish open water	Increased flooding may increase salinity	Y
	Areas of *Phragmites* reedbed	Change from freshwater to intertidal saline habitats; impeded drainage in Glaven valley may increase area of reedbeds	Y
	Sea grass (*Zostera*) beds	Increase in tidal prism may result in some losses	N
	Shingle	Increase in tidal prism may result in some losses	N
	Saltmarsh	Increase in tidal prism may result in some losses	N
	Sand dune	Increase in tidal prism may result in some losses	N
Key species (from Proforma B)	Avocet	Considered under features (pastures)	-
	Bittern	Considered under habitats (*Phragmites* reedbed)	-
	Marsh harrier	Considered under features (pastures)	-
	Skylark	Considered under features (pastures)	-
	Reed bunting	Considered under features (pastures)	-
	Linnet	Considered under features (pastures)	-
	Grey partridge	Considered under features (pastures)	-

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
	Otter	Change from freshwater to intertidal saline habitats may affect food sources but does not breed on site only visiting for food and rest. Conversion to saltmarsh may limit the potential to support an expanding otter population	N
	Water vole	Change from freshwater to intertidal saline habitats may eliminate food sources	Y
	Dysticus circumflexus	Found in brackish water, may be lost as pools become saline (considered under brackish open water)	-
	Helochares lividus	Found in freshwater, slightly saline areas – may be lost from freshwater ditches due to saline flooding (considered under ditches of zoological interest)	-

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Rich diversity of aquatic and emergent plant communities
Question	**Description**
Would the feature be replaced by another feature?	Freshwater plants likely to be replaced by saltwater plants converting the area to saltmarsh. However, if water comes through or over the shingle ridge there may not be accretion of sediments which may prevent colonisation by saltmarsh plants.
How close is the nearest similar feature?	There are other grazing marshes and freshwater ditches nearby, but they may also be converted to saltmarsh in time
Could the original feature return over time?	Not likely under do-nothing
Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Ditches of zoological interest with two nationally scarce plants
Question	**Description**
Would the feature be replaced by another feature?	Ditches would become saline and would support salt tolerant plants
How close is the nearest similar feature?	There are other freshwater ditches nearby, but they may also be converted to saltmarsh in time
Could the original feature return over time?	Not likely under do-nothing
Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Nationally important pastures for wintering and breeding birds
Question	**Description**
Would the feature be replaced by another feature?	Saltmarsh would replace freshwater grazing marshes. Saltmarsh would offer breeding and overwintering habitats for many birds
How close is the nearest similar feature?	There are other grazing marshes nearby, but they may also become saline in time
Could the original feature return over time?	Not likely under do-nothing

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Freshwater grazing marsh
Question	**Description**
Would the habitat be replaced by another habitat?	Grazing marsh would be converted to saltmarsh and intertidal saline habitats
How close is the nearest similar habitat?	There are other grazing marshes nearby, but they may also be converted to saltmarsh in time
Could the original habitat return over time?	Not likely under do-nothing
Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Small area of brackish open water
Question	**Description**
Would the habitat be replaced by another habitat?	Likely to become more saline due to flooding of site, may become stagnant pool of saline water – study of invertebrates shows freshwater and oligosaline has highest species diversity, with diversity decreasing as water became more saline
How close is the nearest similar habitat?	?
Could the original habitat return over time?	Not likely under do-nothing
Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Areas of *Phragmites* reedbed
Question	**Description**
Would the habitat be replaced by another habitat?	Freshwater habitat would become saline and likely to be incorporated into saltmarsh
How close is the nearest similar habitat?	?
Could the original habitat return over time?	Not likely under do-nothing

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Water vole
Question	**Description**
Could the species relocate?	Potential to move upstream or to another site if suitable habitats are available (steep sided banks, no grazing of marginal vegetation, etc.). Individuals could also be introduced to compensatory habitat, but would require very detailed assessment of suitable recipient sites
How would this affect species distribution?	Unknown if other individuals are already present upstream
Would other species move onto the site?	Unlikely to be mammals, area may support young fish fry in ditches

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Freshwater grazing marshes	*Phragmites* reedbed	Shingle		Saltmarsh
Freshwater ditches	Brackish open water	Sand dunes		
Water voles		Sea grass (*Zostera*) beds		

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	**No**
Justification	Although Do-Nothing is likely to be the eventual outcome, there may be conservation benefits of protecting the site at present as it is in favourable conservation status. The preferred option would be to protect the site at present but allow a gradual change to saltmarsh. This may require additional works to ensure that some sedimentation occurs on the site to encourage colonisation by saltmarsh plants.

Proforma E1: Summary of Features, Habitats and Species that Need to be Protected		
Need to be Protected (Long-Term)	**Need to be Protected (Short-Term)**	**Would be Compensated by Changes to Other Features/Habitats**
	Freshwater grazing marshes Freshwater ditches *Phragmites* reedbed Brackish open water Water voles	
If all sites 'need to be protected (short-term)', does work need to be carried out on site? (If yes, complete Proformas E2 to E6)		Yes – tidal River Glaven needs to be realigned to avoid flooding. Some additional drainage work may be required for Cley-Salthouse to increase evacuation of floodwaters. Long-term protection of the site is likely to result in low lying land with a lower chance of developing saltmarsh in the future. Allowing the site to breach sooner will allow sedimentation to keep up with sea level rise.

Proforma E2: The Expected Effects of a Flood	
Five Key Factors	**Description of Impacts**
Floodwater velocity	Likely to be rapid as would be during storm conditions
Area inundated	Could extend beyond the area of grazing marsh
Depth of floodwater	Could be temporarily quite deep (>1m)
Quality of floodwater	Saline – flooding by seawater
Evacuation of floodwater	Most water will be evacuated from Blakeney Freshes on next low tide. Some saline water may be trapped in ditches and pools, however. Drainage of Cley-Salthouse may be much slower and saltwater may persist on site for several weeks.

Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma E1)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Freshwater grazing marshes	Floodwater velocity	Many plants may be scoured and removed from the site	Short
	Area inundated	Freshwater grazing marsh but there are similar habitats nearby that could provide seeds and individuals to recolonise site	
	Depth of floodwater	Any plants not scoured out may be drowned	
	Quality of floodwater	Saline water will kill off non-salt tolerant plants and may change the soil chemistry such that the time taken for recovery is increased; freshwater comes into the site from the River Glaven such that the south-east of the site may revert back to freshwater conditions first	
	Evacuation of floodwater	Standing water on the marshes may increase the time for recovery	
Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma D5)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Freshwater ditches	Floodwater velocity	Floodwaters are likely to be very fast flowing	Short
	Area inundated	All ditches on the site are likely to be affected but there are similar habitats nearby that could provide seeds and individuals to recolonise site	
	Depth of floodwater	Ditches may be filled (at least temporarily)	
	Quality of floodwater	Saline water will replace freshwater in the ditches; freshwater from the River Glaven enters the site from the south-east. Invertebrate study shows that sites with fluctuating salinity were much more species poor than freshwater sites	
	Evacuation of floodwater	Ditch network may help drainage at next low tide	

Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma D5)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Phragmites reedbed	Floodwater velocity	Floodwaters may scour reeds and underlying substrate	Short
	Area inundated	All reedbeds will be flooded but there are similar habitats nearby that could provide seeds and individuals to recolonise site	
	Depth of floodwater	Unlikely to be an issue	
	Quality of floodwater	Saline water will replace freshwater; freshwater from the River Glaven enters the site from the south-east	
	Evacuation of floodwater	Drainage from ditches may remove saltwater but salt deposits are likely to be left in soil	
Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma D5)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Brackish open water	Floodwater velocity	Floodwaters are likely to be very fast flowing	Very Short
	Area inundated	All areas of brackish open water will be affected	
	Depth of floodwater	Unlikely to be an issue	
	Quality of floodwater	Water will be saline rather than brackish, but inputs of freshwater from the River Glaven may help to re-establish a brackish water pool	
	Evacuation of floodwater	Water may stay in pool, with freshwater inputs required to change salinity	
Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma D5)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Water vole	Floodwater velocity	Floodwaters are likely to be very fast flowing and may drown some individuals (particularly if flooding is during the breeding season)	Short
	Area inundated	All areas will be affected resulting in loss of burrows and food source	
	Depth of floodwater	Could drown burrows	
	Quality of floodwater	Water will be saline killing off the food plants	
	Evacuation of floodwater	Drainage from ditches may remove saltwater but time is likely to be required before conditions return to those suitable for water voles	
Scale for qualitative descriptors of time required for recovery:		Very short: less than 2 years; short: 3-10 years; moderate: 10-25 years; long: 25-60 years; very long: >60 years	

Proforma E4: Flooding Requirements of Site		
Feature/Habitat/Species (from Proforma E1)	**Does Site Require Periodic Flooding?**	**If yes, what is maximum time between floods to maintain conservation value of site?**
Freshwater grazing marshes	No, freshwater inputs from rainfall, River Glaven and Catchwater Drain	-
Freshwater ditches	No, freshwater inputs from rainfall, River Glaven and Catchwater Drain	-
Phragmites reedbed	No, freshwater inputs from rainfall, River Glaven and Catchwater Drain	-
Brackish open water	No, freshwater inputs from rainfall, River Glaven and Catchwater Drain, saltwater inputs from seepage	-
Water vole	No	-

Proforma E5: Summary of Results				
Feature/Habitat/Species (from Proforma E3)	**Minimum Estimated Time for Recovery**	**Uncertainty (Range of Time for Recovery)**	**Maximum Estimated Time for Recovery (or Time Between Floods)**	**Uncertainty (Range of Time for Recovery)**
Freshwater grazing marshes	3	May increase in drainage of Cley-Salthouse is slower – could increase time to recovery	10	May increase in drainage of Cley-Salthouse is slower – could increase time to recovery
Freshwater ditches	3		10	
Phragmites reedbed	3		10	
Water vole	3		10	
Brackish open water	<2		2	

Proforma E6: Identifying the Appropriate Standard of Defence			
Most Important Feature(s)/Habitat(s)/ Species	**Time (years) for Recovery or Between Floods**		**Does this 'Feel Right' for the Site Having Completed the Assessment?**
	Minimum	**Maximum**	
Freshwater grazing marshes	3	10	Time could be closer to minimum due to proximity of other similar habitats nearby or greater if drainage is slow resulting in water logging of land.
Freshwater ditches	3	10	
Phragmites reedbed	3	10	
Water vole	3	10	

Proforma F: What Decision has been Made?	
What is the Recommended Appropriate Standard of Defence for the Site?	**Protect to 1 in 3 to 1 in 10 standard**
Justification	This is an important freshwater site and it would be advantageous in terms of biodiversity and conservation interest to protect it in the short term to allow a gradual change to a more saline and then saltmarsh environment. This would provide time for migration of species to nearby sites. Protection in the longer term is unlikely to be sustainable or cost-effective as the costs of providing defences would become increasingly prohibitive. Allowing the standard of defence to decline with eventual managed realignment will allow sedimentation on the site and should help to encourage saltmarsh colonisation. Protection to a higher standard may also mean that the site becomes too low lying for saltmarsh to develop.

A1.2 Case Study 2: Lewes Brooks

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Lewes Brooks, just south of Lewes, Sussex
Site/Project Identification Number	Case Study 2
Assessor	TF
Date Assessment Started	5-11-03
Data Sources	Binnie, Black & Veatch (2002): Sussex Ouse Flood Defence Strategy Study: Strategic Environmental Assessment, Stage 1 – Environment Scoping Study. Peter Brett Associates (1998): Lewes Brooks Water Level Management Plan, Consultation Document for the Environment Agency, April 1998. Binnie, Black & Veatch (2002): Project Appraisal Report: Sussex Ouse Flood Management Strategy, for the Environment Agency. Binnie, Black & Veatch (2002): Economic Assessment of the Development of a Wetland/Intertidal Habitat at Lewes Brooks, Appendix I, Sussex Ouse Management Strategy.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	Significant flood occurred on 12 October 2000, which caused significant damage to Uckfield, Lewes, surrounding rural properties and the farming community. A review indicated this to be a 1 in 200 year event.
	Current situation	Main protection is the River Ouse flood embankments which prevent inundation from the tidal River Ouse. Flood banks are currently in a poor state of repair.
	Management for flood defence	Flood defence management works include weedcutting, dredging and grass cutting on the banks of the tidal River Ouse, plus the maintenance of structures and operation of the Rodmell Pumping Station. The Rodmell Pumping Station drains some 800 ha of the internal drainage area plus a further 1,130 ha of upland catchment. The pump is considered to be very unsatisfactory by landowners – it is very old and has become somewhat unreliable.
Conservation Interest	Designations	SSSI adjacent to River Ouse, 333 ha
	Key features	Wide diversity of invertebrates with water beetles (*Coleoptera*) particularly well represented. Also several rare snails, flies and moths. Ditches cutting through the alluvium vary in salinity from fresh spring fed ditches to brackish water. This variation provides a mosaic of habitats. Within the South Downs Area of Outstanding Natural Beauty.
	Key habitats	Covered in features

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
	Key species	*Haliplus mucronatus* – found in ditches draining arable fields – only locality in south east England.
	Management for conservation	Large parts of Lewes Brooks has been converted to arable land use, the ditches and remaining grassland are of importance for wetland plants, invertebrates and birds. Farmers in the north have drained their fields to a greater extent and have now become reliant on the low water levels for arable production. Farmers to the south generally operate the land as pasture and require higher water levels to provide feed water for livestock and wet fencing. The area is within the Sussex Downs ESA with some graziers taking advantage of payments under this scheme. 226 ha are arable land; 205 ha improved grassland and 111 ha grassland (including semi-improved grassland). The increased intensity of agriculture in some parts of the SSSI has led to a deterioration of the conservation value of the site. In some areas, the scientific interest has fallen below the threshold for notification.
Other Key Factors	Historic environment	None known
	Recreation	None known
	Economic factors	Landowners in the central portion of the site have indicated that they are opposed in principle to the raising of water levels within the ditches. Area includes short length of overhead electricity line.
	Social factors	Village of Rodmell 1847 Act of Parliament to prevent flooding to Parish of Southease

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	Rising sea levels will increase potential for breach in bank protecting Lewes Brooks and may make them unsustainable. Increase of 6mm/year expected.
	Extreme water levels	Predicted increase in flows by 20% (due to increase in median maximum daily winter precipitation and runoff).
	Tidal currents	None known
	Wave direction	None known
	Geomorphology	Settlements of banks protecting Lewes Brook will increase potential for breach/overtopping and risk of failure will increase rapidly.
Other changes	Water quality	N/a

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)	Wide diversity of invertebrates with water beetles (*Coleoptera*) particularly well represented. Also several rare snails, flies and moths.	Breach expected by year 3 without maintenance. Likely that diversity of invertebrates would decrease due to increasing salinity in the ditches.	Y
	Ditches cutting through the alluvium vary in salinity from fresh spring fed ditches to brackish water. This variation provides a mosaic of habitats.	Ditches would become much more saline reducing the variation in habitats.	Covered by above feature
	Within the South Downs Area of Outstanding Natural Beauty	Change in landscape as freshwater area is replaced by intertidal habitat.	Y
Key habitats (from Proforma B)		No specific habitats considered – included in features above	-
Key species (from Proforma B)	*Haliplus mucronatus*	Loss of habitat would result in loss of this beetle from the area (its only known location in south east England).	Y

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Wide diversity of invertebrates with water beetles (*Coleoptera*) particularly well represented. Also several rare snails, flies and moths. Ditches cutting through the alluvium vary in salinity from fresh spring fed ditches to brackish water. This variation provides a mosaic of habitats.
Question	**Description**
Would the feature be replaced by another feature?	Diversity would reduce due to reduction in variety of habitats and increasing salinity in ditches. Species preferring saline conditions such as fennel pondweed (*Potamogeton pectinatus*), spiked water milfoil (*Myriophylum spicatum*), alga (*Enteromorpha intestinalis*), sea club rush (*Scripus maritimus*) and glaucous bulrush (*Schoenoplectus tabernaemontani*) would increase their range. Invertebrates preferring saline conditions would also increase in range. Land would revert to saltmarsh and mudflat. Freshwater springs feeding in from the west would retain some freshwater/brackish habitats, but the areas would reduce.
How close is the nearest similar feature?	Offham Marshes (about 4-5km to the north) contains freshwater ditches and poorly drained fields which support dragonflies (including *Brachytron pratense* – hairy dragonfly), beetles (including *Hydrophilus piceus* – great silver beetle) and flies. Lewes Railway Land Meadows (just to the north of Lewes Brooks) includes ditches which contain 11 Nationally Notable water beetles, including *Haliplus mucronatus* and is described as 'developing into very good aquatic habitats indeed'.

Proforma D2: The Impacts of Do-Nothing on Key Features	
Could the original feature return over time?	No – do-nothing would result in frequent flooding with saline water, although freshwater springs from the west could result in brackish water habitats in the ditches near to the springs.

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Within the South Downs Area of Outstanding Natural Beauty
Question	**Description**
Would the feature be replaced by another feature?	Freshwater SSSI, grazing pasture and arable land would be converted to saltmarsh which could be considered to improve the visual amenity of the area.
How close is the nearest similar feature?	N/a – relates to landscape issues
Could the original feature return over time?	No, the area would be converted to saltmarsh/mudflat.

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	None – considered in features
Question	**Description**
Would the habitat be replaced by another habitat?	N/a
How close is the nearest similar habitat?	N/a
Could the original habitat return over time?	N/a

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	*Haliplus mucronatus* – rare beetle
Question	**Description**
Could the species relocate?	Yes, if suitable habitats are available.
How would this affect species distribution?	Would be lost from this location but has been found in Lewes Railway Land Meadows (just to the north of Lewes Brooks). This area includes ditches which contain 11 Nationally Notable water beetles, including *Haliplus mucronatus* and is described as 'developing into very good aquatic habitats indeed'.
Would other species move onto the site?	Other invertebrates that prefer more saline conditions would move into the area

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Freshwater ditch habitats and associated invertebrates	Brackish water ditch habitats and associated invertebrates	-	Saline ditch habitats	Saltmarsh, mudflat habitats

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	Yes
Justification	Although there would be some loss of freshwater and brackish water habitats, the conservation status of the area has deteriorated somewhat due to the amount of drainage that has been undertaken. The change to saltmarsh/mudflat habitat would greatly increase the extent of intertidal areas and could provide some flood defence benefits to the town of Lewes (upstream). The area is also likely to become important for bird habitats and could attract a considerable number of visitors. Freshwater springs to the west of site will retain some of the salinity gradients in the ditches and there are alternative sites nearby (notably Lewes Railway Land Meadows and Offham Marshes) that would provide alternative habitats for the rare flies and beetles. The rare snails could be accommodated to some extent in the remaining brackish water ditch habitats.

A1.3 Case Study 3: Tinkers Marsh

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Tinkers Marsh, Blyth Estuary, Suffolk
Site/Project Identification Number	Case Study 3
Assessor	TF
Date Assessment Started	6-11-03
Data Sources	Black & Veatch (2003): **The Implications of a 'Do Nothing' Option at Blyford Bridge to Blythborough Bridge (above the A12) and Tinkers and Reydon Marshes, Blyth Estuary PARs, June 2003.**

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	Flooding has occurred regularly over the last 30 years following failure of the defences during storm conditions.
	Current situation	Defences recorded as being in poor condition in a defence condition survey in 1999. An asset survey in 2001 rated Tinkers Marsh as being of urgent priority, with the frontage under significant stress.
	Management for flood defence	Not known
Conservation Interest	Designations	Tinkers Marsh forms part of the Minsmere-Walberswick Heaths and Marshes SPA.
	Key features	Swamp, marginal and inundation, standing water, grassland, coastal lagoons, marsh and heathland which provide important habitats for avocet, bittern, marsh harrier, nightjar and hen harrier. Also provides important habitats for little tern (shingle and shallow coastal waters) and migratory bird species: gadwall, teal, shoveler, European White-fronted goose (grassland, marsh and standing water).
	Key habitats	Saltmarsh
	Key species	Narrow-mouth whorl snail (*Vertigo angustior*) expected to be present within Tinkers Marsh. Marsh, hen harriers. Bittern.
	Management for conservation	Not known
Other Key Factors	Historic environment	Not known
	Recreation	Not known
	Economic factors	Not known
	Social factors	Not known

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	The defences are already in a poor condition and will require continued and increasing effort to maintain them in the future.
	Extreme water levels	Not known
	Tidal currents	Not known
	Wave direction	Not known
	Geomorphology	Increased pressure on sea defences may encourage a breach at other sites, including Reydon Marshes.
Other changes	Water quality	Not known

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)	Swamp, marginal and inundation, standing water, grassland, coastal lagoons, marsh and heathland which provide important habitats for avocet, bittern, marsh harrier, nightjar and hen harrier. Also provides important habitats for little tern (shingle and shallow coastal waters) and migratory bird species: gadwall, teal, shoveler, European White-fronted goose (grassland, marsh and standing water).	If a breach were to occur, the land behind the defences would be completely inundated due to its low level. This could also increase pressure on the opposite bank, encouraging a breach in the Reydon marshes flood defences. Grazing marsh, standing water, reedbeds and saltmarsh islands and fringing saltmarsh likely to be affected as a result of saltwater incursion and flooding inundation and/or erosion due to increased scour.	Y
Key habitats (from Proforma B)	Saltmarsh	Could be improved due to increased area available or could be reduced due to increased scour and erosion.	Y
Key species (from Proforma B)	Narrow-mouth whorl snail (*Vertigo angustior*) expected to be present within Tinkers Marsh.	Loss of grazing marshes and brackish margins may result in loss of habitat and, hence, loss of the snail from this area.	Y
	Marsh harrier, hen harrier	Reduction in food availability due to reduction in extent of area suitable for small-medium sized mammals might mean that this species would relocate elsewhere.	Y
	Bittern	Reduction in food availability due to increase in salinity killing fish might mean that this species would relocate elsewhere	Y

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Swamp, marginal and inundation, standing water, grassland, coastal lagoons, marsh and heathland which provide important habitats for avocet, bittern, marsh harrier, nightjar and hen harrier. Also provides important habitats for little tern (shingle and shallow coastal waters) and migratory bird species: gadwall, teal, shoveler, European White-fronted goose (grassland, marsh and standing water).
Question	**Description**
Would the feature be replaced by another feature?	Flow in and out of the breach could mean that settlement of sediment is unlikely to occur and therefore intertidal habitat will not readily develop through accretion. Scour of the flooded area could be encouraged. Realignment would also cause an increase in the tidal prism which could have a big impact at the mouth of the river, creating pressure to widen but there are not expected to be any upstream effects. The invertebrates at the site would change to those preferring saline conditions, with knock-on changes to the bird population due to reduction in food availability. Replacement with mudflat or prolonged periods of inundation is unlikely to result in alternative food sources. Loss of high tide roosts may also occur.
How close is the nearest similar feature?	Numerous other sites of similar habitat types within local area, but no way for key features to move inland such that the overall area of these habitats is likely to be reduced.
Could the original feature return over time?	No – area would either be converted to intertidal habitat or be scoured.

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Saltmarsh
Question	**Description**
Would the habitat be replaced by another habitat?	Erosion of saltmarsh is currently taking place; do-nothing could help to offset this by increasing the area of intertidal habitat. However, it is uncertain as to whether accretion would take place and the area may be converted to mudflat and/or be inundated for prolonged periods.
How close is the nearest similar habitat?	Saltmarsh exists within the Blyth Valley, but is currently being eroded. However, this could provide a source of seeds for colonising saltmarsh plants which, if they become established, could help increase accretion by trapping sediment.
Could the original habitat return over time?	Area of saltmarsh will increase.

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Marsh harrier, hen harrier
Question	**Description**
Could the species relocate?	Loss of food would mean the harriers would have to relocate. Loss of reedbeds due to saline intrusion could also reduce areas for nesting and cover.
How would this affect species distribution?	Birds would have to move off site unless higher saltmarsh is created that could support small-medium sized mammals.
Would other species move onto the site?	Birds feeding on mudflats and saltmarsh (if created) would move into the area. Higher saltmarsh could also provide roosting sites.

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Bittern
Question	**Description**
Could the species relocate?	Reedbeds in nearby Delacroix Marshes have deteriorated due to saline intrusion. Bitterns would require alternative reedbeds for nesting and cover.
How would this affect species distribution?	Alternative habitats would have to be found, particularly for nesting and cover.
Would other species move onto the site?	Birds feeding on mudflats and saltmarsh (if created) would move into the area. Higher saltmarsh could also provide roosting sites.

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Narrow-mouth whorl snail (*Vertigo angustior*) expected to be present within Tinkers Marsh.
Question	**Description**
Could the species relocate?	Prefers high saltmarsh areas so could relocate if these become available on the site. Creation of new saltmarsh may provide additional habitat.
How would this affect species distribution?	Could be concentrated in a small area.
Would other species move onto the site?	May not be necessary, alternative habitats may be created on site.

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Swamp, marginal and inundation, standing water, grassland, coastal lagoons, marsh and heathland Marsh harrier, hen harrier, bittern Birds feeding on grazing marsh (including gadwall, shoveler, teal, white-fronted goose)	Saltmarsh (if erosion is increased due to change in tidal prism)	Habitat for *V. angustior*	-	Mudflat Saltmarsh (if accretion occurs on the Tinkers Marsh site) Birds feeding on mudflat/saltmarsh

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	**No – due to uncertainty as to what habitats would be created (if any)**
Justification	The potential for creation of saltmarsh/mudflat habitats as replacement for the grazing marsh, etc. is highly uncertain. More work needs to be undertaken to determine if saltmarsh would be created on the site. Without the creation of new saltmarsh areas, the area could be inundated for prolonged periods and may result in a net loss of habitats and feeding grounds, particularly for birds. If it is shown that saltmarsh could develop over time and if suitable alternative habitats (e.g. reedbeds) are available for bitterns and marsh harriers do-nothing would become the acceptable option.

Proforma E1: Summary of Features, Habitats and Species that Need to be Protected		
Need to be Protected (Long-Term)	**Need to be Protected (Short-Term)**	**Would be Compensated by Changes to Other Features/Habitats**
	Feeding areas for birds and habitats for invertebrates, small mammals	Unknown/uncertain
If all sites 'need to be protected (short-term)', does work need to be carried out on site?	Research needs to be undertaken to determine whether saltmarsh could be created on site. This will need to consider the height of the land and number of inundations expected per year. Also important will be the availability of seeds for colonising saltmarsh plants that could help increase the rate of accretion.	

A1.4 Case Study 4: Cantley Marshes

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Cantley Marshes, Norfolk
Site/Project Identification Number	Case Study 4
Assessor	TF
Date Assessment Started	6/11/03
Data Sources	George M (1996): **The Aquatic Flora of the Cantley Level Dyke System**. Kindleysides D (1993): **The Flooding of the Cantley Level in 1993: Monitoring the Effects of Saline Intrusion on the Aquatic Dyke Flora in an Area of Broadland Grazing Marsh**. Drake CM (2002): **A Survey of the Aquatic Molluscs and Beetles of the Yare Valley, 2001**, report for the Broads Authority.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	Bank breached and 1953 and 1963. Breached again in March 1968. East Suffolk & Norfolk River Authority said the breach was 321ft (98m) long (3rd Annual Report, 1968). A level of 5.08ft (1.55m) was recorded at Hardley Dyke. The bank breached again in January 1976 and February 1993. The 1993 event resulted in both overtopping and breaching, with the entire Level flooded to a mean depth of over a metre with water whose salinity ranged from 30% to 47% seawater. Prior to flushing of the Level with water drawn from the river, the conductivity was measured as 24,000 µS/cm. Floodwaters remained on the site for three weeks until the water level on the marsh was pumped as low as possible. River water was flushed through the marsh three times to remove residual salt. After the third flushing, the conductivity had reduced to 2000-3000 µS/cm.
	Current situation	Not known
	Management for flood defence	Not known
Conservation Interest	Designations	Cantley Marshes SSSI, Broadland Ramsar site, part of Broadland SPA and The Broads cSAC.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
	Key features	Highly varied and species-rich aquatic flora in dykes including two nationally rare species: *Potamogeton acutifolius* and *Chara connivens*; three nationally scarce species: *Myriophyllum verticillatum*, *Potamogeton trichoides* and *Stratiotes aloides*. The flora of almost every dyke is different from that of the others. Conductivity of the dykes is variable, but had fallen back to 1980s levels in most places by August 1996 (3.5 years after the 1993 flood). The variation of salinity across the site is gradual.
	Key habitats	Covered in features
	Key species	*Oxyloma sarsi* (rare mollusc) was found in two locations, generally with low covers of emergent vegetation. *Gyrinus paykulli* (whirligig beetle) found in ditches with high conductivity (more than 1000 µS/cm), much open water (>70%), little floating vegetation and in ditches that had not been cleaned for a little while. *Hydraticus transversalis* (water beetle) well grazed, poached margins frequently with a shelf; preference for ditches with less emergent vegetation and a greater amount of open water. This species is scarce in the east. *Peltodytes caesus* (water beetle) present in ditches with low cover of emergent, floating and raft vegetation, high cover of submerged vegetation and considerable open water.
	Management for conservation	The diversity of aquatic flora is dependent on three factors: dyke morphology (water depth, angle and slope of margins); major ion concentration of the water in the dyke (alkalinity, pH and chloride concentration); and trophic status (amount of nutrients (N and P) available to plants growing in it). Damming of the soke dyke prevents nutrient-rich, brackish water entering the main dyke system of the Level. Dyke management including weedcutting and-slubbing. Dykes cleared on an approx. five yearly rotation.
Other Key Factors	Historic environment	Not known
	Recreation	Not known
	Economic factors	Not known
	Social factors	Not known

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	Estimated sea level rise based on 6mm/yr at Yarmouth is 1 mm/yr at Reedham. This is likely to increase salinity of river water and, hence, salinity of water on the site.
	Extreme water levels	Not known
	Tidal currents	Not known
	Wave direction	Not known
	Geomorphology	Not known
Other changes	Water quality	Increased nutrient content of water in the dykes may be as important to the types of aquatic communities found as infrequent saline flooding.

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)	Highly varied and species-rich aquatic flora in dykes	Flooding of the site will introduce nutrient rich water from the River Yare and/or saline water during tidal surges. The survey in 1994 (following the 1993 flood) showed that 77% of dykes showed end-group degradation. All but two of the dykes declined to eutrophic/brackish communities with almost half degrading to A7a, mainly from A2, A5a and A5b. Another main pathway of degradation was from A4 to A5b.	Y
Key habitats (from Proforma B)		Covered in features	-
Key species (from Proforma B)	Water beetles	Covered in features above	N

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Highly varied and species-rich aquatic flora in dykes
Question	**Description**
Would the feature be replaced by another feature?	Monitoring after the flood of 1993 showed that the more botanically valued mesotrophic and mesoeutrophic communities were only occasional. The eutrophic and brackish water communities were dominant. Brackish communities would increase at the expense of end-groups A1, A2 and A3a. A4 would be expected to reduce and A5a and A6 could be totally lost. A4, A5a and A6 are significantly less frequent throughout Broadland in comparison to A5b. Overall, over half of the species recorded before the flood had declined together with decreasing species cover for a smaller number of species. This left a high proportion of macrophyte poor and algae dominated communities throughout the level.

Proforma D2: The Impacts of Do-Nothing on Key Features	
How close is the nearest similar feature?	Proximity of similar end-group distributions not known but likely to be upstream due to increasing salinity downstream.
Could the original feature return over time?	The reduction of salinity showed that, in 1996, 6 out of 10 end-groups were present on the site including the botanically valuable A2 and A5a (this compares with 8 end-groups in 1994 suggesting that the dykes had become more nutrient enriched). Most species were still present on the marsh after the 1993 flood which suggests they could recover given sufficient time and a reduction in salinity.

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Aquatic flora in end-groups A1, A2, A3, A5a and A6 – the botanically most valuable end-groups Overall reduction in number of species and, hence, biodiversity Knock-on impacts on molluscs and water beetles	Aquatic flora in end-group A4	-	Increase in end-groups preferring brackish water conditions.	-

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	**No**
Justification	Diversity of aquatic flora would reduce, with the most botanically valuable species being lost from the site completely. These may be replaced by species preferring brackish water conditions, but overall diversity would reduce with around half of species disappearing. However, salinity in the ditches is increasing already due to sea level rise. Nutrient levels are also increasing such that some loss of species is already occurring. This indicates that the site is not sustainable in the long-term.

Proforma E1: Summary of Features, Habitats and Species that Need to be Protected		
Need to be Protected (Long-Term)	**Need to be Protected (Short-Term)**	**Would be Compensated by Changes to Other Features/Habitats**
-	Ditches with low salinity and low nutrient levels to provide habitat for botanically valuable species of aquatic flora.	-
If all sites 'need to be protected (short-term)', does work need to be carried out on site?	Continued maintenance is required; actions to reduce salinity and nutrient levels are likely to be outside the control of the site managers such that gradual changes will occur to the dyke flora and fauna.	

Proforma E2: The Expected Effects of a Flood	
Five Key Factors	**Description of Impacts**
Floodwater velocity	Not known
Area inundated	The 1993 flood inundated the whole site.
Depth of floodwater	Not known
Quality of floodwater	Salinity of water in 1993 was 30-47% seawater.
Evacuation of floodwater	Floodwaters remained on the site for three weeks but the site was then flushed with river water to reduce the salt content.

Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma E1)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Highly varied and species-rich aquatic flora in dykes	Floodwater velocity	Not known	-
	Area inundated	Whole area would be affected	Short
	Depth of floodwater	The main issue is that dykes would be filled with nutrient rich and/or seawater	Short
	Quality of floodwater	Water is likely to be saline changing the area from freshwater/brackish to brackish. Without flushing with freshwater, recovery of the dyke flora is likely to take considerably longer than after the 1993 event.	Moderate without flushing – possibly long
	Evacuation of floodwater	Water likely to remain on site for a considerable length of time.	Short
Scale for qualitative descriptors of time required for recovery:		Short: less than 3 years; moderate: 3-10 years; long: >10 years	

Proforma E4: Flooding Requirements of Site		
Feature/Habitat/Species (from Proforma E1)	**Does Site Require Periodic Flooding?**	**If yes, what is maximum time between floods to maintain conservation value of site?**
-	No – aquatic flora require certain trophic and management conditions as much as high summer water levels	-

Proforma E5: Summary of Results				
Feature/Habitat/Species (from Proforma E3)	**Minimum Estimated Time for Recovery**	**Uncertainty (Range of Time for Recovery)**	**Maximum Estimated Time for Recovery (or Time Between Floods)**	**Uncertainty (Range of Time for Recovery)**
Highly varied and species-rich aquatic flora in dykes	3 years (based on 1993 flood)	10 years (without flushing of saline water from dykes, recovery of freshwater species unlikely to occur)	>10 years	Recovery may not occur due to changing salinity of dykes – brackish water aquatic flora are likely to dominate

Proforma E6: Identifying the Appropriate Standard of Defence			
Most Important Feature(s)/Habitat(s)/ Species	**Time (years) for Recovery or Between Floods**		**Does this 'Feel Right' for the Site Having Completed the Assessment?**
	Minimum	**Maximum**	
Highly varied and species-rich aquatic flora in dykes	3	>10	Current standard is probably about right (from flood history this seems to be about 1 in 10 years). The changing salinity (and nutrient levels) of the dykes suggests that the current communities are not sustainable and a gradual change to more brackish water/eutrophic end-groups is likely. Maintenance of the defences to allow the botanically valuable plants to continue to live on the site is unlikely to be sustainable. It is unclear whether similar habitats (freshwater, low nutrient levels) are available upstream but it is inevitable that the freshwater species will be lost on the site even with maintenance.

Proforma F: What Decision has been Made?	
What is the Recommended Appropriate Standard of Defence for the Site?	**Protect to 1 in 3 to 1 in 10 standard (short-term)**
Justification	Potential loss of botanically valuable aquatic flora may not be compensated elsewhere such that biodiversity would be reduced. Protection in the short-term will allow other sites to be found where the botanically valuable species requiring freshwater and low nutrient levels could be moved. Over time, the site is not sustainable as salinity levels and nutrient levels are both increasing. Therefore, protection of the site to a higher standard is unlikely to protect the valuable species currently present on the site.

A1.5 Case Study 5: Selsey to Bracklesham Sea Defence

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Selsey to Bracklesham Sea Defences, West Sussex
Site/Project Identification Number	Case Study 5
Assessor	JA
Date Assessment Started	November 2003
Data Sources	Posford Duvivier (2001): **Pagham to East Head Coastal Defence Strategy**, Final Report. Environment Agency (2002): **Selsey to Bracklesham Sea Defence Ecological Surveys**

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	No detailed record of flooding has been found. Breaching of the defence and inundation of the low lying area has occurred 10 times since 1994.
	Current situation	The shingle bank is maintained to about a 1 in 1 year standard against breaching by importing and dozing shingle on an annual basis. The cost of this operation is estimated to be in the region of up to £500,000 per year.
	Management for flood defence	Profile of shingle bank and timber groynes are maintained annually.
Conservation Interest	Designations	SSSI (202ha)
	Key features	Low lying fields inland, the shingle ridge, intertidal zone on seaward side of ridge (deposits of high geological interest).
	Key habitats	Unimproved coastal grassland subject to seasonal flooding, shingle ridge, saltmarsh (small amount)
	Key species	Grasses associated with the unimproved pasture (red fescue, sea couch, creeping bent, sweet vernal grass). Evidence of Water Voles in Broad Rife to rear of shingle ridge but mainly at either end. Lapwing (10% Sussex population but reducing), snipe, ringed plover, redshank breeding. Brent geese, teal, golden plover, ruff, pintail, wigeon, over-wintering and exceptional numbers of short eared owls.
	Management for conservation	Not known
Other Key Factors	Historic environment	Not known
	Recreation	Large holiday parks on either side of SSSI
	Economic factors	Some properties protected by ridge
	Social factors	Not known

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	Estimated to be 300mm over next 50 years
	Extreme water levels	Presently: +4m ODN for 1 in 200 year event. MHWS 2.4m, with potential for increasing
	Tidal currents	Parallel to shore. Change not known
	Wave direction	No significant change expected
	Geomorphology	Natural budget of shoreline sediments is negative and will continue as sea level rises
Other changes	Water quality	Ditches become more saline as sea level rises

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)	Intertidal zone	Lowering and widening of beaches	Y
	Shingle Ridge	Shingle ridge would be flattened and moved inland by storms	Y
	Low lying land adjacent to coast	Low lying land flooded on an annual basis Intermittent flooding of surrounding higher land	Y
Key habitats (from Proforma B)	Saltmarsh	Existing saltmarsh eroded	N
	Shingle	Forms natural shingle bank	Y
	Unimproved grassland	Flooded on a regular basis	Y
Key species (from Proforma B)	Grasses	Flooded regularly (but less regularly around the perimeter of area where ground is higher)	Y/N
	Water Voles	Main habitat in Broad Rife will be lost	Y
	Breeding birds	Part of area may be flooded in breeding season	Y
	Over-wintering birds	Part of area may be flooded during winter	Y

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Intertidal Zone
Question	**Description**
Would the feature be replaced by another feature?	Clay would become exposed and could lead to conditions that do not assist deposition of sand and shingle
How close is the nearest similar feature?	Selsey Bill, East Head
Could the original feature return over time?	Unlikely unless rate of transport of sand /shingle increases
Key Feature:	Shingle Ridge
Question	**Description**
Would the feature be replaced by another feature?	Lower and wider shingle ridge moving inland
How close is the nearest similar feature?	Not certain about location of nearest similar feature. Possibly in Pagham beach.
Could the original feature return over time?	Existing feature is maintained by human intervention and therefore would not return to original feature

Key Feature:	Low lying grassland
Question	**Description**
Would the feature be replaced by another feature?	Most of low-lying grassland would be inundated on a regular basis and replaced by saltmarsh.
How close is the nearest similar feature?	Not certain about location of nearest similar feature. Possibly in West Wittering.
Could the original feature return over time?	No, original feature is man made by maintaining defence

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Saltmash
Question	**Description**
Would the habitat be replaced by another habitat?	Unlikely
How close is the nearest similar habitat?	Chichester Harbour, Pagham Harbour
Could the original habitat return over time?	Yes, but inland
Key Habitat:	Shingle
Question	**Description**
Would the habitat be replaced by another habitat?	Shingle ridge would move inland but in changed form i.e. flatter and more extensive
How close is the nearest similar habitat?	Not certain about location of nearest similar feature. Possibly in Selsey Bill.
Could the original habitat return over time?	No (it would require shingle to naturally recharge the bank)
Key Habitat:	Unimproved grassland (but in poor condition)
Question	**Description**
Would the habitat be replaced by another habitat?	Yes, saltmarsh on low lying areas
How close is the nearest similar habitat?	West Wittering (but not so extensive)
Could the original habitat return over time?	No

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Grasses
Question	**Description**
Could the species relocate?	Yes, to edges of flooded area
How would this affect species distribution?	May be constrained as it is would be relocated to a smaller area with a different gradient (at the edge)
Would other species move onto the site?	Yes, saltmarsh species

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Water Voles
Question	**Description**
Could the species relocate?	Probably yes, to ditches at edge of saltmarsh
How would this affect species distribution?	May reduce numbers which are of County significance
Would other species move onto the site?	Yes, birds and flora on saltmarsh
Key Species:	Breeding birds
Question	**Description**
Could the species relocate?	Yes, to edge of saltmarsh or other similar habitats nearby
How would this affect species distribution?	Could reduce numbers as it is a smaller area
Would other species move onto the site?	Yes
Key Species:	Over-wintering birds
Question	**Description**
Could the species relocate?	Yes
How would this affect species distribution?	Not known
Would other species move onto the site?	Yes

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Grassland	Intertidal habitat Breeding birds Water Voles	Over-wintering birds Shingle habitat	-	Gain in saltmarsh and associated species

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	**Yes**
Justification	Although there would be a loss of shingle and the species poor grassland habitat this would be compensated by an increase in saltmarsh and associated species. The shingle habitat is also poor as it is heavily managed. The present standard of protection to the grassland is 1 in 1 year and is unsustainable in that it relies on importing shingle on an annual basis (at significant cost).

A1.6 Case Study 6: Pett Level SPA and Ramsar Site

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Pett Level SPA and Ramsar Site, near Winchelsea, East Sussex
Site/Project Identification Number	Case Study 6
Assessor	TF
Date Assessment Started	27-11-03
Data Sources	Halcrow (1998): **Strategic Environmental Assessment**, Study Report 5, Volume 2: Study Reports, October 1998. SPA citation: **Dungeness to Pett Level** Ramsar citation: **Dungeness to Pett Level** Halcrow (1998): **Coastal Studies**, Study Report 3, Volume 2: Study Reports, October 1998. Halcrow (1998): **Economic Appraisal**, Study Report 6, Volume 2: Study Reports, October 1998.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	Main problems relates to loss of beach fronting the area due to erosion
	Current situation	Ecological interest results mainly from freshwater that occurs in the area. Saline intrusion and flooding is generally prevented by existing coastal defences, including a seawall, although lakes located adjacent to the coast have a range of salinities.
	Management for flood defence	Area currently protected by a seawall. The standard of protection ranges from 1 in 10 to 1 in 100 years (current) depending on location and is expected to fall to 1 in 5 years to 1 in 10 years with sea level rise. The seawall is dependent on the retention of a beach to provide protection during storm events.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Conservation Interest	Designations	SPA, Ramsar, SSSI.
	Key features	Extensive shingle beaches, alluvial grazing marshes and artificial lakes.
	Key habitats	Intertidal sands and mudflats.
	Key species	Several rare or nationally scarce plants: least lettuce (*Lactuca saligna*), rootless duckweed (*Wolffia arrhiza*), soft honrwort (*Caeratophyllum submersum*), brackish water crowfoot (*Ranunculs baudotii*), hair-like pondweed (*Potamogeton trichoides*), divided sedge (*Carex divisa*), marsh mallow (*Althaea officinalis*), and sea heath (*Frakenia laevis*). More than 15 Red Data Book invertebrates: ground beetle (*Omophron limbatum*), aquatic weevil (*Bagous cylindrus*), two hoverflies (*Lejops vittata* and *Sphaerophoria loewi*), medicinal leech (*Hirudo medicinalis*), three aquatic beetles (*Cercyon bifenestratus, Haliplus variegates* and *Hydrovatus clypaelis*). Internationally important population of Bewick's Swan (*Cygnus columbianus* bewickii). Nationally important wintering populations of Shoveler (*Anas clypaeta*), pochard (*Aythya farina*), smew (*Mergus albellus*), sandlering (*Calidris alba*) and ruff (*Philomachus pugnax*). Site supports a nationally important population of whimbrel (*Numenius phaeopus*) during spring and autumn passage periods. Nationally important breeding populations of gadwall (*Anas strepera*), garganey (*A. querquedula*), Mediterranean gull (*Larus melanocephalus*), Sandwich Tern (*Sterna sandvicensis*), common tern (*Sterna hirundo*) and little tern (*Sterna albifrons*).
	Management for conservation	Not known
Other Key Factors	Historic environment	Disused Royal Military Canal. Wet marsh conditions over the Pett Level provide the ideal environment for the preservation of pollen and organic materials such as textiles, leather and wood. Drying out of the marshland may be detrimental to the integrity of archaeological deposits.
	Recreation	Saxon Shoreway walk
	Economic factors	Not known
	Social factors	Low wage economy and relatively high levels of unemployment. Main sources of employment include tourism.

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	Sea level rise would result in a lowering of protection from the current seawall
	Extreme water levels	Loss of beach fronting the current seawall will result in higher wave heights as less energy would be absorbed
	Tidal currents	Not known
	Wave direction	Not known
	Geomorphology	Erosion of shingle beach
Other changes	Water quality	Not known

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)	Extensive shingle beaches, alluvial grazing marshes and artificial lakes.	Provide breeding and over-wintering habitats for important assemblages of resident and migratory wetland bird species, particularly wildfowl, waders and terns. These include internationally important numbers of Bewick's Swan, the breeding Sandwich Tern and the wintering Shoveler and Sanderling. The site also supports a number of rare plant and animal species as well as a rich invertebrate fauna. There are over 15 Red Data Book invertebrate species including ground and aquatic beetles and several non-wetland Red Data Book species. Do-nothing would result in surface waters reverting to a saline regime and erosion of shingle (although this may be able to reform further back behind the current defence line). This would cause the loss of the distinctive salinity gradient of the water filled pits. The change in salinity gradient would cause the loss of several rare animal and plant species from the site.	Y
Key habitats (from Proforma B)	Intertidal sands and mudflats.	Flooding by saline water could increase areas of these habitats.	N
Key species (from Proforma B)	Specific plants, invertebrates and birds.	Assumed to be included under key features and habitats.	N

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Extensive shingle beaches, alluvial grazing marshes and artificial lakes.
Question	**Description**
Would the feature be replaced by another feature?	Saline intrusion could lead to establishment of saltmarsh habitat creating important feeding and breeding areas for migratory birds and wildfowl.
How close is the nearest similar feature?	Saltmarsh lining the River Rother. Many beetle species also founding Rye Harbour, which also supports breeding little terns.
Could the original feature return over time?	No, would be converted to saline environment.

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Covered in key features
Question	**Description**
Would the habitat be replaced by another habitat?	N/a
How close is the nearest similar habitat?	N/a
Could the original habitat return over time?	N/a

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Covered in key features
Question	**Description**
Could the species relocate?	N/a
How would this affect species distribution?	N/a
Would other species move onto the site?	N/a

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Extensive shingle beaches(uncertain), alluvial grazing marshes and artificial lakes	-	-	-	Intertidal mudflats and saltmarsh

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable ?	**No**
Justification	There is no higher ground behind the current seawall such that the whole are would become saline. This would result in the loss of the salinity gradient across the site such that diversity would be reduced. There is also the potential that the shingle beaches could be eroded (although these may reform behind the current defence line)

Proforma E1: Summary of Features, Habitats and Species that Need to be Protected		
Need to be Protected (Long-Term)	**Need to be Protected (Short-Term)**	**Would be Compensated by Changes to Other Features/Habitats**
Shingle beaches	Alluvial grazing marshes and artificial lakes.	Saltmarsh is likely to be created on the site.
If all sites 'need to be protected (short-term)', does work need to be carried out on site? (If yes, complete Proformas E2 to E6)		Assisted migration of species requiring freshwater conditions may be required to avoid loss of some rare/scarce plants and animals

Proforma E2: The Expected Effects of a Flood	
Five Key Factors	**Description of Impacts**
Floodwater velocity	Likely to be very rapid with floodwaters washed in by waves.
Area inundated	The area inundated after a breach of the seawall varies according to the size of flood event. Up to a 1:5 year event would flood most of the Pett Level, although some areas at the rear of the site and along the east and west sides would not be affected. Floodwaters could cover more of the site as the return period increases.
Depth of floodwater	Not known – will depend on size of event
Quality of floodwater	Saline
Evacuation of floodwater	The Pett Level is covered by main ditches which may aid evacuation of floodwaters.

Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma E1)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Extensive shingle beaches, alluvial grazing marshes and artificial lakes.	Floodwater velocity	High velocities could transport shingle inland on a breach encouraging roll back of the shingle ridge to a new defence line.	The time required for recovery of habitats is likely to be 5-10 years. More important is the allowance of a gradual change to a new salinity gradient.
	Area inundated	Almost all of the Pett Level is likely to be inundated.	
	Depth of floodwater	Depth is not known but will increase with flood event as the area that can be inundated does not extend far beyond that covered by the 1:5 year event	
	Quality of floodwater	Saline	
	Evacuation of floodwater	Drainage ditches may aid evacuation although the introduction of shingle onto the site may block many of the ditches such that drainage is impeded.	
Scale for qualitative descriptors of time required for recovery:		N/a	

Proforma E4: Flooding Requirements of Site		
Feature/Habitat/Species (from Proforma E1)	**Does Site Require Periodic Flooding?**	**If yes, what is maximum time between floods to maintain conservation value of site?**
Extensive shingle beaches, alluvial grazing marshes and artificial lakes.	No	N/a

Proforma E5: Summary of Results				
Feature/Habitat/Species (from Proforma E3)	**Minimum Estimated Time for Recovery**	**Uncertainty (Range of Time for Recovery)**	**Maximum Estimated Time for Recovery (or Time Between Floods)**	**Uncertainty (Range of Time for Recovery)**
Extensive shingle beaches, alluvial grazing marshes and artificial lakes.	The time for recovery is not relevant here as the aim is to allow a new salinity gradient to develop over time. This provides time for relocation of important species and adaptation/development of new habitats.			

Proforma E6: Identifying the Appropriate Standard of Defence			
Most Important Feature(s)/Habitat(s)/ Species	**Time (years) for Recovery or Between Floods**		**Does this 'Feel Right' for the Site Having Completed the Assessment?**
	Minimum	**Maximum**	
Extensive shingle beaches, alluvial grazing marshes and artificial lakes.	5	10	Allowing the standard of defence provided by the seawall to decrease gradually over time will allow new habitats to develop in a modified salinity gradient. This should support similar numbers of birds as at current. Providing some defences should also ensure that the area continues to provide important breeding sites.

Proforma F: What Decision has been Made?	
What is the Recommended Appropriate Standard of Defence for the Site?	**No defence standard is proposed. Instead, the recommendation is to maintain the beach and seawall but to allow gradual reduction is standard of protection provided (due to sea level rise).**
Justification	The approach proposed will give those species requiring freshwater and/or brackish water conditions time to relocate to other sites. Repairing breaches to a low standard will ensure that flooding of property is avoided as much as possible and should allow the development of a new salinity gradient across the site. Breeding and roosting sites should be maintained with limited protection.

A1.7 Case Study 7: Brancaster, North Norfolk

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Brancaster, North Norfolk Coast
Site/Project Identification Number	Case Study 7
Assessor	RS
Date Assessment Started	18-11-2003
Data Sources	English Nature (2000): **National Vegetation Classification Surveys of Coastal Grazing Marsh at Holkham NNR**, Norfolk Holkham National Nature Reserve Annual Report 1998 Lawton (1999): **Winter Bird Survey**, Brancaster Grazing Marsh, Winter 1998/99 Environment Agency (2000): **Brancaster West Marshes Flood Defence**, Environmental Statement Environment Agency (1997): **Hydrodynamic Assessment of Brancaster West Marsh**, Final Report Environment Agency (2000): **Brancaster West Marsh Engineers Report**, Final Draft, May 2000.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	1996-97 severe storm partially breached dune revetment.
	Current situation	Defences to the east and west of the marshes in good condition. Northern line of sea defence remains in poor condition and in danger of breaching with a storm event greater than 1:5 years return period.
	Management for flood defence	Retreat the line to provide a more sustainable and cost-effective long-term solution
Conservation Interest	Designations	Marshes and adjacent areas are of significant conservation and landscape value and include: SPA, cSAC, SSSI, NNR, AONB
	Key features	Mediterranean saltmarsh scrubs; shifting dunes; shifting dunes with marram grass; reedbed; grazing marsh
	Key habitats	Dune grasslands, lagoons, saltmarsh
	Key species	Garganey, Sandwich tern, common tern, little tern, arctic tern, bittern, marsh harrier, Montagus's harrier, avocet, dark bellied Brent geese, pink-footed geese, knot, wigeon, European white-fronted geese, pintail, shelduck, grey plover, ringed plover, oystercatcher, redshank, natterjack toads, red squirrels, otters
	Management for conservation	NNR managed by EN; there are also other plans and policies: Norfolk Structure Plan, North Norfolk Local Environment Agency Plan, North Norfolk Shoreline Management Plan, North Norfolk Coast AOBN Management Strategy

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Other Key Factors	Historic environment	Roman Fort of BRANODONUM is nearby, Roman pottery shard; Neolithic flint arrowhead. There are no scheduled ancient monuments in or immediately adjacent to the site. There are archaeological remains from World War II (two pill boxes, a spigot mortar base, gun emplacement)
	Recreation	There are footpaths and public rights of way, as well as the Royal West Norfolk Golf Club
	Economic factors	-
	Social factors	-

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	Storm damage is predicted to increase in both severity and frequency over the next two decades as a consequence of rising sea levels and increased climatic storminess
	Extreme water levels	Storm damage is predicted to increase in both severity and frequency over the next two decades as a consequence of rising sea levels and increased climatic storminess
	Tidal currents	-
	Wave direction	-
	Geomorphology	-
Other changes	Water quality	-

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)		Covered in habitats	
Key habitats (from Proforma B)	cSAC - dune and intertidal habitats	Do-nothing will likely increase the area of intertidal habitat	N
	SPA - freshwater grazing marsh and reedbed	Do-nothing would potentially affect the integrity of the habitat due to salt water intrusion, and hence creating a dis-benefit.	Y
	Saline lagoons	In the long term, do-nothing would result in creation of, saline lagoon or brackish lagoon in low lying areas, and hence result in a benefit.	N
	Saltmarsh	Do nothing would result in erosion of the saltmarsh.	Y
Key species (from Proforma B)		Covered in habitats	

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Covered in habitats
Question	**Description**
Would the feature be replaced by another feature?	N/a
How close is the nearest similar feature?	N/a
Could the original feature return over time?	N/a

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	SPA - freshwater grazing marsh and reedbed
Question	**Description**
Would the habitat be replaced by another habitat?	Yes, intertidal habitats
How close is the nearest similar habitat?	Not known
Could the original habitat return over time?	Unlikely
Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Saltmarsh
Question	**Description**
Would the habitat be replaced by another habitat?	Unlikely
How close is the nearest similar habitat?	Not known
Could the original habitat return over time?	Unlikely

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	N/a – covered in habitats
Question	**Description**
Could the species relocate?	-
How would this affect species distribution?	-
Would other species move onto the site?	-

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Integrity of SPA likely to be affected	Loss of saltmarsh habitat	Neutral impact on landscape designation	Saline lagoon or brackish lagoon in low lying areas in the long term	-

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	**No**
Justification	Because of impacts to SPA site as a result of abandonment of the north wall

Proforma E1: Summary of Features, Habitats and Species that Need to be Protected		
Need to be Protected (Long-Term)	**Need to be Protected (Short-Term)**	**Would be Compensated by Changes to Other Features/Habitats**
SPA	SPA	
If all sites 'need to be protected (short-term)', does work need to be carried out on site? (If yes, complete Proformas E2 to E6)		**Yes, partial re-alignment (retreat the line by around 300m)**

Proforma E2: The Expected Effects of a Flood	
Five Key Factors	**Description of Impacts**
Floodwater velocity	High
Area inundated	Unenclosed saltmarshes to the east and west embankments will be frequently flooded;by tide; west marshes will also be flooded if north wall breaches
Depth of floodwater	Unknown
Quality of floodwater	Saline
Evacuation of floodwater	-

Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma E1)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
SPA	Floodwater velocity	Unknown	-
	Area inundated	Area behind the north wall	-
	Depth of floodwater	Unknown	-
	Quality of floodwater	Saline	-
	Evacuation of floodwater	Unknown	-
Scale for qualitative descriptors of time required for recovery:		-	

Proforma E4: Flooding Requirements of Site		
Feature/Habitat/Species (from Proforma E1)	**Does Site Require Periodic Flooding?**	**If yes, what is maximum time between floods to maintain conservation value of site?**
SPA	No	-

Proforma E5: Summary of Results				
Feature/Habitat/Species (from Proforma E3)	**Minimum Estimated Time for Recovery**	**Uncertainty (Range of Time for Recovery)**	**Maximum Estimated Time for Recovery (or Time Between Floods)**	**Uncertainty (Range of Time for Recovery)**
SPA	Unknown	-	Unknown	-

Proforma E6: Identifying the Appropriate Standard of Defence			
Most Important Feature(s)/Habitat(s)/ Species	**Time (years) for Recovery or Between Floods**		**Does this 'Feel Right' for the Site Having Completed the Assessment?**
	Minimum	**Maximum**	
SPA	?	?	-

Proforma F: What Decision has been Made?	
What is the Recommended Appropriate Standard of Defence for the Site?	**Partial realignment**
Justification	Will be of net benefit to the habitats for which the cSAC was designated, and does not therefore pose significant threats; May result however in very limited long-term negative impacts to some of the bird species for which the SPA was designated (e.g. oystercatcher and redshank). However, precise prediction is difficult, and the resulting habitats that are likely to form after construction, together with improved conservation land management of the remaining freshwater habitats, are likely to be of benefit to these and other SPA species.

A1.8 Case Study 8: Tollesbury Wick Marshes

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Tollesbury Wick Marshes, Essex
Site/Project Identification Number	Case Study 8
Assessor	CG
Date Assessment Started	14-11-03
Data Sources	Tollesbury Wick Marshes Management Plan 1999-2003

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	Unknown
	Current situation	In 1996 the sea walls at Tollesbury Wick were estimated to be to the 1 in 24 year standard.
	Management for flood defence	The Blackwater shore is being protected to the extent possible, through beach recharge with dredgings from Harwich Harbour approaches. Proposed counterwall to act as a secondary flood defence should the sea wall be breached in times of heavy weather.
Conservation Interest	Designations	In addition to being an Essex Wildlife Trust reserve, the area is part of a SSSI, NNR, SPA, Ramsar Site, and ESA, and is a candidate Special Area of Conservation under the EC Habitats Directive.
	Key features	Enclosed grazing marshes which retain the former saltmarsh creeks and channels. The mixture of unimproved, neutral grassland and ditch, open water and fen habitats supports an outstanding assemblage of invertebrates, including one which is restricted to the coastal marshes of Essex and Kent. The Reserve is of major importance as a feeding area for wintering wetland birds, and also provides suitable breeding habitat for wetland and grassland birds.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
	Key habitats	Saltmarsh - the presence of saltmarsh habitat was one of the qualifying criteria for inclusion of the Blackwater Estuary as part of a Ramsar 'wetland of international importance', and is also a key criterion in the recommendation that the estuary also be designated as a Special Area of Conservation under the EC Habitats Directive Shingle banks – key ecological relationships exist (flora and birds). Important for nesting birds. Unimproved grazing marshes – unique flora and invertebrate fauna established on the land and in the associated borrow dykes and ditches. Important for breeding wildfowl and waders. One of the largest tracts of ancient grazing marsh in Essex. Improved grassland has little botanical value but is of major importance to wintering wetland birds, some of which occur in nationally important numbers.
	Key species	Covered under features/habitats.
	Management for conservation	Managed by Essex Wildlife Trust. Primary objective is to maximise the wildlife value of those habitats which it is feasible to manipulate – the grazing marsh and water bodies – through a combination of grazing by cattle and sheep, careful timing of hay cutting, and management of water levels and salinity.
Other Key Factors	Historic environment	There are a number of archaeological sites upon the Tollesbury Wick Marshes including two enclosures and associated mounds of an undetermined date, a pond and a possible medieval saltern.
	Recreation	The public footpath around the seawall is popular for dog walking and hiking, and the area is valued for the landscape aspects. It has been a popular birdwatching area for many years. These activities do not normally give rise to conflict with the wildlife objectives of the reserve. The principal area of concern relates to Shinglehead Point where boats occasionally land in Spring and Summer , thereby causing disturbance to nesting waders, and Little Terns.
	Economic factors	Not known.
	Social factors	The area is valued for the landscape aspects, but there is no present or planned regular use of the site for educational purposes as there are no facilities on site. In addition, the site has not been used extensively for formal research purposes as there are limited facilities on site.

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	Rising sea levels and coastal squeeze threaten shingle banks and saltmarsh.
	Extreme water levels	Projections state that by 2046 the existing sea walls will only be to the 1 in 6 year standard. This represents a significant increased risk of flooding to the grazing marshes with an associated loss of its valuable fauna and flora.
	Tidal currents	Not known
	Wave direction	Not known
	Geomorphology	Not known
Other changes	Water quality	Not known

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)		Covered in habitats	
Key habitats (from Proforma B)	Saltmarsh	Salthmarsh is a threatened habitat since it is being eroded by rising sea levels resulting from isostatic adjustment after the last Ice Age, exacerbated by global warming (sea level rise and more frequent and intense storm activity). Although in a natural system the saltmarsh could be expected to migrate up-shore, this is not possible where the coastline is fixed by sea defences. The Blackwater Estuary alone has lost around one quarter of such habitat since 1973.	Y
	Shingle banks	Threatened by sea level rise and coastal squeeze.	Y
	Unimproved grazing marsh	Although grazing marsh on the site appears to be much more resilient habitat than saltmarsh, in the longer term it is considered fragile by virtue of the increasing danger of seawall breaches as sea levels rise, and if storm intensity increases.	Y
	Improved grassland	-	U
Key species (from Proforma B)		Covered in habitats	

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Covered in habitats
Question	**Description**
Would the feature be re placed by another feature?	-
How close is the nearest similar feature?	-
Could the original feature return over time?	-

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Saltmarsh
Question	**Description**
Would the habitat be replaced by another habitat?	Unlikely
How close is the nearest similar habitat?	Essex has 10% of the UK total saltmarsh habitat, but Blackwater Estuary alone has lost around one quarter of such habitat since 1973.
Could the original habitat return over time?	Threatened nationally as a result of coastal squeeze. In a natural system the saltmarsh could be expected to migrate up-shore, but this is not possible where the coastline is fixed by sea defences.

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Shingle
Question	**Description**
Would the habitat be replaced by another habitat?	Unlikely
How close is the nearest similar habitat?	Locally rare
Could the original habitat return over time?	Unlikely

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Unimproved grazing marsh
Question	**Description**
Would the habitat be replaced by another habitat?	Yes, intertidal habitat, possibly saltmarsh
How close is the nearest similar habitat?	Close proximity of a number of similar protected areas reinforces the reserve's importance. The whole complex essentially forms one mega-reserve.
Could the original habitat return over time?	Although the grazing marsh is considered to be more resilient than the saltmarsh, it is not expected to return under the do-nothing option and is considered irreplaceable.

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Covered in habitats
Question	**Description**
Could the species relocate?	-
How would this affect species distribution?	-
Would other species move onto the site?	-

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Saltmarsh Unimproved grazing marsh	Shingle	Improved grassland	-	-

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	**No**
Justification	Reserve forms part of internationally important designation, based on the areas of saltmarsh and unimproved grazing marshes. Flooding of the marshes would result in the destruction of this sensitive and rare habitat, which is irreplaceable.

Proforma E1: Summary of Features, Habitats and Species that Need to be Protected		
Need to be Protected (Long-Term)	**Need to be Protected (Short-Term)**	**Would be Compensated by Changes to Other Features/Habitats**
Unimproved grazing marsh	-	-
If all sites 'need to be protected (short-term)', does work need to be carried out on site? (If yes, complete Proformas E2 to E6)		**Yes**

Proforma E2: The Expected Effects of a Flood	
Five Key Factors	**Description of Impacts**
Floodwater velocity	Inundation likely to be fast
Area inundated	Unknown
Depth of floodwater	Unknown
Quality of floodwater	Saltwater
Evacuation of floodwater	Unknown

Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma E1)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Unimproved grazing marsh	Floodwater velocity	Unknown	-
	Area inundated	Flood water is likely to damage the vegetation	-
	Depth of floodwater	Unknown	-
	Quality of floodwater	Inundation of saltwater	3 years
	Evacuation of floodwater	Unknown	-
Scale for qualitative descriptors of time required for recovery:		n/a	

Proforma E4: Flooding Requirements of Site		
Feature/Habitat/Species (from Proforma E1)	**Does Site Require Periodic Flooding?**	**If yes, what is maximum time between floods to maintain conservation value of site?**
Unimproved grazing marsh	No	-

Proforma E5: Summary of Results				
Feature/Habitat/Species (from Proforma E3)	**Minimum Estimated Time for Recovery**	**Uncertainty (Range of Time for Recovery)**	**Maximum Estimated Time for Recovery (or Time Between Floods)**	**Uncertainty (Range of Time for Recovery)**
Unimproved grazing marshes	3 years	-	-	-

Proforma E6: Identifying the Appropriate Standard of Defence			
Most Important Feature(s)/Habitat(s)/ Species	**Time (years) for Recovery or Between Floods**		**Does this 'Feel Right' for the Site Having Completed the Assessment?**
	Minimum	**Maximum**	
Unimproved grazing marshes	-	-	-

Proforma F: What Decision has been Made?	
What is the Recommended Appropriate Standard of Defence for the Site?	**1 in 10**
Justification	Although data on recovery of species would suggest that grassland species can recover within 3 years, it is estimated that by 2046 the existing sea wall would provide only defences to a 1 in 6 year standard (as opposed to the current 1 in 24 year standard). Essex Wildlife Trust suggests this represents a significant increased risk of flooding which would destroy the habitat. Therefore a higher standard of defence than 1 in 6 is required, and 1 in 10 would suggest that species would have time to recover between flooding events.

A1.9 Case Study 9: Burnham Overy Staithe

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Burnham Overy Staithe, North Norfolk
Site/Project Identification Number	Case Study 9
Assessor	TF
Date Assessment Started	27-11-03
Data Sources	Anon (1998): **Holkham National Nature Reserve**, Annual Report 1998. Ecological Services Ltd (2000): **National Vegetation Classification: Surveys of Coastal Grazing Marsh at Holkham NNR, Norfolk**, Draft, November 2000.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	Flooded in 1976 and 1995. Recovery of the site on both occasions was rapid.
	Current situation	Freshwater marsh between Wells Harbour and Burnham Overy is relatively stable.
	Management for flood defence	Area protected by a seawall and reclaimed dunes.
Conservation Interest	Designations	The whole area is part of the North Norfolk Coast SPA, North Norfolk Coast cSAC, North Norfolk Coast Ramsar site, North Norfolk Coast SSSI, Blakeney National Nature Reserve, North Norfolk Coast Biosphere Reserve and the Wash and North Norfolk Coast World Heritage Site (potential). The North Norfolk Coasts is also designated as an Area of Outstanding Natural Beauty, Heritage Coast and Character Area. Burnham Overy is designated as it regularly supports over 10,000 wildfowl in winter and also supports internationally important numbers of breeding birds, waterfowl species and nationally important number of over-wintering species and breeding populations of rare species.
	Key features	Grazing marshes, reedbeds, scrapes and ponds.
	Key habitats	Saltmarsh
	Key species	Birds (breeding redshank, oystercatcher, reed bunting, little grebe, greylag goose, shelduck, gadwall, shoveler, pochard, tufted duck, marsh harrier, water rail, black headed gull, moorhen, coot, mallard, avocet, lapwing, yellow wagtail,); natterjack toads
	Management for conservation	Stock fencing, clearing of ragwort, thistles and rushes. Dyke clearing on a 7 year rotation. Management to open up reedbed and ditches.
Other Key Factors	Historic environment	Not known
	Recreation	Not known
	Economic factors	Not known
	Social factors	Not known

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	Increase in sea level rise of about 6mm/year.
	Extreme water levels	Likely to increase as water depths due to sea level rise increase.
	Tidal currents	Not known
	Wave direction	Not known
	Geomorphology	Not known
Other changes	Water quality	Not known

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)	Grazing marshes, reedbeds, scrapes and ponds.	Breaching of defences would cause flooding of area and loss of freshwater habitats	Y
Key habitats (from Proforma B)	Saltmarsh	Breaching of defences and change to saline habitats would encourage colonisation by saltmarsh plants.	N – likely increase in area
Key species (from Proforma B)	Natterjack toads	Loss of shallow freshwater areas for spawning would mean species is lost from site.	Y

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Grazing marshes, reedbeds, scrapes and ponds.
Question	**Description**
Would the feature be replaced by another feature?	Change to saline habitats likely to occur, may result in creation of additional areas of saltmarsh.
How close is the nearest similar feature?	Saltmarsh is already present on site. Other areas of freshwater habitats are adjacent to this site at present.
Could the original feature return over time?	No, the area would be inundated too frequently under do-nothing to allow redevelopment of freshwater habitats.

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	N/a
Question	**Description**
Would the habitat be replaced by another habitat?	-
How close is the nearest similar habitat?	-
Could the original habitat return over time?	-

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Natterjack toads
Question	**Description**
Could the species relocate?	Yes, shallow ponds and scrapes are available at Holkham or could be created in sites nearby.
How would this affect species distribution?	May reduce distribution in terms of area unless new scrapes/ponds are created and/or colonised by the toads.
Would other species move onto the site?	Unlikely that the site would be suitable for amphibians. Habitats would become saline.

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Grazing marshes, reedbeds, scrapes and ponds. Natterjack toads	-	-	Saltmarsh	-

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	**No**
Justification	Loss of internationally important breeding sites for birds. Although there are potential alternative sites sudden loss of breeding areas at Burnham Overy Staithe could have a significant effect on breeding birds. Natterjack toads could be relocated to other sites.

Proforma E1: Summary of Features, Habitats and Species that Need to be Protected		
Need to be Protected (Long-Term)	**Need to be Protected (Short-Term)**	**Would be Compensated by Changes to Other Features/Habitats**
	Grazing marshes, reedbeds, scrapes and ponds.	Natterjack toads
If all sites 'need to be protected (short-term)', does work need to be carried out on site? (If yes, complete Proformas E2 to E6)		**Not known**

Proforma E2: The Expected Effects of a Flood	
Five Key Factors	**Description of Impacts**
Floodwater velocity	Likely to be relatively rapid and follow a breach of the seawall (overtopping of the seawall may also lead to a breach).
Area inundated	Much of the area behind the seawall would be inundated.
Depth of floodwater	Will depend on flood event.
Quality of floodwater	Saline water.
Evacuation of floodwater	Previous flood events suggest evacuation will be rapid.

Proforma E3: The Impacts of Flooding			
Feature/Habitat/Species (from Proforma E1)	**Factor**	**Description of Expected Changes**	**Time Required for Recovery**
Grazing marshes, reedbeds, scrapes and ponds.	Floodwater velocity	Vegetation may be uprooted.	Previous flood events suggest that recovery of the site is very rapid, potentially several months for recovery of grassland.
	Area inundated	Depth of flooding likely to cause some damage to vegetation.	
	Depth of floodwater		
	Quality of floodwater	From freshwater to saline water	
	Evacuation of floodwater	Previous flood events have been evacuated rapidly off the site	
Scale for qualitative descriptors of time required for recovery:		N/a	

Proforma E4: Flooding Requirements of Site		
Feature/Habitat/Species (from Proforma E1)	**Does Site Require Periodic Flooding?**	**If yes, what is maximum time between floods to maintain conservation value of site?**
Grazing marshes, reedbeds, scrapes and ponds.	No	N/a

Proforma E5: Summary of Results				
Feature/Habitat/Species (from Proforma E3)	**Minimum Estimated Time for Recovery**	**Uncertainty (Range of Time for Recovery)**	**Maximum Estimated Time for Recovery (or Time Between Floods)**	**Uncertainty (Range of Time for Recovery)**
Grazing marshes, reedbeds, scrapes and ponds.	Several months	Based on anecdotal evidence on quality of grassland. May be longer for other habitats/species	2-3 years (assuming more extreme flood event)	Could be as high as 10 years if area is flooded to depth of 0.5m or more for several weeks

Proforma E6: Identifying the Appropriate Standard of Defence			
Most Important Feature(s)/Habitat(s)/ Species	**Time (years) for Recovery or Between Floods**		**Does this 'Feel Right' for the Site Having Completed the Assessment?**
	Minimum	**Maximum**	
Grazing marshes, reedbeds, scrapes and ponds.	Several months	2-3 years (potentially up to 10 years)	Limited information for this site means that there is considerable uncertainty as to what is the appropriate standard.

Proforma F: What Decision has been Made?	
What is the Recommended Appropriate Standard of Defence for the Site?	**Protect (short-term) but allow sea level rise to result in reduction in standard of protection over time.**
Justification	More information is required as to the potential impacts of breaching on the site. Previous flood events suggest that the site can recover very quickly following flooding which may suggest that, even under a low standard of defence, some freshwater/brackish water habitats may persist or recover. With regular flooding, however, it is likely that the site would revert to saline habitats. Breeding habitats could be protected by providing protection against flood events during the breeding season, which would require a low standard of protection.

A1.10 Case Study 10: Slapton Ley

Proforma A: Identification of Site and Administrative Details	
Site Name and Location	Slapton Ley, South Devon
Site/Project Identification Number	Case Study 10
Assessor	SD
Date Assessment Started	27-11-03
Data Sources	Atkins (2002): **Slapton Line Coast Protection Scoping Study**, September 2002. Orford J (2001) **Slapton Sands: implications of rock armouring**, report prepared for English Nature, July 2001. Pethick J (2001): **Slapton Sands: proposed road re-alignment, Assessment of geomorphological impacts in relation to management of the road**, report prepared for English Nature, February 2001. Dunsford S (2002): **Briefing on Slapton Ley SSSI**. Dunsford S (2003): **Slapton Ley SSSI and NNR – current scenario**, Briefing for Chief Executive, Andy Brown. Reed S (2001): **Slapton Ley Shingle Bar – Shingle vegetation**, Request for advice on damage to the SSSI due to construction of carriage way.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Management	Flood history	The barrier beach ridge experiences periodic wash-over caused by storm waves and this has allowed the whole landform to transgress landward in response to rising sea levels. A breach in the shingle barrier occurred in 1824 along the shore of the Lower Ley. The village of Hallsands was abandoned in 1917 following storms over the winter of that year. More recently severe damage was caused to the village of Torcross and to the A379 at the southern end of Slapton Sands by storms in 1978/9. During the winter of 2000/2001 a series of storms caused significant damage at Slapton Sands with the loss of up to five metres of the shingle beachhead. This erosion caused significant damage to a 250 metre section of the A379 highway.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
	Current situation	The shingle ridge of Slapton Sands is retreating backwards at approximately 1m per year, leading to a thinning of the barrier between the sea and the fresh water leys behind. A breach of the shingle ridge can be expected within 25 to 50 years. Any localised coastal protection can be expected to exacerbate rather than allay or prevent the retreat of the shingle. The same goes for concrete revetments on the car park. Assessment of the current condition of Slapton Ley SSSI (May, 2003): • shingle bar active geomorphology- unfavourable, no change; • fossil lake sediments – favourable; • freshwater lagoon – favourable; • vegetated shingle – unfavourable, declining; • swamp communities – favourable; • standing open water – unfavourable, no change; • breeding bird assemblage – favourable; • plant assemblage – unfavourable, recovering; and • lichen assemblage – favourable;
	Management for flood defence	A 300m long concrete wall was constructed protect Torcross village, with a further 250m of rock armour protecting the A379 north of the village. Further south, coastal defences have also been constructed to protect Beesands village, and the former caravan site. In addition, the public car park at the central part of the Slapton beach had concrete revetment installed in conjunction with surface improvements in the late 1980s.

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
Conservation Interest	Designations	The shingle ridge and Slapton Ley is designated as SSSI, as a NNR and as a Geological Conservation Review Site. The site also lies within the South Devon AONB and this stretch of coast forms part of the South Devon Heritage Coast.
	Key features	The following features qualify Slapton Ley as a SSSI and NNR: • coastal geomorphology - the site is listed as a Geological Conservation Review Site, and has been the focus of considerable research interest and is a major site for educational studies. It forms part of a larger coastal system including Bee Sands and Hallsands; • freshwater coastal lagoon - largest natural freshwater lake in south west England; • vegetated shingle barrier (24ha), which is a nationally important example of a bay bar; • fen communities; reed-bed, tall-herb fen and fen woodland occupying around 50 ha of land, currently threatened by nutrient enrichment of water;
	Key habitats	Covered in features
	Key species	• the site supports a diverse vascular plant flora (over 490 species recorded, including Strapwort (*Corrigiola littoralis);*St. John's-wort (*Hypericum linariifolium*)), and non vascular plant flora (including lichens); • the site is important for wintering birds in addition to a large number of migrants (Marsh harrier (*Circus aeruginosus),* Bitterns *(Botaurus stellaris),* Dartford Warbler (*Sylvia undata)* among others); • important mammals in the site include Otters (*Lutra lutra*) in the Ley margins and Dormice (*Muscardinus avellanarius*) in the woodland and fringes of the Ley,

Proforma B: The Current Situation		
Criteria	**Factor**	**Description**
	Management for conservation	English Nature has responsibility for the GCR, SSSI and NNR. There are also other plans and policies to consider such as the South Hans Local Plan, Lyme Bay and South Devon SMP and South Devon AONB Management Plan and Action Programme (1997-2002). Slapton Ley has been selected as a pilot catchment for the Environment Agency's 'Eutrophication Control Action Plan' (ECAP). Slapton Ley has also been identified as one of 100 high priority designated sites at risk from diffuse agricultural pollution and this will lead to further action to reduce diffuse nutrient pollution.
Other Key Factors	Historic environment	Surrounding area is of importance in terms of historical and cultural heritage including Ancient Monument Sites, Conservation Areas and Listed Buildings. The shingle ridge contains archaeological resources within it, but only significantly important if associated with the rest of the area.
	Recreation	Tourism is an important industry in the area, therefore all recreational activities linked with the Slapton Ley and the beach that fronts it are important to the area.
	Economic factors	Local economy is characterised by small seasonal businesses and is heavily dependant on trade from tourists and local visitors. Area falls under the EU structural funds objective 2 remit, and it is an area under the Government's Rural Priority scheme
	Social factors	A379 serves a strategically important role as an alternative HGV route into Dartmouth other than the A3122. The route provides an important link for the communities it serves, particularly the villages of Slapton, Strete, Chillington and Stokenham.

Proforma C: Predicted Future Changes		
Criteria	**Factor**	**Description**
Climate Change	Sea level rise	0.5 to 1 mm a year
	Extreme water levels	Storm damage is predicted to increase in both severity and frequency as a consequence of rising sea levels and increased climatic storminess.
	Tidal currents	Not known
	Wave direction	Not known
	Geomorphology	Slapton Sands are described as being at the breakdown stage of its development, with inevitable future breaching and tidal inundation of the freshwater lagoon. The long term transgression rate is difficult to estimate but is put at 1.40m per meter of sea level rise. Breaching is expected in 20 to 50 years.
Other changes	Water quality	If shingle bridge breaches the freshwater lagoon would be flooded and over time would become an intertidal habitat. The Leys suffer from eutrophication from point source (STW) and diffuse inputs (agriculture). Action to improve water quality (AMP3 and ECAP) will result in lower water column nutrient concentrations, limiting the development of blue-green algal blooms, and improved water quality.

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
Key features (from Proforma B)	Coastal geomorphology	Geomorphology of shingle ridge is recorded as unfavourable, due to restriction of movement (produced by road and some sea defences). With do-nothing, it is likely to move both horizontally and vertically as the result of over washing or overtopping during storm events or exceptional swell wave conditions. The beach may roll-back resulting in crest lowering or the crest may roll-back and reform at a higher elevation than the pre-storm barrier. Under both processes there will be a net migration landwards.	N
	Freshwater lagoon	Saline inundation would change the nature of the freshwater habitat (becoming more saline) and would result in the loss of many of the associated unique species.	Y

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
	Vegetated shingle ridge	Vegetation of the shingle ridge is recorded as unfavourable and declining due to current restrictions of the mobility of the shingle bar which distorts the natural zonation pattern of shingle vegetation.	Y

Proforma D1: The Impacts of Do-Nothing			
Criteria	**Feature/Habitat/Species**	**Description**	**Impact Expected (Y/N/Unsure)**
	Fen communities; reed-bed, tall-herb fen and fen woodland	Flooding of Slapton Ley would increase salinity of the site becoming less favourable to these types of habitats. More frequent flooding would also impede sedimentation and in turn impacting the prosperity of the community. These habitats are also threatened by nutrient enrichment of freshwater. It is possible, however, that the habitat would move landward if no abstraction is present.	Y
Key habitats (from Proforma B)	n/a		
Key species (from Proforma B)	*Corrigiola littoralis and Hypericum linariifolium*	Potential loss of this species.	Y
	Wintering birds and migrants	Changing characteristics of habitats in the site can potentially lead to some loss and/or natural relocation of these species to nearby similar sites, such as the Exe Estuary SSSI.	Y
	Mammals including Otter and Dormice	Changing characteristics of habitats in the site can potentially lead to some loss and/or relocation of these species to nearby similar sites.	Y

Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Freshwater lagoon
Question	**Description**
Would the feature be replaced by another feature?	Freshwater lagoon would be progressively replaced by new intertidal habitat with its own particular range of species.
How close is the nearest similar feature?	There are 3 other smaller SSSIs with open water features in South Devon
Could the original feature return over time?	Unlikely
Proforma D2: The Impacts of Do-Nothing on Key Features	
Key Feature:	Vegetated shingle ridge
Question	**Description**

Proforma D2: The Impacts of Do-Nothing on Key Features	
Would the feature be replaced by another feature?	It is unlikely.
How close is the nearest similar feature?	No such feature exists in South Devon.
Could the original feature return over time?	Unlikely
Key Feature:	Fen communities; reed-bed, tall-herb fen and fen woodland
Question	**Description**
Would the feature be replaced by another feature?	Progressively it would become an intertidal habitat
How close is the nearest similar feature?	South Milton Ley and Otter Estuary.
Could the original feature return over time?	Unlikely

Proforma D3: The Impacts of Do-Nothing on Key Habitats	
Key Habitat:	Covered in features
Question	**Description**
Would the habitat be replaced by another habitat?	-
How close is the nearest similar habitat?	-
Could the original habitat return over time?	-

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	*Corrigiola littoralis*
Question	**Description**
Could the species relocate?	It is possible that manmade relocation could transplant this species to a similar site nearby. However, rate of success of such relocation is uncertain.
How would this affect species distribution?	Yes, this is the only known site where this particular species occurs in the UK.
Would other species move onto the site?	Yes
Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	*Hypericum linariifolium*
Question	**Description**
Could the species relocate?	It is possible that manmade relocation could transplant this species to a similar site nearby. However, rate of success of such relocation is uncertain.
How would this affect species distribution?	Species only occurs in 7 10 km squares in England and 2 in Wales, with South Devon being a strong-hold for the plant with sites both within SSSIs and the wider countryside. This is a Red Book species, and therefore, should be given particular attention.
Would other species move onto the site?	Yes

Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Wintering birds and migrants
Question	**Description**
Could the species relocate?	Yes, to nearby site.
How would this affect species distribution?	There might be reduction in numbers due to disturbance of habitat, but this would not be significant
Would other species move onto the site?	Yes
Proforma D4: The Impacts of Do-Nothing on Key Species	
Key Species:	Otter and Dormice
Question	**Description**
Could the species relocate?	Yes, to nearby site, either naturally or aided by man.
How would this affect species distribution?	There might be reduction in numbers due to disturbance of habitat, in particular since it seems that they use this site for breeding.
Would other species move onto the site?	Yes.

Proforma D5: Summary of Expected Changes under Do-Nothing				
Large Loss	**Small Loss**	**No Change (or insignificant)**	**Small Gain**	**Large Gain**
Fresh water lagoon	Wintering birds and migrants	Shingle ridge	Vegetation in shingle ridge	New intertidal habitat and species
Corrigiola littoralis *Hypericum linariifolium*	Otter and Dormice	-	-	-

Proforma D6: Is the Do-Nothing Option Acceptable?	
Is the Do-Nothing Option Acceptable?	**Yes**
Justification	At present the natural development of one of the main features of the site, the shingle ridge, is being restricted due to the existence of a road on top of it and its protection from the advancing sea. It is also predicted that the ridge would breach in the next 25 to 50 years. It is clear from the literature that the beach and the shingle ridge have been evolving for many years in response to rising sea levels, therefore further rising in sea level should not constitute a conservation problem to these features. Furthermore, the freshwater lagoon that is located behind them is, by nature, a temporary feature in the coast, and although a rare element, it is not sustainable to preserve it in a stagnant/museum like state. It becomes clear from recent surveys that a significant quantity of the characteristic species and habitats of the Slapton Ley SSSI have an unfavourable status of conservation, some of it caused by the restricted natural development of the shingle ridge. The majority of species that are present at the site, although important and some of them protected, in their majority that can be relocated to nearby similar sites. Regarding those species that might be considered an undesirable loss, such as *Corrigiola littoralis*, arrangements should be made for a replacement habitat, for example. More importantly, a breach of the shingle ridge will potentially occur only in 25 to 50 years, giving the habitats and species plenty of time to adapt naturally to the changes occurring in the site. It should be noted however, that this decision should be reviewed in the light decisions taken in other similar sites that exist in South Devon.

Annex 2: Recovery of species after flooding

Table A2-1: Species Information

Species (common name)	Time to recovery	Details	Flood event	Source
Adders	5 years	Still confined to isolated and higher areas and not seen on the marshes.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Avocet	?	Retuned with five pairs rearing 17 young.	31 December 1921 'within the course of a single night the sea … by shattering a concrete wall has … placed under natural conditions acres of reclaimed marshland … which have reverted to the ideal breeding-ground they once were. Surplus water in Salthouse Broad normally drains away for the Cley Channel, through the Cley marshes. This channel became blocked, hence, there was no natural exit for the water.	Wild Bird Protection in Norfolk, 1922
Avocet, Black tailed godwit, Ruffs	3 weeks	Feeding on the reserve.	31 December 1921 'within the course of a single night the sea … by shattering a concrete wall has … placed under natural conditions acres of reclaimed marshland … which have reverted to the ideal breeding-ground they once were. Surplus water in Salthouse Broad normally drains away for the Cley Channel, through the Cley marshes. This channel became blocked, hence, there was no natural exit for the water.	Wild Bird Protection in Norfolk, 1922

Species (common name)	Time to recovery	Details	Flood event	Source
Bearded tit	9 months	Bearded tits returned, but did not breed on the site for three years	31 December 1921 'within the course of a single night the sea … by shattering a concrete wall has … placed under natural conditions acres of reclaimed marshland … which have reverted to the ideal breeding-ground they once were. Surplus water in Salthouse Broad normally drains away for the Cley Channel, through the Cley marshes. This channel became blocked, hence, there was no natural exit for the water.	Wild Bird Protection in Norfolk, 1922
Bearded tits	1 year	Three pairs bred	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Bearded tits	2.5 years	Wiped out by severe frosts and no stock known from which they can be replenished	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Bittern	29 days	Booming on site; eggs found in nest inundated 40 days after first flood		Wild Bird Protection in Norfolk, 1949:
Bittern	1 month	Booming on site	6 April 1943: forced tide swept over whole length from Salthouse to Cley, making marshes an inland sea and flooding both villages and the road connecting them to a depth of several feet. Still a lot of water on the marsh at the end of April. Breeding season was very poor due to nests being washed away and it being too late for may species to nest again once the water had subsided. Took some time for the salt conditions to be eradicated; bird populations were low in April 1944 (may also be due to mild winter).	Wild Bird Protection in Norfolk, 1943

Species (common name)	Time to recovery	Details	Flood event	Source
Bittern	1 month	Returned to Cley marshes and later bred successfully.	31 December 1921 'within the course of a single night the sea … by shattering a concrete wall has … placed under natural conditions acres of reclaimed marshland … which have reverted to the ideal breeding-ground they once were. Surplus water in Salthouse Broad normally drains away for the Cley Channel, through the Cley marshes. This channel became blocked, hence, there was no natural exit for the water.	Wild Bird Protection in Norfolk, 1922
Bittern	1 year	Slight increase – 5 pairs compared to the normal 10 – absence of frogs main problem	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Bittern	3 months	Nesting/breeding	1949 floods - water subsided quickly such that after 3 days it was full of duck	Bagnall-Oakeley (1949?)
Bittern	4 months	Began booming again, numbers were much reduced (to about a quarter) and only one (of four) pair bred.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1935-1938 The Norfolk Sea Floods, 334-390
Common rush	2 years	Beginning to reappear in a few places	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Common rush	3 years	Died where it had reappeared before, but was now growing in some new areas	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419

Species (common name)	Time to recovery	Details	Flood event	Source
Common rush	4 years	Still absent everywhere except for a very few clumps in isolated places.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Cuckoos	2.5 years	First time since flood, marshes have been populated with cuckoos.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Divers	5 years	Divers gradually extended their feeding grounds to practically the whole of Horsey Mere suggesting that the weeds had returned	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Diving ducks	1.5 years	Returned to Heigham sounds and Hickling	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Dragonflies	1.5 years	Quite numerous in September (none seen in May/June)	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Earthworms	1 year	Spread only a very short distance	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419

Species (common name)	Time to recovery	Details	Flood event	Source
Earthworms	2.5 years	No evidence in marshes or at any distance from the high water mark. In Holland, small worms appeared for the first time, three years after the flood.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Earthworms	3.5 years	Still no signs of worms hatching from eggs that had lain dormant. Mature worms had spread further but the process is very slow.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Frogs	2 years	Reappear in small numbers in the second spring after the flood.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1935-1938 The Norfolk Sea Floods, 334-390
Frogs	2.5 years	Returned in considerable numbers to spawn, but no small frogs seen so may not have hatched	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Frogs and toads	3.5 years	Some breeding success for first time since flood.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Garganey teal	29 days	Increased to five after a few more days, but did not stay long ('apparently not liking the salt condition of the marsh'). Only one pair stayed to breed	1949 floods - water subsided quickly such that after 3 days it was full of duck	Wild Bird Protection in Norfolk, 1949:

Species (common name)	Time to recovery	Details	Flood event	Source
Garganey teal	1 month	Arrived on marsh but only stayed for ten days	6 April 1943: forced tide swept over whole length from Salthouse to Cley, making marshes an inland sea and flooding both villages and the road connecting them to a depth of several feet. Still a lot of water on the marsh at the end of April. Breeding season was very poor due to nests being washed away and it being too late for may species to nest again once the water had subsided. Took some time for the salt conditions to be eradicated; bird populations were low in April 1944 (may also be due to mild winter).	Wild Bird Protection in Norfolk, 1943
Giant sedge	1 year	Very weak, but alive.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Goosefoot	8 months	Colonised the land by September	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1935-1938 The Norfolk Sea Floods, 334-390
Grassland	1 year	Change in composition of sward with increased populations of *Puccinellia maritima*, *Salicornia* spp. and *Bulboschoenus maritimus*.	Flood of February 1996 on Cley and Salthouse Marshes. Water remained on site for several weeks with flood depths of 2m in some places. Little rainfall during that time meant that salinity problems were increased.	University of Cambridge (1997): North Norfolk Sea Defences: Cley to Kelling Environmental Investigation, report to Environment Agency
Grassland	3 years	Large increase in grass on the marshes with maritime plants only visible in the lows.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419

Species (common name)	Time to recovery	Details	Flood event	Source
Grassland	3 years	Complete recovery in three years. Initial growth of grass began after about 8 months, except where drainage had been particularly bad.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1935-1938 The Norfolk Sea Floods, 334-390
Great Crested Grebe	2.5 years	Reared broods, probably advantaged by reduced number of pike. Had not previously succeeded since the flood.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Great spearwort	5 years	Had not reappeared	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Hair weed	1 year	Only water weed that had returned to Horsey Mere and was choking up Hickling Broad.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Hares	2.5 years	Increased over all the area	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Hares, rabbits	1 year	Increased from a very small winter stock	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Kingfisher	21 days	Flying down the main drain	1949 floods - water subsided quickly such that after 3 days it was full of duck	Wild Bird Protection in Norfolk, 1949:

Species (common name)	Time to recovery	Details	Flood event	Source
Lesser bulrush	1 year	Much of the hover broke up and disintegrated in winter of 1938-39 leaving a much larger area of open water. The hover that remained recovered well –its growth in the second year was taller than the reed and flowered well.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Lesser bulrush	2 years	Recovered well	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Long-tailed field mice	1.75 years	Reappeared	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Marsh harrier	2.5 years	Did not breed – but reason not known	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Marsh harrier	1 year	Reduced fertility of eggs (2 out of 5 hatching)	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Marsh sow thistle	several months	Grew late and small but flowered in 1938, by 1939 had almost recovered its full growth.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419

Species (common name)	Time to recovery	Details	Flood event	Source
Milk parsley	1 year	Patches in a few places	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Owls	2.5 years	Retuned and up to pre-flood numbers, except short-eared.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Pike	1 year	Small number of young pike seen in spring	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Pike	5 years	Still no large pike in Horsey Mere although other fish numbers were good	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Rabbits	2.5 years	Still confined to small areas and higher ground	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Ragged robin	1 year	Begun to reappear in a few places	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419

Species (common name)	Time to recovery	Details	Flood event	Source
Reed	After flood event	Will survive inundation by saltwater, but its growth is slow and patchy. Common rush is completely killed off. Reed resumed normal growth in the second year after the flood.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1935-1938 The Norfolk Sea Floods, 334-390
Reed	1 year	Much better growth in the second year, but had not returned to normal on the lowest parts of the marshes.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Reed	2 years	Improved where salt has diminished, but still poor growth in the lowest marshes. Reed in the low marshes is an even poorer crop than in 1939.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Reed bunting	1 year	Returned and bred in normal numbers	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Reeve	3 months	Remaining on marsh for three weeks, but did not stay to breed	1949 floods - water subsided quickly such that after 3 days it was full of duck	Wild Bird Protection in Norfolk, 1949:
Samphire	5 months	Sprang up all over the salted marshes and arable but withered and died two months later	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1935-1938 The Norfolk Sea Floods, 334-390
Sandwich terns	40 days	500-600 seen resting for the first time	1949 floods - water subsided quickly such that after 3 days it was full of duck	Wild Bird Protection in Norfolk, 1949:

Species (common name)	Time to recovery	Details	Flood event	Source
Sedge	2 years	Still much affected, but shows more seed than in 1939	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Short-tailed field mice	1.5 years	Began to reappear	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Short-tailed voles	1.5 years	Began to reappear in Autumn 1939 and were again a large number in Spring of 1940 – sufficient to attract and support several pairs of short-eared owls.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Shovelers	4 months	Noticeably fewer than usual in 1949 season	1949 floods - water subsided quickly such that after 3 days it was full of duck	Wild Bird Protection in Norfolk, 1949
Snipe	2.5 years	Few seen on marshes but no probings	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Stoneworts	3 years	Return of two species in Horsey Mere, also water milfoil and frogbit.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Swallowtail butterflies	1 year	Numbers about the same as 1938, but more hope of survival due to presence of ragged robin and milk parsley.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419

Species (common name)	Time to recovery	Details	Flood event	Source
Swallowtail butterflies	2.5 years	Considerable increase in numbers, with a good quantity of milk parsley around	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Swallowtail butterflies	4.5 years	Back in full force with plenty of caterpillars at the end of July.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Swans	1 year	Returned but did not breed	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Swans	2.5 years	Few swans fed on hair weed but did not breed	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Swans	3 years	Still did not breed.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Trees	After flood event	Oaks may survive (young trees having a better chance); common beech is quite resistant to salt (much more than copper beech). Ash, alder, willow, horse chestnut, conifers were all killed. Poplar survived in some cases.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1935-1938 The Norfolk Sea Floods, 334-390

Species (common name)	Time to recovery	Details	Flood event	Source
Trees	3 years	Some recovery (but limited) of silver birch and horse chestnut.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Warblers	2.5 years	A few more sedge warblers and plenty of reed warblers which stayed to nest; grasshopper warblers passed through but did not stay.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Water lilies	3 years	Reappeared in Mere for first time since flood.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Water rails	3.5 years	Returned	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Water rats	2.5 years	Returned in more than normal numbers	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Water vole	5 years	Water vole population appeared to have recovered by 2001	Cley marshes suffered severe saltwater flooding in 1996	Harris (2001) in Harris (2002)
Wheatear	22 days		1949 floods - water subsided quickly such that after 3 days it was full of duck	Wild Bird Protection in Norfolk, 1949:

Species (common name)	Time to recovery	Details	Flood event	Source
Willows (black sallow, wood willow)	1 year	New shoots	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Willows	4 years	Replanting in best drained areas still resulted in many dying.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Woodcock, snipe	1 year	Avoided the salted area	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Worms	3 years	Begin to reappear after three years – although probably from eggs.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1935-1938 The Norfolk Sea Floods, 334-390
Yellow wagtails	1 year	Increase in number of breeding stock from 2-3 pairs normally to 30 pairs.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419
Yellow wagtails	2.5 years	Again, ten times more numerous than prior to the flood.	Flood of 12 February 1938 – inland sea that turned into a desert. It took until early May to get the water out of the area, after which time it was impregnated with salt.	Transactions of the Norfolk and Norwich Naturalists' Society, Vol XIV, 1939-1943 The Norfolk Sea Floods, 22-40; 150-159; 259-267; 332-341; 410-419

Research Information Note

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Flood defence standards for designated sites

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Keywords: flood defence; standard of defence; species recovery; flooding

Introduction

Flood risk management on coasts and estuaries can impact conservation sites. Recent practice has often been to provide a high standard of protection. The present guidance in Flood and Coastal Defence PAG3 suggests a standard of 50 – 200 years for international sites. However many sites have developed their current conservation interest with a history of regular or intermittent flooding such that a high standard of protection may not be appropriate. English Nature recognises the need to advise on appropriate standards of defence based on the conservation objectives for a particular site, but there is little information relating to 'what standards may be appropriate'. This issue is of particular importance for those sites where the sole justification for the scheme is the site's status as a Natura 2000 site.

What was done

English Nature commissioned a report to assist staff in making informed decisions regarding 'appropriate' standards of flood defence for designated sites on the coast and tidal rivers.

The report
- introduces standards of defence & reviews 'appropriate' standards;
- provides generic guidance & applies to a series of cast studies;
- provides information on the recovery of species after flooding;
- suggests further studies that are required.

A literature review was also undertaken but little information of relevance was found.

Results and conclusions

The report recommends using the 'do-nothing' option (no active intervention) as the base-line case against which all other options are compared.

A flood defence strategy (if available) should provide a detailed description of what may happen under the do-nothing option and provide a useful indication of which features could be affected. If the do-nothing option is expected to cause changes to the site that are not considered acceptable, then the appropriate standard of protection should be identified using the following information: site citation and conservation objectives, flood history, flood risk management (past & present), predicted future changes to site (eg with climate change), and impacts associated with different standards of protection.

Continued……

Since every site is unique, it is difficult to predict generalised effects of flooding on a particular site. Five factors can be used to give an indication of the immediate effects of a flood on a site: floodwater velocity, area inundated, depth of floodwater, water quality of floodwater and time required for floodwater evacuation.

The timescale for recovery will be dependent upon: i) changes in the physical and chemical condition of the site that could affect the suitability of the site as a habitat, ii) the degree of connectivity with similar habitats that could provide a source of colonists, and iii) the succession that would be required before species could recolonise.

It may be necessary to look at the site within the context, not just of the site itself, but also its proximity to other sites, its location with regard to options for rolling back the site (or migration of the conservation interest) and how this sits within the overall coastal ecosystem in the general area.

English Nature's viewpoint

English Nature's view is that the standard of protection required varies according to what features of nature conservation interest are present, or should be present, on any particular site. It is not possible to provide a fixed standard of protection that covers all sites.

This report provides a useful framework to help English Nature staff provide consistent and justified advice on the 'appropriate' standard of defence for a particular designated site. It also provides a valuable summary of information on species recovery from flooding that could be turned into a searchable database and kept updated.

It is important to recognise that the case study assessments have been undertaken by RPA and do not necessarily represent the views of English Nature as to the flood defence requirements of any of the sites. Neither do the results provide any recommendations for future flood defence standards at the case study sites.

The approach is based on qualitative description of impacts, supported by quantitative information, where available. More information/data are required on the impacts/benefits of different types of flooding at specific sites, the impact of repeate flood events on the conservation interest and the time-scales required for recovery. Following consideration of this report English Nature has offered revised advice to Defra on indicative standards of protection for sites of national and international conservation interest.

Selected references

MAFF. 1999. *Flood and coastal defence appraisal guidance - economic appraisal* (FCDPAG3).

Further information

English Nature Research Reports and their *Research Information Notes* are available to download from our website: www.english-nature.org.uk

For a printed copy of the full report, or for information on other publications on this subject, please contact the Enquiry Service on 01733 455100/101/102 or e-mail enquiries@english-nature.org.uk

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Front cover photographs:
Top left: Using a home-made moth trap.
Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
Main: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
Paul Glendell/English Nature 24,888