ENVIRONMENTALLY SENSITIVE AREAS SCHEME

Environmental Monitoring in the North Kent Marshes ESA 1993–1996

ADAS REPORT TO THE
MINISTRY OF AGRICULTURE, FISHERIES & FOOD

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PREFACE

When the Environmentally Sensitive Areas (ESA) Scheme was launched in 1987, the Ministry of Agriculture, Fisheries and Food (MAFF) recognised a need to ensure that the scheme was delivering the desired environmental benefits. A national monitoring strategy was developed and a monitoring programme has been established in each ESA, covering the landscape, wildlife and historical interest. The monitoring surveys are tailored to the characteristics and environmental objectives of each ESA. The general approach has been to monitor change by establishing a baseline record of conditions when the ESA was launched and to compare this with information from subsequent surveys. Where appropriate and practicable, comparisons are also made between land that has entered the scheme (agreement land) and land which has not (non-agreement land).

The North Kent Marshes ESA is one of six Stage III ESAs in England that were launched in 1993. Each ESA is reviewed by MAFF on a 5-year cycle, to assess the performance of the scheme. The results of monitoring from 1993 to 1996, as presented in this report, will be used in the first review of this ESA, due to take place during 1997.

This report takes a broad look at the impact of the ESA scheme on the designated area as a whole. It presents the methods and results of the monitoring surveys and evaluates the impacts on the total environmental resource. The survey period is short in relation to expected rates of change for many of the features monitored; some monitoring activities have yet to yield results that show change. Thus, this report presents interim results of a longer-term monitoring programme and gives an early evaluation of the impact of the scheme.

ACKNOWLEDGEMENTS

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The assistance of farmers, landowners and land managers who allowed access to their land and provided information is also acknowledged. This work would not have been possible without their co-operation.

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SUMMARY

This report summarises the environmental monitoring programme carried out in the North Kent Marshes Environmentally Sensitive Area (ESA) from 1993 to 1996. A brief description is given of the ESA, the environmental objectives of the scheme and the monitoring methods used. The results and conclusions of the programme are presented to enable the performance of the scheme to be assessed in relation to the performance indicators, environmental objectives and overall environmental aim. It should be borne in mind that the ESA has been in operation for only four years and it remains early to fully assess the impacts of the scheme on the environmental of the area.

A landscape assessment was undertaken at the commencement of the scheme, to provide an overview of the landscape character of the ESA and to identify the key characteristics of each landscape type The landscape monitoring programme included identification of changes in land cover (from 1993 to 1996) using aerial photography, and sample-based surveys of linear and point features, such as ditches, fences, hedgerows, gates and wing fences.

Nearly 90% of the ESA is in agricultural use, with semi-natural grazing marsh covering 45% of the ESA area. A further 35% is in arable production, and improved grassland accounted for 8%. The major change in land cover, from 1993 to 1996, involved the conversion of over 600 ha of arable to improved grassland under Tier 2 agreement (further land entered this tier during 1996). This change brought about distinct landscape benefits, particularly in the *Exposed Grazing Marsh.* In addition, 45% of the eligible grassland in the ESA is under agreement and protected from conversion to arable. A small amount of semi-natural grazing marsh was lost to arable and improved grassland but this occurred on non-agreement land.

Ditches are the traditional field boundary in the *Exposed* and *Sheltered Grazing Marshes*, the majority of which were in a stockproof condition in 1993. The total length of ditches was maintained over the monitoring period but there was a deterioration in the stockproof condition of 19% of ditches, on both agreement and non-agreement land. Fences and hedges are more common in the *Marshland Edge* and *Cultivated Slopes* and changes to fencing was minimal. There was no change in length of hedgerows but there was also no evidence of positive management of hedgerows.

The wildlife conservation value of the ESA was assessed from surveys of breeding and wintering birds, field vegetation and ditch vegetation. The results from the bird monitoring showed no significant change in numbers between baseline and resurvey, suggesting that there was no downward trend on agreement land. Owing to lack of uptake and short time period which raised water level agreements (Tier 1A) have been available it was not possible to assess the effects of this type of management on bird numbers. The monitoring of field vegetation provided a baseline description of the grassland communities. The results from the ditch vegetation monitoring described the communities present.

Monitoring of the historical resource involved the preparation of a baseline inventory of historical features for the ESA, against which the impact of known changes in land cover were assessed. The uptake of ESA agreements ensured the protection of historical features: 35% of these are now protected from further agricultural damage. Changes in land cover from arable

to grassland under the arable reversion tier had a potentially beneficial effect on 6% of features, by removing the threat of ploughing.

Four environmental objectives were set by MAFF following the launch of the scheme. The first of these, *"to maintain and enhance the landscape quality and wildlife conservation value by retention of existing grazing marsh and increasing the area of grazing marsh"*, has been achieved as far as maintenance is concerned, and there has been notable enhancement of the landscape as a results of arable reversion. It is too early to assess whether the wildlife conservation value has been enhanced.

The second objective, *"to maintain and enhance the wildlife conservation value of grazing marsh without detriment to the landscape by maintaining high water levels in ditches"*, has not been addressed by the monitoring, as there was insufficient uptake of the raised water level tier.

The third objective is *"to maintain and enhance landscape quality through management of characteristic landscape elements"*. The monitoring showed that there was no loss of ditches, hedgerows, gates or wing fences, but the stockproof condition of 1 in 5 ditches deteriorated and no evidence of positive management of hedgerows was recorded. Therefore, this objective has been met only in part, with the characteristics elements being maintained, but not enhanced.

The final objective is *"to maintain and enhance archaeological and historic features"*. No historical features were lost during the monitoring period and over a third of features are protected from damage or destruction on agreement land. Several of these experienced potentially beneficial change as a result of arable reversion. However, potentially damaging operations on arable land continue to take place on non-agreement land, and a further three features on non-agreement land experienced potentially detrimental change. Taking account of the beneficial and detrimental change that has occurred, this objective has been met in full.

The overall environmental aim for the ESA is *"to maintain and enhance the landscape, wildlife and historic value of the area by encouraging beneficial agricultural practices"* This has been partly achieved; the landscape, wildlife and historical value of the area has been maintained but there is only limited evidence of enhancement.

KEY MESSAGES

- There has been moderate uptake of land ino the scheme. A total of 45% of grassland has been entered into the scheme and this includes 43% of the environmentally important semi-natural grazing marsh. Tier 2 has been responsible for the reversion of 14% of the arable land in 1993 to grassland.

- Overall, the results of the various monitoring activities showed that there has been little change to the landscape, wildlife and historical value of the ESA. Maintenance of the environmental value of the ESA has therefore been achieved, but there is little evidence of enhancement at this early stage of the scheme, other than the arable reversion.

- Ditches, which form the traditional field boundaries in the majority of the ESA, and are important for their vegetation and invertebrate communities, were found to have suffered a

loss in quality. Although this may have been partly a result of low rainfall during the monitoring period, it is a cause for concern and should be monitored closely in future.

- The monitoring confirmed the importance of the ESA for breeding redshank and lapwing, and for wintering wigeon and teal.

- The monitoring of ditch vegetation and grassland revealed the presence of nationally scarce plant species and communities within the ESA.

1. INTRODUCTION

THE ESA SCHEME

1.1. The North Kent Marshes is one of 22 areas in England designated by MAFF under the ESA scheme. This scheme was introduced in 1987, to encourage farmers to help safeguard areas of the countryside where the landscape, wildlife and historic interest is of national importance and is dependent on the use of beneficial farming practices. The North Kent Marshes ESA was designated in 1993.

1.2. The scheme is voluntary. Farmers and landowners receive annual payments for entering into 10-year management agreements which require them to follow a set of management prescriptions. An ESA has one or more tiers of entry. In most cases, the higher tiers place greater restrictions on management; in others, the tiers relate to particular habitats or changes in management practices, such as reversion of arable land to permanent grassland. Participants in the scheme can also apply for a conservation plan, which provides grant aid for carrying out capital works to improve particular environmental features.

1.3. Each ESA has a number of specified environmental objectives and associated performance indicators. The environmental monitoring programme for each ESA is designed to provide information that will enable assessments to be made of the performance of the scheme in relation to the set objectives. The national strategy for environmental monitoring of ESAs is detailed in the *ADAS National Strategy for ESA Monitoring* (ADAS, 1995).

THE NORTH KENT MARSHES ESA

1.4. The ESA forms an almost continuous coastal marshland fringe extending from Whitstable in the east to Gravesend on the Thames estuary in the west, including the Medway estuary and the Isle of Sheppey. The marshes are typically two to five kilometres wide but they broaden on the Hoo peninsular and on the southern side of the Isle of Sheppey. The ESA extends, in total, to 13,715 hectares and is bounded by a belt of higher ‘upland’ which forms a pronounced landscape feature defining the southern boundary. Most of the marshes have been enclosed by sea walls (‘inned’) since medieval times to prevent flooding.

1.5. The marshes are a distinctive, exposed, flat landscape of pasture land, with mudflats and saltings beyond the sea wall. In combination, they provide a habitat of international significance for over-wintering and breeding birds. Part of the ESA has been designated as a Special Protection Area under the EC Directive on Conservation of Wild Birds (79/409) and as a Wetland of International Importance under the 1971 Ramsar Convention. The marshes, ditches and dykes contain important aquatic flora and invertebrates, and over one third of the area has been designated as a National Nature Reserve or Sites of Special Scientific Interest. Further local designations and reserves also occur.

1.6. The area contains evidence of occupation and use since prehistoric times and adjoins two important routeways to London, either via the sea and River Thames or via the land along the Roman Watling Street. There are remains from Roman pottery production, Saxon farms

and Medieval salt-working mounds, as well as more recent armament production and defensive sites. The process of reclamation of land from the sea has been continuing since at least the early medieval period, and there is a complex pattern of old sea walls (which now cross the area) as well as the ditch patterns of Saxon and Medieval farms. There are potentially significant features from the prehistoric, Roman and early-Medieval period buried within the alluvium of the marshes, which have been preserved by the anaerobic conditions maintained by high water levels. The higher ground bordering the marsh includes a number of historical settlement sites.

1.7. The pattern of agriculture in the North Kent Marshes changed considerably after the major flood events of 1953. Improvements to the sea defences allowed underdrainage and field amalgamation, leading to increased agricultural intensification on much of the former grazing marsh. These processes extended over much of the higher marshland, particularly during the 1970s, and allowed the conversion of large areas of grass to arable crops, with a consequent reduction in the wildlife conservation value, landscape character and historical value of the areas affected. The continuing threat to the remaining marshland was the major reason for the designation of the North Kent Marshes as an ESA in 1993.

Environmental objectives

1.8. An overall environmental aim, common to all ESAs, has been specified by MAFF and this is "*to maintain and enhance the landscape, wildlife and historic value of the area by encouraging beneficial agricultural practices*". For each ESA, there are specific environmental objectives and associated performance indicators. These focus on the priorities within that ESA through which the wider environmental aim can be addressed.

1.9. The environmental objectives for the North Kent Marshes ESA are:

Objective 1 To maintain and enhance landscape quality and wildlife conservation value by retention of existing grazing marsh and by increasing the area of grazing marsh.

Objective 2 To maintain and enhance the wildlife conservation value of grazing marsh, without detriment to the landscape, by maintaining high water levels in ditches and dykes.

Objective 3 To maintain and enhance landscape quality through management of characteristic landscape elements.

Objective 4 To maintain and enhance archaeological and historic features.

1.10. A full list of the objectives and performance indicators for the North Kent Marshes ESA is given in Appendix I.

Scheme structure and uptake

1.11. The scheme was launched in 1993, with three tiers. The following paragraphs summarise the management requirements of the tiers, and Table 1.1 provides details of tier

uptake after four years, to December 1996. Further uptake of land into the ESA is expected in 1997.

1.12. Tier 1 provides for extensive management of existing grassland, with restrictions on cultivation, stocking rates and fertiliser and pesticide applications. The management prescriptions also require the agreement holders to maintain ditches and other landscape features, such as wing gates. By the end of December 1996, nearly 2,790 ha of grassland (40%) had entered Tier 1.

1.13. Tier 1A (Wet Grassland) agreement holders are required to follow Tier 1 prescriptions, and also to maintain high water levels in ditches through winter and early spring. The aim of this tier is to enhance the wildlife interest of the land, particularly the numbers of wintering and breeding birds. A further 8% of the eligible grassland in the ESA (nearly 620 ha) were being managed under this tier by the end of December 1996.

1.14. An arable reversion tier (Tier 2) is also included, in which a grass mix containing at least six grasses from a specified list must be sown. Once land is under permanent grass, agreement holders are required to follow Tier 1 prescriptions and may enter the land into Tier 1A. In the first year of agreement certain practices prohibited under Tier 1 may be allowed, to enable the establishment of a grass sward. Over 660 ha (14%) was being managed in this manner by the end of December 1996.

Table 1.1. Uptake of eligible land to the tiers of ESA agreement.

Tier of agreement	Area eligible to enter tier (ha)	Area under agreement * (ha)	% eligible area under agreement
1	7,337	2,784	40
1A	7,337	616	8
2	4,816	663	14

* Includes all applications and signed agreements as at the end of December 1996.

1.15. Works eligible for conservation plans include construction of bunds (embankments) to control water levels, restoration of ditches and dykes, restoration of ponds, construction of culverts, and works to protect historic and archaeological features.

1.16. Of the 67 signed ESA agreements at the end of December 1996, five (8%) have conservation plans. One of these conservation plans includes provision for re-instatement of abandoned ditches; the remainder are all concerned with raising water levels. There are no conservation plans for the provision of positive management of historical features..

1.17. A summary of all current management tiers and prescriptions is given in Appendix II, together with a list of capital works that can be included in a conservation plan.

THE NORTH KENT MARSHES ESA ENVIRONMENTAL MONITORING PROGRAMME

1.18. The environmental monitoring programme in the North Kent Marshes ESA has been developed to provide information on the way in which the landscape, wildlife and historical resource in the ESA is changing under the ESA scheme.

1.19. The scheme has a direct influence on the management of the vegetation and of the agricultural artefacts that contribute to the environmental value of the ESA. In particular, the presence of semi-natural grazing marsh which supports breeding and wintering birds, the ditches which dissect the marsh with their associated gates and wing-fences, and the protected archaeological remains, are seen as characteristic of this ESA. The extent and condition of these elements are seen as indicators of the scheme's success.

1.20. This report assesses how the extent and quality of these elements have changed over the life of the scheme. The impact of any change to the landscape, wildlife and historical interest is evaluated, bringing together all the relevant results. The extent to which change to these elements can be attributed to the ESA scheme is also evaluated. This enables an assessment to be made of the overall impact of the scheme on the designated area.

1.21. A landscape assessment, carried out at the start of the scheme, is used to evaluate the results of the various monitoring exercises in terms of the ESA landscape (ADAS, 1994). This assessment identifies landscape types, or areas of similar environmental character. A brief description of landscape types and details of how to obtain a map showing their distribution within the ESA is presented in Appendix III. Landscape types are identified in this report in italics.

1.22. The effect of the scheme on the wildlife value of the ESA has been evaluated primarily on the basis of the results of monitoring of permanent grassland and breeding and wintering birds. The botanical quality of ditch vegetation has been investigated. The data gathered for the landscape monitoring programme have also, where appropriate, been interpreted from a wildlife perspective.

1.23. The historical value of the ESA is measured by the presence of historical and archaeological remains and the degree of protection afforded to them. An inventory of historical features for the ESA has been compiled, and the features mapped. The potential impact of known changes in land cover on these features has also been evaluated.

Report structure

1.24. Before presenting the evaluation, the methods and results of each of the monitoring activities which provide the data on which the evaluation is based, are described. Monitoring data have been collected by a variety of techniques. The following provides an overview of the monitoring programme and the techniques used.

- **Land Cover:** aerial photography has been used to describe the extent and distribution of the various classes of land cover when the scheme was designated in 1993 and to examine how this has changed by 1996.

- **Historical Features:** an inventory of historical features within the ESA has been compiled and a desk exercise has assessed the impact of changes in land cover on these features.

- **Grassland:** a botanical survey was undertaken in 1993, to describe the grassland communities present on the grazing marsh at the time of ESA designation.

- **Breeding Waders:** counts of breeding waders took place in a sample of the ESA in 1993, to describe the numbers of wader territories at ESA designation; resurvey in 1996 has assessed how the numbers have changed since the start of the scheme.

- **Wintering Birds:** counts of wintering birds in a sample of the ESA in 1993/94 have been used to describe the density of wintering birds at ESA designation; resurvey in 1995/96 has assessed how the numbers have changed since the start of the scheme.

- **Linear and Point Features:** ground survey, within a sample of the ESA in 1993 and 1996, has been used to describe specific features within the landscape, notably field boundaries and other artefacts, and how they have changed since the start of the scheme.

- **Ditch Vegetation:** a botanical survey of a small sample of ditches was undertaken in 1994, to describe the botanical interest of the ditches on land subject to Tier 1A (raised water-level tier).

1.25. The report concludes by examining the success of the scheme in meeting the environmental objectives and associated performance indicators, and the overall environmental aim.

SELECTION OF MONITORING SITES

1.26. Monitoring of land cover and historical features is undertaken across the whole of the ESA. However, the monitoring of birds, grassland and linear and point features is restricted to a sample of the ESA.

1.27. A stratified random sampling strategy was used to select 11 sample areas early in 1993. The ESA was subdivided into approximately 150 blocks of land, each of approximately 100 to 150 hectares, delineated by roads, railway lines, ditches and field boundaries. The location of (proposed) agreement land was taken into consideration when delineating the blocks of land, to provide, where possible, blocks entirely under agreement or entirely non-agreement. Land known to be under English Nature management agreement, or ineligible to enter the ESA scheme, was excluded from the sampling frame. Each block of land was numbered and random numbers used to select a sample. A mix of land under grassland and arable, both agreement and non-agreement, was required and sampling continued until at least one block of each type of land had been selected; grassland under agreement was the most common, and selection of this land was halted after six blocks had been selected.

1.28. The 11 sample areas provide a representative sample of the ESA, covering approximately 11% of the eligible area However, certain landscape types were found to be

under-represented by this sample so two additional areas were chosen; these were not selected randomly. Also, three areas in the initial sample were slightly enlarged to take in areas in other landscape types. The characteristics of each of the sites is summarised in Table 1.2.

Table 1.2. Characteristics of sample areas.

Sample area	Area (ha) [Ψ]	Land cover [†]	Agreement status *		Landscape type [#]
			1993	*1996*	
1	97	Grass	A	A	EGM
2	127	Grass	NA	A	EGM (52%) SGM (48%)
3	107 (159)	Grass	A	A	EGM (55%) SGM (45%)
4	98	Grass	A	A	EGM
5	83 (122)	Grass	NA	A	EGM (68%) ME (32%)
6	106	Grass	A	A	EGM
7	131 (155)	Grass	A	A	EGM (85%) ME (15%)
8	108	Grass	A	A	EGM
9	154	Arable	A	A	EGM
10	123	Arable	NA	NA	EGM
11	128	Arable	NA	NA	EGM
12	188	Arable	NA	NA	EGM (53%) ME (47%)
13	126	Arable	NA	NA	CS

[Ψ] Figures in parentheses are the enlarged areas used for the linear and point feature surveys only

[†] Predominant land cover within the sample area in 1993

* A = agreement; NA = non-agreement.

[#] EGM = *Exposed Grazing Marsh*; SGM = *Sheltered Grazing Marsh*; ME = *Marshland Edge*; CS = *Cultivated Slopes*.

1.29. Monitoring of birds has taken place in all 11 randomly selected sample areas (numbers 1 to 11) and monitoring of grassland in the eight grassland areas. Monitoring of linear and point features has taken place in all areas, with the exception of number 10 where access was denied for this work.

2. LAND COVER

INTRODUCTION

2.1. Monitoring of land cover provides an overview of the land within the ESA and identifies the amount of land which is eligible to enter the scheme. In particular, it provides a baseline description of the vegetation types, from which to monitor change.

2.2. This chapter describes the methods and results of such monitoring. The methods follow those set out in Volume 2 of ADAS (1995). The baseline (1993) data and the changes (from 1993 to 1996) are related to agreement status and landscape type. This assessment provides the basis for evaluating the impact of the scheme on the landscape value.

METHODS

Classification of land cover

2.3. The development of the classification of land cover in the North Kent Marshes ESA was a multi-stage process, involving field testing and liaison with the Project Officer and those involved in the botanical monitoring programme. Aerial photography was used as the basis for mapping the various classes of land cover, each of which can be identified by a combination of shape, colour, tone and texture. The criteria used when developing the classification specify that the classes must be:

- distinguishable using aerial photographic interpretation (API), supported by limited ground checking;
- relevant to the objectives and performance indicators for the ESA;
- defined with sufficient precision to allow repeat surveys to record accurately changes which are relevant to the ESA objectives;
- verifiable on the ground.

2.4. The land cover classes were chosen to enable identification of land eligible to enter the ESA scheme (i.e. agricultural land) and ineligible land (e.g. woodland, open water and urban areas), to allow assessment of the scheme uptake. It was also necessary that they allowed the discrimination between arable, permanent grassland and semi-natural grazing marsh. The classification was based on NCC Phase 1 habitat survey definitions, which broadly define the classes according to their botanical composition. Minor modifications to these definitions were made, to ensure that the categories could be mapped consistently and relate more specifically to the ESA prescriptions. A minimum mapping unit of 0.25 ha was used for all classes.

2.5. The land cover classification is set out in Table 2.1. Full definitions of the nine classes are given in Appendix IV.

Table 2.1. Land cover classes in the North Kent Marshes ESA.

Land cover class	Type of land cover included
Arable	Includes cultivated soil, cropped land & grass leys
Improved grassland	Typically species-poor, intensively managed permanent grassland
Semi-natural grazing marsh	Extensively managed permanent grassland, with higher species diversity than improved grassland
Swamp & marginal vegetation	Includes a mosaic of grasses, sedges, herbs & reeds
Scrub	Dominated by shrub species ≤ 5 m tall
Woodland	Dominated by tree species ≥ 5 m tall. Includes new planting or coppice rotation
Saltmarsh	Coastal/saline habitats above the mean high water mark
Open water	Includes rivers, ponds, lakes, main ditches, creeks and reservoirs.
Non-agricultural land	Includes farmsteads, recreational land & all other urban areas

Survey methods

Baseline

2.6. The land cover classes were mapped from stereoscopic examination of 1:12,000 scale true-colour aerial photographs taken in May 1992. This was supplemented by field visits as necessary, to confirm the classification. Features such as roads, railway lines and rivers were mapped from Ordnance Survey (O.S.) information after checking the aerial photographs for recent changes. The baseline information was mapped at 1:10,000 scale.

Resurvey

2.7. Changes in land cover since 1993 were identified by systematically comparing 1:12,000 true colour aerial photographs taken in April 1996 with the baseline map. Any changes identified were verified, where necessary, by field visits. Maps of the changes in land cover were produced for the whole ESA at 1:10,000 scale. When combined with the baseline (1993) map of land cover, a 1996 map of land cover can be produced.

Accuracy assessment

2.8. An accuracy assessment for the 1996 map of land cover was carried out to establish the level of confidence that can be placed in the map and to calculate the potential error associated with the area measurements for each class. The methods used for the assessment are presented in Appendix V of this report.

Data handling and analysis

2.9. All the maps are held in a digital form, which facilitates extraction of selected data, area measurement and future editing. Other information, such as agreement and landscape type boundaries, can be combined with the data to generate new maps and area measurements.

2.10. The area measurements from the 1993 map of land cover have been broken down by landscape type and by agreement status, to provide information on the composition and patterning of land cover in the ESA. These provide the baseline against which change has been assessed. Changes in land cover, from 1993 to 1996, are expressed as change in the total area and as losses and gains of each class. These changes have also been examined by agreement status and landscape type.

RESULTS

Accuracy assessment

2.11. An overall map accuracy of 88% was achieved in 1996, well above the minimum acceptable value. However, the swamp & marginal, open water, woodland, scrub and saltmarsh classes did not have sufficient observation points (minimum of 50) to give a reliable estimate of their accuracies. These are all fairly rare classes within the ESA.

2.12. Semi-natural grazing marsh was incorrectly mapped as improved grassland in a number of instances, leading to an over-estimate of the area of the latter class within the ESA and a lower than expected user accuracy. The mis-classification of semi-natural grazing marsh as non-agricultural land arose mainly in areas where rough ground (e.g. abandoned mineral workings) had been colonised by coarse vegetation.

2.13. Full results of the accuracy assessment can be found in Appendix V.

Land cover areas in 1993

2.14. Three types of land cover covered the majority of the ESA at designation in 1993 (Table 2.2): arable (35%), improved grassland (8%) and semi-natural grazing marsh (45%). A total of 89% of the ESA was in agricultural use (either arable or grassland) and therefore eligible to enter the scheme. By the end of 1995, a total of 4,048 ha of land was under agreement, approximately one-third of the total area of eligible land.

2.15. Semi-natural grazing marsh covered the largest proportion of the ESA and is the grassland of highest ecological, landscape and historical value. The majority (83%) of it occurred in the *Exposed Grazing Marsh*, representing 54% of this landscape type. It occurred in large expanses throughout the ESA, and formed the dominant land cover over large areas of the outer coastal strip. The large blocks were often separated by tracts of arable land. Smaller areas of semi-natural grazing marsh were located in the *Sheltered Grazing Marsh.* A total of 43% of this land cover class was under ESA agreement at the end of 1995, including extensive blocks in the western half of the ESA.

Table 2.2. Land cover areas in 1993.

Land cover class	Total area (ha)	Proportion of ESA (%)
Arable	4,820	35
Improved grassland	1,161	8
Semi-natural grazing marsh	6,176	45
Swamp & marginal vegetation	224	2
Scrub	74	<1
Woodland	44	<1
Saltmarsh	70	<1
Open water	513	4
Non-agricultural land	633	5
Total	13,715	100

2.16. Improved grassland, which is of lower value, was generally located in the *Exposed* and *Sheltered Grazing Marsh*, where it often occurred as single fields on the landward side of semi-natural grazing marsh, particularly in the western half of the ESA. There were small pockets of this land cover class in the *Cultivated Slopes* and *Marshland Edge*. Almost half (47%) of the improved grassland was under agreement, with uptake throughout the ESA.

2.17. Arable land occurred throughout the ESA, with concentrations on the Isle of Sheppey and in several areas on the mainland. The majority (64%) of arable occurred within the *Exposed Grazing Marsh*, although significant areas were also located within the *Marshland Edge* and the *Cultivated Slopes*. The 13% of arable land under Tier 2 (arable reversion to permanent grassland) agreement was mostly located on the mainland (within the *Exposed Grazing Marsh*), with a large block in the western half of the ESA adjoining an expanse of semi-natural grazing marsh. There was a block of Tier 2 land on the south side of the Isle of Sheppey, reducing the amount of arable land between two important areas of grazing marsh. Otherwise, there were small areas of arable reversion across the ESA, often alongside fleets, some of which joined up previously fragmented semi-natural grazing marsh.

2.18. Open water and swamp & marginal vegetation are valuable wildlife habitats. These two classes of land cover often occur together, with swamp & marginal vegetation forming narrow strips alongside open water. Together they comprised 6% of the total area of the ESA and are typically located in the *Exposed Grazing Marsh* and *Sheltered Grazing Marsh.* Open water occurs virtually throughout these two characteristically wet landscape types.

2.19. There was only a very small area of saltmarsh within the ESA boundary, and this was located along estuaries and the banks of the larger dykes. The majority occurred within the *Exposed Grazing Marsh* and a total of 7% was under agreement at the end of 1995.

2.20. Woodland was virtually restricted to strips around farms, often in the *Cultivated Slopes* and *Marshland Edge.* The small areas of scrub also occurred in these landscape types.

2.21. The areas of the various classes of land cover in each landscape type are given in full in Appendix VI.

Changes in land cover from 1993 to 1996

2.22. The major change in the total areas of the land cover classes, from 1993 to 1996, was the increase in improved grassland (564 ha), which was matched by a fall in the arable area (Table 2.3). The only other classes to increase in area were open water and non-agricultural land. Semi-natural grazing marsh, the most extensive class in 1993, showed the second largest decrease in area (76 ha), although this resulted in only a small percentage reduction. The relatively small area decrease in swamp & marginal vegetation, however, amounted to a reasonably large percentage reduction. Woodland, scrub and saltmarsh were all unaffected by change.

Table 2.3. Changes in total area of each land cover class from 1993 to 1996.

Land cover class	**Total area (ha)**		**Change (1993–1996)**	
	In 1993	***In 1996***	***Area (ha)***	***% of 1993 area***
Arable	4,820	4,257	-563	-12%
Improved grassland	1,161	1,725	+564	+49%
Semi-natural grazing marsh	6,176	6,100	-76	-1%
Swamp & marginal vegetation	224	202	-22	-10%
Scrub	74	74	0	–
Woodland	44	44	0	–
Saltmarsh	70	70	0	–
Open water	513	585	+72	+14%
Non-agricultural	633	658	+25	+4%
Total	13,715	13,715	–	–

2.23. The changes in the total areas of the various classes of land cover are the results of both losses and gains in each class. From 1993 to 1996, a total of 830 ha of land changed class, the majority (76%) of which occurred on agreement land. Details of change between all classes during this period are shown at Appendix VII and Table 2.4 shows the change between the five major classes in the ESA.

Table 2.4. Changes between the five main classes of land cover (ha) from 1993 to 1996 *.

Land cover class		TO: Land cover class in 1996				
		Arable	**Improved grassland**	**Semi-natural grazing marsh**	**Swamp & marginal vegetation**	**Open water**
FROM:	**Arable**	–	614	11	0	3
		–	(602)	(0)	(0)	(1)
Land	**Improved grassland**	63	–	3	0	3
		(0)	–	(3)	(0)	(3)
cover	**Semi-natural grazing marsh**	20	48	–	22	23
		(0)	(0)	–	(9)	(13)
class	**Swamp & marginal veg.**	0	0	2	–	45
		(0)	(0)	(0)	–	(7)
in 1993	**Open water**	0	0	0	3	–
		(0)	(0)	(0)	(0)	–

* Figures in parentheses are changes on agreement land.

2.24. The largest change was from arable to improved grassland (72% of the total area of change). All but 12 ha (2%) of this change occurred as a result of Tier 2 (arable reversion) agreements. Over 80% of the arable to grassland change occurred on the *Exposed Grazing Marsh* and a further 10% on the *Marshland Edge*. However, during the monitoring period, 63 ha of improved grassland and 20 ha of semi-natural grazing marsh were lost to arable cultivation. These changes occurred on non-agreement land and demonstrate the continuing threat to the environmental value of the area.

2.25. The largest loss of semi-natural grazing marsh was to improved grassland on non-agreement land. A further 19 ha of grazing marsh was lost through non-agricultural development within the ESA.

2.26. A significant proportion of the changes from semi-natural grazing marsh and swamp & marginal vegetation to open water can be accounted for by localised raising of the water levels on agreement land. Much of this change occurred in the *Exposed Grazing Marsh*, most notably on the RSPB reserves at Elmley and Northward Hill, where water levels are being raised by pumping. The occurrence of standing water in shallow pools and rills within the fields, resulted in the land being classified as swamp & marginal vegetation or open water in the resurvey of land cover.

SUMMARY

2.27. In 1993, the ESA was dominated by three classes of land cover: arable (35%), improved grassland (8%) and semi-natural grazing marsh (45%). Nearly 90% of the ESA is in agricultural use and therefore eligible to enter the scheme.

2.28. From 1993 to 1996, the most important change was from arable to grassland. A total of 614 ha has been reverted from arable land to improved grassland. The majority of this has occurred on agreement land on *Exposed Grazing Marsh,* in some cases linking blocks of semi-natural grazing marsh. Much of the remaining change from arable to improved grassland occurred in the *Marshland Edge*, with very small percentages in the other two landscape types. However, some change from improved grassland (63 ha) and semi-natural grazing marsh (20 ha) to arable was also recorded.

2.29. Semi-natural grazing marsh was also lost to improved grassland (48 ha) and non-agricultural land (19 ha). A total of 45 ha of semi-natural grazing marsh was lost to swamp & marginal vegetation and open water, mainly due to the raising of water levels on agreement land.

3. HISTORICAL FEATURES

INTRODUCTION

3.1. This chapter describes the historical resource of the North Kent Marshes ESA, describes the methods used for, and presents the results of, the historical monitoring programme. The methods follow those set out in Volume 4 of ADAS (1995). For the purpose of this report, the term 'historical features' includes both sites and features of 'archaeological and historic' importance.

3.2. The ESA contains a wide variety of historical features, ranging from potential sites of historical interest (represented by flint and pottery scatters or crop marks) to earthworks, buildings and quarry workings. It is also extremely likely that many more features or even entire landscapes exist within the waterlogged, alluvial deposits which characterise the North Kent Marshes. The anaerobic condition of much of the alluvium is likely to have preserved valuable palaeo-environmental information. All of these sites, no matter what their size or extent, represent evidence of past human activities and are essential to the understanding of the historical resource of the marshes.

3.3. The location of the North Kent Marshes ESA, in the extreme south east of Britain, means that it was one of the first areas to be occupied by settlers from the continental mainland. Five Palaeolithic flints axes (recovered near Pickles Way, in the *Sheltered Grazing Marsh* at Cliffe Marshes) demonstrate that the North Kent Marshes have been occupied since before 10,000 BC. Evidence of Bronze Age, Iron Age, Roman, Medieval and post-Medieval occupation can also be seen through the many barrows, settlements, salt workings and more recent industrial and military sites. The historical inventory includes sites up to, and including, those from the Second World War as they are believed to be of great historical significance to many people.

METHODS

Inventory of features of historical interest

3.4. An inventory of historical features relevant to the ESA scheme was derived from the County Sites and Monuments Records (SMRs) for Kent. Only features which could be influenced by the ESA scheme were included in the ESA inventory. Features situated on land that was ineligible to join the scheme (other than scrub and woodland) or those features without any agriculturally related use (e.g. churches or traditional buildings used for residential purposes) were not included. Features associated with scrub and woodland were included, because agreement holders have to seek advice on the management of their scrub and woodland and this advice should specifically take account of any historical features that are present.

3.5. The inventory also includes features which are believed to be of national importance, and these have been registered by English Heritage as Scheduled Monuments (SMs). There are six SMs in the North Kent Marshes ESA.

3.6. To aid description of the historical resource in the ESA, historical features were grouped into three categories. These are outlined below (Table 3.1) and full details are provided in Appendix VIII.

Table 3.1. Description of the categories of historical features.

Category	Description
Earthworks	Features distinguishable from natural landforms, including salt workings or salterns.
Buried features & artefacts	Includes sites of features and those determined from Aerial Photograph Interpretation, not identified on the ground.
Buildings	Intact and relic traditional farm buildings.

Potential impact of changes in land cover

3.7. This historical monitoring programme assessed the condition of historical features by looking at the changes in land cover from 1993 and 1996. Ground survey to confirm changes in the condition of historical features was not possible within the resources available. The results, therefore, refer to the 'potential' impact of changes in land cover.

3.8. An assessment of the likely effects of change was made for the historical resource of this ESA. Chapter 2 of this report provides details of the methods used to map the land cover in 1993 and to identify changes from 1993 to 1996; full results are presented in that chapter. Changes in land cover were characterised as 'beneficial' or 'detrimental', on the basis of available literature detailing the effects of agricultural practices (Darvill, 1987). Table 3.2 lists the types of change in land cover that affected historical features in the North Kent Marshes ESA and provides an explanation of why the changes are considered to be beneficial or detrimental to historical features.

3.9. Changes in land cover of less than 0.25 hectares (i.e. for individual historical features) were generally not mapped. More subtle changes in the vegetation, at a scale that cannot be detected readily by interpretation of aerial photographs, may have occurred but will not have been detected. These subtle and often gradual changes, such as scrub encroachment, can have an impact upon historical features.

Table 3.2. Types of beneficial and detrimental change in land cover in the North Kent Marshes ESA, 1993–1996.

Beneficial change		**Detrimental change**	
Type	***Reason***	***Type***	***Reason***
Arable to improved grassland.	Reduced risk of plough damage, especially to buried features and earthworks.	Semi-natural grazing marsh to arable	Plough damage and increased risk of damage from subsoiling, especially to buried features and earthworks.
		Arable to non-agricultural	Development can damage or destroy historical features.
		Swamp & marginal vegetation to open water	Water can damage or destroy historical features.
Improved grassland to semi-natural grazing marsh.	An associated rise in water levels may prolong the preservation of water-logged sites where water levels are stable.	Improved grassland to semi-natural grazing marsh	Fluctuating water levels may damage or destroy historical features.

RESULTS

Features of historical interest in the ESA

3.10. The ESA inventory for the North Kent Marshes contains 115 historical features. By September 1996, 40 were wholly or partly[1] on land under ESA agreement, representing 35% of all features. This included almost one third of the earthworks, half of the buried features and nearly one third of the buildings (see Table 3.3).

3.11. Earthwork features were found to comprise 75% of the historical resource. Of these, 55% were Roman and Medieval salt workings and 20% were Iron Age to Medieval settlement sites. The remainder were field systems, barrows, mounds and quarry workings.

3.12. Buried features and artefacts account for 19% of the historical resource. Pottery and flint scatters were the most common (41%), followed by cemetery sites and burials which constituted 23% of the category. Crop-mark features, such as previous earthworks and settlements also comprised 27%, while the remaining 9% included a boat and the site of an explosives factory.

[1] Those historical features which are only partly under agreement were generally those which covered extensive areas (such as ancient settlement sites).

3.13. The final category of historical features is that of buildings. There were only seven examples of these, constituting 6% of the total resource. These included military structures near to the coastline, and Roman occupation sites, such as villas and forms.

Table 3.3. Historical features protected under the ESA scheme.

Type of historical feature	Number in ESA	Number (& percentage) on agreement land *
Earthworks	86	27 (31)
Buried features & artefacts	22	11 (50)
Buildings	7	2 (29)

3.14. There are six Scheduled Monuments (SMs) in the North Kent Marshes ESA, all of which are Medieval salt workings, or salterns. These are all situated on the *Exposed Grazing Marsh*, at the eastern end of the ESA. These six SMs represent 5% of the known historical resource. One of the salterns is protected under ESA agreement.

3.15. The majority of the historical features (67%) occur on *Exposed Grazing Marsh* (see Table 3.4). On the basis of proportional areas, this is to be expected, as this landscape type covers almost 70% of the ESA. The most frequently occurring features within this landscape type are the earthworks (79%). Buried features & artefacts (17%) and buildings (4%) constitute the remainder of the resource in this landscape reflecting a similar distribution to the whole ESA.

3.16. The *Sheltered Grazing Marsh*, the *Marshland Edge* and the *Cultivated Slopes* each cover around 10% of the total ESA area and harbour fewer historical features. The *Sheltered Grazing Marsh* contains 17% of the total historical features within the ESA. These again comprise mainly earthworks (65%), with buried features and buildings forming 25% and 10% of the historical resource, respectively. The *Marshland Edge* contains 11% of historical features; the earthworks are once again the most common (62%), followed by buried features (31%) and buildings (7%). Finally, the *Cultivated Slopes* contains the fewest historical features (4% of the total historical resource). Earthworks are still the most commonly occurring feature (80%), but there are no known buried features and only one building.

Table 3.4. Landscape types and associated historical features in the North Kent Marshes ESA.

Types of historical feature	Number in each landscape type			
	Exposed Grazing Marsh	*Sheltered Grazing Marsh*	*Marshland Edge*	*Cultivated Slopes*
Earthworks	61	13	8	4
Buried features & artefacts	13	5	4	0
Buildings	3	2	1	1
Totals	77	20	13	5

3.17. Data from 1993 show that 68 historical features (59%) occurred on semi-natural grazing marsh or improved grassland, with nearly half (47%) now under ESA agreement. The grassland tier (Tier 1) aims to maintain existing permanent grassland in the ESA and should, therefore, ensure the continued protection of the historical resource afforded by grassland management. This tier now protects 32 features from detrimental change. Forty-two of the remaining features (37%) were on arable land and seven of these have since been entered into ESA agreement. The final five features were on other classes of land cover, with one feature, on land entering into ESA agreement. Therefore, 75 features on non-agreement land remain at risk of damage or destruction, 46% of which are associated with arable cultivation.

Potential impact of changes in land cover

3.18. Of the 115 historical features on land eligible to join the ESA, 11 features were located on land for which a change in land cover was identified (Chapter 2). This represents almost 10% of all historical features within the ESA. The types of change in land cover, and the features affected, are shown in Table 3.5. Earthworks were the most commonly affected features (82%), followed by buried features & artefacts (18%). None of the buildings was affected. The effect of these changes in land cover is summarised in Table 3.6.

Table 3.5. Numbers of historical features associated with changes in land cover, 1993–1996.

Change in land cover		**Earthworks**	**Buried features & artefacts**	**Buildings**
From (1993)	***To (1996)***			
Arable	Improved grassland	7	0	0
Improved grassland	Semi-natural grazing marsh	0	1	0
Semi-natural grazing marsh	Arable	0	1	0
Swamp & marginal vegetation	Open water	1	0	0
Arable	Non-agricultural land	1	0	0

3.19. Beneficial change (i.e. arable to improved grassland) occurred to seven (6%) features (17% of all features on arable land). All of this occurred on agreement land, and affected earthwork features. This represents 78% of the changes affecting earthworks and almost two thirds (64%) of all the changes associated with historical features. Arable reversion to permanent pasture under Tier 2 agreement affords protection to historical features by the cessation of ploughing or subsoiling. This means that further damage to earthworks and buried features is halted. Loss of topsoil through wind erosion will also be reduced, thus preventing exposure of those features below ground level.

Table 3.6. The effect of changes in land cover on historical features, 1993–1996.

	Changes in land cover		No. of features affected	No. on agreement land
	From	***To***		
Beneficial change:	Arable	Improved grassland	7	7
Detrimental change:	Semi-natural grazing marsh	Arable	1	0
	Swamps & marginal vegetation.	Open Water	1	0
	Arable	Non-agricultural land	1	0
Beneficial or detrimental change:	Improved grassland	Semi-natural grazing marsh	1	1

3.20. Detrimental change was experienced by three features (2%): two earthworks and one buried feature. All of these were on non-agreement land. The remaining feature (a buried feature) requires further, in depth, investigation in order to ascertain whether the change was beneficial or detrimental. This feature was on Tier 1A land (wet grassland tier). Where the water level is stable, the rise in water level associated with this tier may prolong the preservation of waterlogged sites. However, where the water levels fluctuate, this may increase the rate of decay. Indirect effects may also arise from colonisation by wetland vegetation but the exact results of this are not yet known. Four historical features are entered into this tier, although only one of these sites changed from improved grassland to semi-natural grazing marsh.

SUMMARY

3.21. In total, 115 historical features which could be affected by agricultural practices were recorded in the ESA inventory. ESA agreements are potentially helping to protect 40 (35%) of these historical features. In contrast to this, 46% of the 75 features not in ESA agreement remain at risk of damage or destruction as a result of agricultural operations.

3.22. The results of the monitoring suggest that no historical features were lost on land in ESA agreement, but that potentially detrimental change occurred to three features on land that was not in agreement. Potentially beneficial changes were associated with seven features, all of which involved the conversion of arable land to grassland as a direct result of the ESA scheme. For these historical features it is particularly significant that the damage caused by ploughing has been halted.

4. GRASSLAND

INTRODUCTION

4.1. The 1993 baseline survey provided data on the composition of grassland within the ESA from which to monitor change. Because there were few changes in grassland management on Tier 1 land following the inception of the ESA, it was thought unlikely that there would be any significant change in the botanical composition of the grassland between the baseline and resurvey (originally scheduled for 1996). For this reason, and for resource reasons, the resurvey was not undertaken.

4.2. Much of the grassland on the remaining grazing marsh within the ESA could be described as unimproved neutral grassland with a residual brackish influence, a consequence of the land's history as salt marsh. The low rainfall and small catchment size result in only slow flushing of salt from the reclaimed marsh, and occasional flooding and seepage through sea walls help to maintain the fairly high salinity levels. The grassland found on the North Kent grazing marsh is generally species-poor when compared with other unimproved grassland communities, but contains several local and national rarities. This grassland type appears to have been overlooked in much of the phytosociological literature (including the National Vegetation Classification (NVC) (Rodwell, 1992)) but can be regarded as a distinct community specific to south-east England, with its distribution centred on the Thames Estuary. The occurrence of this grassland, together with other nationally restricted plant communities found within the grazing marsh complex, creates an extremely diverse habitat of high wildlife conservation value.

4.3. The vegetation of the level grazing marsh is grass-dominated; perennial rye-grass (*Lolium perenne*), creeping bent (*Agrostis stolonifera*), red fescue (*Festuca rubra*), meadow barley (*Hordeum secalinum*) and crested dog's-tail (*Cynosurus cristatus*) are amongst the most ubiquitous grasses. Species characteristic of upper saltmarsh occur in the sward, such as common couch (*Elymus repens*) and saltmarsh rush (*Juncus gerardii*). Brackish plants of more restricted distribution, such as divided sedge (*Carex divisa*), hairy buttercup (*Ranunculus sardous*) and strawberry clover (*Trifolium fragiferum*) also occur regularly. White clover (*Trifolium repens*) is the most frequently occurring broad-leaved species, while bird's-foot-trefoil (*Lotus corniculatus*), lady's bedstraw (*Galium verum*) and grass vetchling (*Lathyrus nissolia*) are found in the less agriculturally improved grassland.

4.4. The predominantly flat topography of the grazing marsh is interrupted by the raised banks of the main sea wall and counter walls. These are much more freely draining than the marsh and support different plant communities. It is on these walls that many of the scarcer plants can be found, including the Red Data Book species least lettuce (*Lactuca saligna*), slender bird's-foot-trefoil (*Lotus angustissimus*) and hog's fennel (*Peucedanum officinale*).

4.5. Another group of plants with fairly specific habitat requirements is found in the rills which wind across the marshes. The rills are usually inundated in winter, and remain damper than the surrounding grassland later into spring. The wetter rills support several scarce annuals of bare muddy ground, including pink goosefoot (*Chenopodium botryodes*) and annual beardgrass (*Polypogon monspeliensis*). The drier rills, in which perennial vegetation

can survive, often contain inundation grassland, dominated by creeping bent and marsh foxtail (*Alopecurus geniculatus*). The scarce grass bulbous foxtail (*Alopecurus bulbosus*) is also found in these communities.

METHODS

4.6. This section explains the criteria which were applied when selecting the botanical monitoring sites and the methods used to collect and analyse data. The methods used follow those set out in ADAS (1995).

4.7. Monitoring fields were selected from the eight sample areas which contained permanent grassland. In order to obtain a random sample of vegetation within these areas, all fields were numbered consecutively from west to east, across areas. From the total of 150 fields, 40 were chosen randomly, irrespective of agreement status. These were then re-numbered from 1 to 40 from west to east. Within each field the stand was located objectively by taking a random measurement along the longest diagonal. This was permanently marked with buried steel pipes.

4.8. Botanical data were collected using a field method developed by ADAS for specific use in ESA monitoring (Critchley & Poulton, in preparation). Data were recorded within each of the 4 m × 2 m stands. These were divided into thirty-two 0.5 m × 0.5 m units, and species and vegetation height were recorded using nested quadrats (nests) in each of these units.

4.9. Stands were assigned to the closest NVC communities and subcommunities. This was carried out on the basis of between-nest frequencies of species, using the MATCH computer programme (Malloch, 1992), and by reference to keys, tables and descriptive text from the NVC, and descriptive field notes and photographs. With relatively large stands, inevitably a proportion fell across community boundaries or included mosaics. However, individual stands were allocated to the dominant community.

RESULTS

4.10. All stands keyed out as mesotrophic grassland communities. The fit with NVC communities for most stands was poor, many falling between MG6 (*Lolium perenne–Cynosurus cristatus* grassland), MG7 (*Lolium perenne* leys) and MG11 (*Festuca rubra–Agrostis stolonifera–Potentilla anserina* grassland). Several sites showed distinct affinities with SM28 *(Elymus repens* saltmarsh), which can be explained by the saltmarsh origin of the marshes. The reason for the poor fits with recognised grassland communities was the high frequency of species such as divided sedge, meadow barley and common couch, none of which occur in widely recognised grassland vegetation types. Similar communities, however, have been described in the Broads (ADAS, 1996a) and the South Downs ESA (ADAS, 1996b). The more diverse stands tended to key out as ‘coastal’ variants of MG6c (*Trisetum flavescens* sub-community), while the less diverse stands keyed out as transitional between MG7a/b (*Lolium perenne–Trifolium repens* leys/*Lolium perenne–Poa trivialis* leys) and MG11a (*Lolium perenne* sub-community).

4.11. It was possible to split the stands into three broad groups, based on species composition, NVC community and geographical location. These are described in more detail in the following paragraphs.

Group 1 (MG6c)

4.12. The eight stands in this group came from two sample areas and tended to be the most species-rich in the sample. As with all stands, they were grass-dominated; perennial rye-grass, meadow barley, creeping bent and red fescue were constant, with small-leaved timothy (*Phleum bertolonii*), yellow oat-grass (*Trisetum flavescens*) and crested dog's-tail frequent. The distinguishing feature of this group was the relatively high diversity of broad-leaved plants. Several of the stands are located close to the sea wall, so are fairly well-drained, and subject to occasional disturbance from sea defence maintenance and other vehicular activity. These conditions provided suitable habitat for the scarce species slender hare's-ear (*Bupleurum tenuissimum*) and toothed medick (*Medicago polymorpha*), as well as more ubiquitous dry grassland species, such as yarrow (*Achillea millefolium*), ribwort plantain (*Plantago lanceolata*) and bird's-foot-trefoil.

Group 2 (MG6/MG7/MG11)

4.13. Twenty-five stands, from five of the sample areas, fell into this group. Generally slightly less species-rich than group 1, the stands in this group comprised the predominant vegetation type on the marshes. They were dominated by the same grass species as group 1, with the addition of meadow foxtail (*Alopecurus pratensis*) and common couch. The dry grassland species were mostly absent and species characteristic of damper, brackish conditions, such as hairy buttercup and strawberry clover, occured preferentially. Divided sedge was found in around half of the stands in this group, as in group 1. In most cases, broad-leaved species were scarce, with the exception of white clover, which was constant across all stands in this group.

Group 3 (MG7a/MG7b)

4.14. Six of the seven stands in this group are located in one sample area. This site was reverted to grassland two years prior to the baseline survey, and the sward still contained a high proportion of annuals, such as barren brome (*Bromus sterilis*) and wall barley (*Hordeum murinum*). This was the least species-rich group, most of the stands being dominated by perennial rye-grass, which was sown, and common couch. The seventh stand is located close to a sea wall and is subject to regular disturbance.

SUMMARY

4.15. A survey of 40 stands of vegetation was done in 1993, and this provides a baseline from which change can be monitored. The range of grassland was representative of the nationally restricted vegetation communities found within the grazing marsh complex in the ESA, with three broad groupings identified.

5. BREEDING WADERS

INTRODUCTION

5.1. The North Kent Marshes are nationally important for their breeding wader populations. The area is one of the top five sites in lowland England & Wales for breeding waders and is particularly important for lapwing (*Vanellus vanellus)* and redshank (*Tringa totanus)*. Twenty-six species of bird which the RSPB consider to be of conservation importance (six of which are nationally rare) breed on the marshes in significant numbers.

5.2. Under the ESA scheme, the aim is to conserve and restore the characteristic grazing marsh which was once widespread in the area. Over 50% of this valuable habitat has been lost in the last 50 years (Williams *et al*. 1983). Restrictions on grazing levels during the bird nesting season, together with controls on cutting dates, help to maintain and enhance populations of breeding waders. Where appropriate, raising of water levels will benefit breeding waders and wildfowl. The objectives of the monitoring programme are:

- to determine whether the breeding populations of waders, particularly of lapwing and redshank, are maintained on Tier 1 agreement land;

- to determine whether there is an upward trend in the breeding populations of waders mentioned above on land under Tier 1A agreement (raised water level).

5.3. This chapter describes the methods and results of the monitoring programme from a baseline survey in 1993 and resurvey in 1996. The two key species surveyed were lapwing and redshank, which are identified in the performance indicators (Appendix I). Additional data, collected by ADAS in 1992 for some sites as part of a pilot survey, are reviewed, as are results from earlier surveys conducted by other organisations.

METHODS

Selection of monitoring sites

5.4. As described in Chapter 1, monitoring sites were selected randomly from within the ESA as a whole. Eleven sample areas were selected: nine agreement and two non-agreement, ranging in size from 83 ha to 154 ha. By 1995, two of the Tier 1 sample areas (numbers 4 and 8) had successfully met the requirements for Tier 1A (raised water level). Both these sample areas are managed by RSPB as reserves; site 8 since 1974, although site 4 had only just been purchased by 1993 and was still under agricultural management. The two non-agreement sample areas were under arable cultivation.

Survey methods

5.5. The methods used follow those set out in ADAS (1995), based on standard methodology used by the British Trust for Ornithology (BTO) and RSPB for monitoring

breeding wader populations in lowland wet meadows (O'Brien & Smith, 1992). In the 1993 baseline survey three visits were made to each site, but subsequently this was reduced to two visits as data from only the April and May visits are used to estimate the numbers of breeding territories.

Interpretation of bird counts

5.6. The numbers of territories for each species were calculated using the standard procedures in O'Brien & Smith (1992). These involve simple calculations using the numbers of birds (excluding flocks) found on each visit to a site, as follows:

- lapwing: half the maximum number of displaying or paired birds at either visit 1 or visit 2;
- redshank: the mean of the number of displaying or paired birds at visits in April and May.

Meteorological data

5.7. Breeding bird habitat and breeding success can be affected by seasonal or annual variations in weather conditions. It was important to take account of this when interpreting and assessing the results of the monitoring. Cold weather can affect the availability of the food supply, which can delay the onset of breeding behaviour and may influence selection of territories. Rainfall, or lack of it, may also affect food availability and nest site selection. Temperature and rainfall data were obtained for this purpose from the Met. Office for the period May 1992 to May 1996 (Appendix IX). Temperature data were taken from the weather station at East Malling. Monthly rainfall data were obtained from three weather stations, one at the western boundary of the ESA and two on the Isle of Sheppey towards the eastern boundary of the ESA.

Analysis methods

5.8. The estimate of the number of territories for each site was a census and so had no statistical sampling error associated with it. However, the sites were a sample of the population of sites within the boundaries of the ESA and have been used statistically to infer changes within the ESA as a whole.

5.9. Repeated-measures analysis-of-covariance (ANCOVA) was used to compare the number of territories between the two years (1993 & 1996) and between tiers (non-agreement, Tier 1 & Tier 1A). Separate models were constructed for each species and for the totals of both species. Differential change within tiers was tested using the interaction of tier and year. Site area was included as a covariate. To test for changes within tier 1 alone, parametric t-tests were used. All estimates of territories were log transformed ($x' = \log_e[x+1]$).

5.10. RSPB survey data on breeding waders, prior to ESA designation, were available for sites 2 and 3 from the. ADAS also undertook a pilot survey of these sites in 1992 and these data were used to provide contextual information on the two key species, lapwing and

redshank. Population trends for 1993–96 will be related to national trends provided by the BTO, although these were not available at the time of writing.

RESULTS

5.11. The numbers of wader territories recorded in all sites in each of the two years are presented in Appendix X along with the results of the ANCOVA models. Overall, there was no significant change in the numbers of territories for either species or for both species combined. The total number of lapwing and redshank territories in 1993 was 478; this declined by 25% to 358 in 1996. Furthermore, there were no differences between tiers in the changes from 1993 to 1996 (as represented by the Tier × Year interaction in the ANCOVA models).

5.12. Similarly, within Tier 1 alone there were no significant changes in numbers of territories for either species or both species combined (see Appendix X). Only two sites (4 and 8) were able to meet the requirements of Tier 1A and then only in 1995. Owing to the large difference between them, the changes between 1993 and 1996 were not significant.

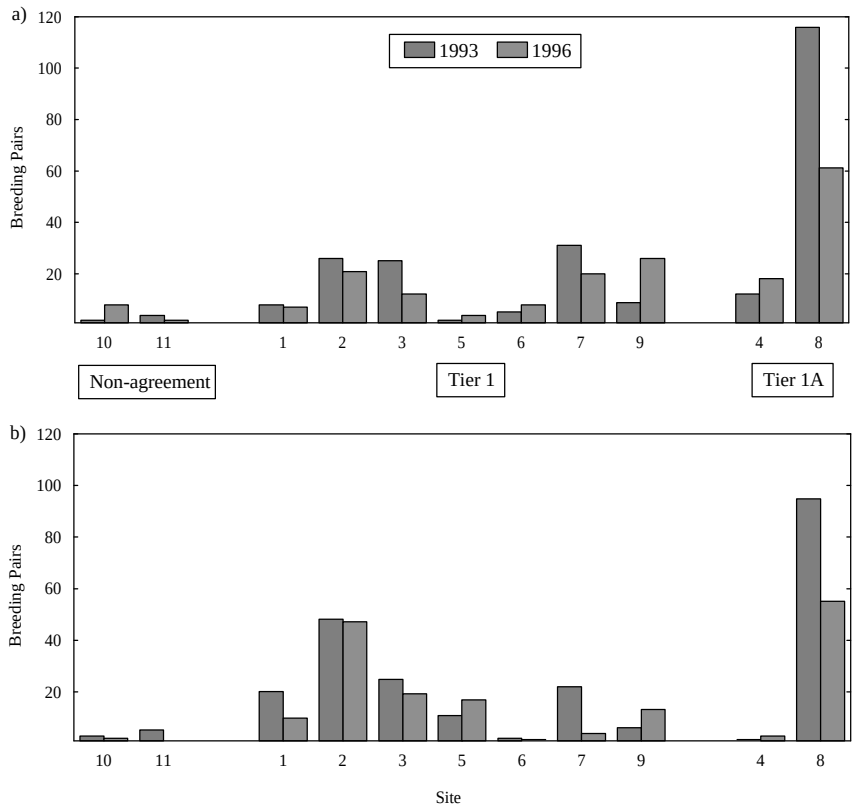

Figure 5.1. The number of a) lapwing and b) redshank territories in 1993 and 1996 for all sites.

5.13. The numbers of lapwing and redshank territories are shown graphically in Figure 5.1. This shows that the major variation was between sites, with site 8 alone in 1993holding nearly half the total number of territories. Lapwing territories increased at five sites and decreased at six, whilst redshank increased on three sites and decreased on eight. Although the declines for

both species in site 8 appeared to be large, in relative terms they were similar to those found in a number of other sites (e.g. site 3 for lapwing and site 1 for redshank).

5.14. The RSPB survey data on breeding waders are combined with ADAS data for sites 2 and 3 in Figure 5.2. Both species showed a significant upward trend over the period 1982 to 1996 (lapwing; $\beta = 1.59$, $P = 0.047$, redshank; $\beta = 3.67$, $P = 0.002$). However, the effects of the very high counts in 1993 are clearly evident. Indeed, the trend for lapwing disappears if this year is excluded ($\beta = 0.98$, $P = 0.084$), although that for redshank remains highly significant (($\beta = 2.98$, $P = 0.002$).

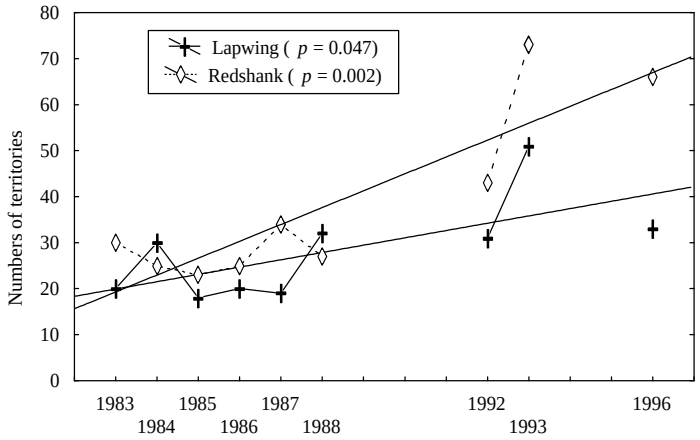

Figure 5.2. Long-term trends in number of territories for lapwing and reshank in sites 2 and 3. (Data for 1983 to 1988 were obtained from RSPB and for 1992 to 1996 from ADAS).

Discussion of results

5.15. The changes detected within sites may be explained by a number of factors. It was a fairly cold, dry spring in 1996; the average maximum temperature in February, March and May was between 1.0°C and 2.4°C below normal and spring rainfall (March to May) was only 35% of normal. These factors could affect breeding behaviour and selection of nest sites resulting in a suppression in numbers. Changes in sward structure could also influence breeding numbers. For example, some areas on site 8 favoured by lapwing because of the short open sward, changed to a closed, longer sward and the numbers of birds using this part of the site consequently decreased. Conversely, changes in management practices, e.g. pumping water to create shallow flooding on site 4, or reinstatement of ditch management on site 5, could have contributed to the noticeable increase of both species on these sites.

5.16. For a variety of reasons such as weather, winter mortality and availability of food supply, all of which are outside the control of the ESA, breeding wader populations are known to fluctuate considerably from year to year. The results presented in this report are based on only two years fieldwork and it is, therefore, impossible to comment on long-term trends in populations. The upward trend detected on sites 2 and 3 should be viewed with caution in terms of the ESA as a whole and must be put in context with national trends (which are

generally downward). It should be noted that the increase started before the launch of the ESA and may be explained by a redistribution of the existing populations within the ESA.

SUMMARY

5.17. Despite a 25% reduction in breeding wader territories from 1993 to 1996 populations appear to have been maintained on Tier 1 land. However, there was no difference in the changes between agreement and non-agreement sites, so this result should be viewed with caution. Although two sites qualified for Tier 1A status, this was not achieved until 1995, so it is too early to comment on the success of this tier.

6. WINTERING BIRDS

INTRODUCTION

6.1. The North Kent Marshes are nationally and internationally important for their wintering populations of wildfowl and waders. Internationally important numbers of dark-bellied brent geese (*Branta bernicla bernicla***)**, wigeon (*Anas penelope*), teal (*Anas crecca*), redshank, ringed plover (*Chiadris hiaticula*) and grey plover (*Pluvialis squatarola*) overwinter in the area.

6.2. The performance indicators given in Appendix I identify two species of wildfowl (wigeon and teal) and four species of wader (redshank, golden plover (*Pluvialis apricaria*), curlew (*Numenius arquata*) and lapwing) for particular interest. The objectives of the monitoring programme are to determine whether the wintering populations of these species are maintained within the ESA. This chapter describes the methods used and results obtained from this programme.

METHODS

Survey methods

6.3. The methods used follow those set out in ADAS (1995). Monitoring sites were those used for the breeding wader survey. The survey involved counting all waders and wildfowl on or near the dates determined for all Wetland Bird Survey (WeBS) counts. Four counts were undertaken between November and February, when the numbers of most species attain their winter peaks. As with the breeding wader survey, data from the two RSPB sites were obtained by RSPB staff using the same methods.

Meteorological data

6.4. Meteorological information was obtained for the ESA as described in Chapter 5 (paragraph 5.7.).

Analysis methods

6.5. The procedures for analysis were the same as those employed for breeding waders (Chapter 5). The independent variables were the same and site area was used as a covariate. In this case, however, the response variables were ‘Site Usage Indices’, derived from the mean of the four counts undertaken in each year. Separate indices were derived for each of the six species and these were summed to give indices for total waders, total wildfowl and total birds. Indices were log transformed to allow parametric analysis.

RESULTS

6.6. Tables summarising wader and wildfowl site usage indices are given in Appendix XI. For all six species, there were no significant differences between years; nor were there any significant differences in the changes between tiers. The three summary response variables are plotted in Figure 6.1. For all species and for the four wader species there were no significant changes, but for the two wildfowl species (wigeon and teal) there was a (barely) significant increase in the Site Usage Index overall ($F_{(1,8)} = 5.84$, $P = 0.042$). Furthermore, although the Year × Tier interaction was not significant, for the seven Tier 1 sites alone there was a significant increase in the index ($t_{(6)} = 3.68$, $P \approx 0.010$).

6.7. The percentage cover of standing water was estimated for each site visit and averaged over the four visits in each year. Non-parametric ANOVA revealed that between 1993/4 and 1995/6 there was a very highly significant reduction in standing water (Kruskal-Wallis $H = 242$, $P \approx 0$). However, linear regression of the Site Usage Indices on these cover values showed no significant relationships.

Discussion of results

6.8. As with the breeding waders there was a large variation in numbers of birds between sites. Again, Site 8 stands out from the others, with over half the total numbers in 1993/4 (*c.* 20 birds per ha, mostly wigeon). In this site the optimal conditions for waders and wildfowl had already been created by the RSPB beyond that required for Tier 1A. Although the marked decrease here may have been expected, as numbers in 1993/4 were at a record high, other factors should be considered. Owing to the lower rainfall during November, January and February, there was less surface flooding at this site than in previous years, and so less favourable habitat for waders and wildfowl. There was a change in the winter stock grazing programme, with sheep present on part of the site from January to March, so increasing the level of disturbance. There was also increased shooting activity on adjacent land, causing much disturbance of the birds in the whole area.

6.9. The change in Site Usage Index for wildfowl should be viewed with caution. Although six of the seven sites in Tier 1 showed an increase, the index also increased greatly in one of the non-agreement sites. This implies that even if the effect is real, it may not be due to the influence of the ESA. (However, the non-agreement site included arable land where additional food was put out to attract wildfowl for shooting, which might explain the large increase in numbers.) Furthermore, multiple testing has been carried out which increases the probability of a significant result occurring by chance alone.

6.10. Weather conditions may account for some of the results. Three of the four months during the 1995/96 survey period, November, January and February, had lower than normal rainfall. Temperatures were lower than normal from December onwards and it was a snowy season, with 24 days of lying snow. Such conditions influence the behaviour of wintering waders and wildfowl, which may move in large numbers from site to site in search of food and shelter. This redistribution of birds within the ESA could account for the decrease in numbers on some sites and increases on other sites. It also illustrates that bird numbers can change considerably in a very short time, often due to factors outside the control of the ESA scheme.

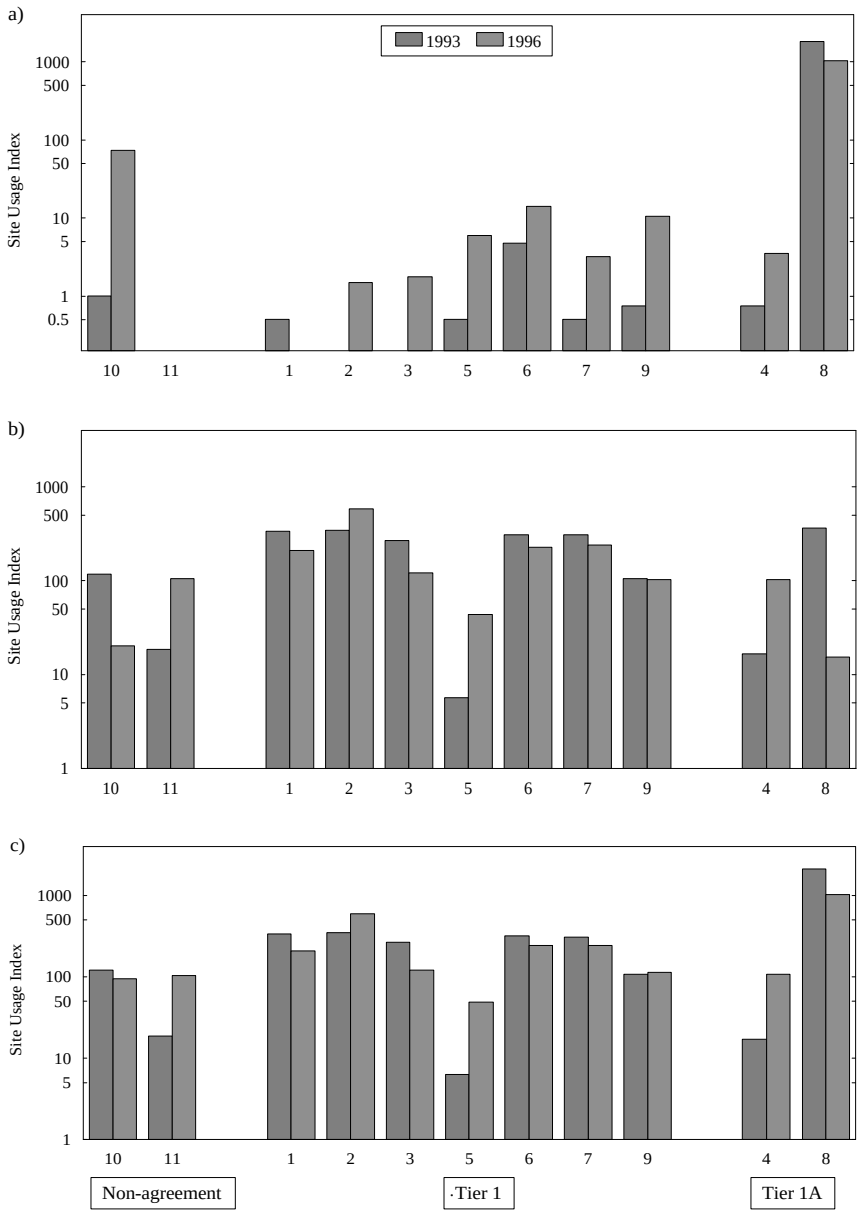

Figure 6.1. Site Usage Indices for a) twowildfowl species, b) four wader species and c) all species. Note that the indices are plotted on logarithmic scales.

6.11. There is some variation in bird numbers between sites and years, although no significant differences were detected. As with breeding waders, populations fluctuate naturally as a result of factors outside the control of the ESA and the results presented here are for two seasons only. It is therefore not possible to comment on long-term trends.

SUMMARY

6.12. Generally, the wintering populations of waders and wildfowl have been maintained within the ESA. Indeed, there is tentative evidence that on Tier 1 land the numbers of wildfowl may have increased. However, numbers on a non-agreement site also increased and

on a Tier 1A site a large decrease was observed, giving a complex overall picture. It is likely that weather conditions had an influence on these variations, as did human disturbance in the form of shooting.

7. LINEAR AND POINT FEATURES

INTRODUCTION

7.1. An overview of the number, length, condition and distribution of linear and point features, such as ditches, fences, hedgerows and trees, has been obtained by the ground survey of 12 sample areas. These features were considered to be important elements in determining the character of particular landscape types and which might be liable to change over time. The sample areas include both agreement and non-agreement land and cover all four landscape types.

7.2. This chapter describes the methods and results of the linear and point feature monitoring. The baseline data (1993) and the changes to the features (from 1993 to 1996) are related to agreement status and landscape type. Changes to the features have been assessed in terms of overall losses or gains, as well as changes in condition or quality.

METHODS

Selection of monitoring sites

7.3. The linear and point features monitoring has taken place in 12 sample areas (site 10 was exluded because of lack of access). Sample areas 1 to 11 were selected at random, but areas 12 and 13 were preferentially selected to improve the coverage of the overall sample (see paragraphs 1.27 and 1.28 for details). Table 1.2 shows the characteristics of the sample areas selected.

7.4. The different selection procedure used to obtain sample areas 12 and 13 means that the overall sample cannot be used to provide statistically valid information that can be extrapolated to cover individual landscape types or the whole ESA. Also, it is not possible to quantify the degree of bias in the sample. For these reasons, the monitoring sites are better regarded as providing a series of case studies in relation to individual landscape types. The changes identified are therefore discussed as trends.

7.5. The predominant landscape type within the sample areas is *Exposed Grazing Marsh*, comprising 74% of the total sample area; 11 of the 12 sample areas have land in this landscape type. The *Marshland Edge* is represented by 10% of the total sample and occurs in three sample areas. The *Sheltered Grazing Marsh* and the *Cultivated Slopes* account for 8% each of the sample areas, being represented by land in two and one of the sample areas, respectively.

Survey methods

Baseline

7.6. The baseline survey was done in 1993. Within each sample areas, important landscape elements, such as linear features (fences, hedges and ditches) and point features (gates, wing fences, sheepfolds and trees), were recorded, mapped and photographed. The classification used for the features is given in Table 7.1 and full definitions of the classes are presented in Appendix XIII. The fences, hedges and ditches were classified according to whether they were stockproof or non-stockproof. Farm buildings were also surveyed and classified according to their weatherproof condition. Each feature was photographed and mapped onto 1:10,000 scale O.S. maps.

Table 7.1. Linear and point feature classes in the North Kent Marshes ESA

Feature class	Definition
Ditch – stockproof	Ditch or watercourse which forms an effective barrier to livestock.
Ditch – non-stockproof	Ditch or watercourse which is ineffective as barrier to livestock.
Fence	Post and wire, post and netting, post and rail, or boarded fences.
Hedgerow – stockproof	Hedgerow which is an effective barrier to livestock, with gaps less than 0.3 m wide and 0.5 m high.
Hedgerow – non-stockproof	Hedgerow which is ineffective as a barrier to livestock, with gaps greater than 0.3 m wide and 0.5 m high.
Tree line	A line of trees, maximum of 3 trees (25 m) wide.
Individual tree/tree group	A single tree or a non-linear aggregation of two or more woody tree species capable of naturally forming a single trunk of more than 3 m. Includes orchards.
Gates with wing fences	Gate with wing fencing at ditch crossing point.
Gates alone	Gate alone at ditch crossing point.
Wing fences alone	Wing fencing without gate at ditch crossing point.
Farm building	Agricultural building constructed of traditional materials. Recorded as weatherproof or non-weatherproof.
Ponds	Small wet depression with signs of standing water.

Resurvey

7.7. Each sample area was revisited in 1996 and the important landscape elements assessed against the baseline information, to determine which features had changed. All changes were mapped, recorded and re-photographed. To be recorded as a change, the appearance of the feature had to have significantly altered, either as a result of agricultural land management or the lack of it. Changes resulting from the routine replacement of fencing or the growth of trees were not recorded.

7.8. Additional information on the continuity of hedgerows was recorded by measuring (pacing) the actual length of the gaps and recording them as a percentage of the total length of the feature. This provides more information about the condition of hedgerows and will allow more detailed recording of changes in future surveys.

7.9. Analysis of the changes to the features has been undertaken for each of the sample areas. The changes identified were analysed in relation to the agreement status of the land, and the landscape types in which they occurred. Photographs from the baseline and resurvey were compared to allow identification of management operations that may have taken place but not resulted in a change of class (such as replanting within a non-stockproof hedgerow).

RESULTS

Ditches

7.10. An intricate network of sinuous and straight ditches traditionally formed 'wet fences' which subdivided the flat, open and exposed land of the *Exposed Grazing Marsh* and *Sheltered Grazing Marsh* into grazing fields, delineated land ownership and helped to drain the land. Consequently, there was little need for fencing or hedging, and the homogeneous, exposed open landscape character of the marshes was maintained.

7.11. A total of 128 km of ditches was identified during the baseline survey, of which 85% was classified as stockproof. Of the total ditch resource, 76% occurred on agreement land and 88% of this was stockproof. On non-agreement land, 74% of ditches were stockproof. The density and stockproof condition of ditches by landscape type is described in Table 7.2.

Table 7.2. Density and stockproof condition of ditches in 1993.

	Exposed Grazing Marsh	**Sheltered Grazing Marsh**	**Marshland Edge**	**Cultivated Slopes**
Density (km/ ha)	0.08	0.2	0.02	0.03
% stockproof	87	95	59	27

7.12. The density of ditches was highest in the *Sheltered Grazing Marsh* where the fields tend to be small (thus there is a greater length of field boundary relative to field size). In the *Exposed Grazing Marsh*, the more expansive fields resulted in a lower density of ditches. In both these landscape types, the proportion of ditches in a stockproof condition in 1993 was large. Ditches are not generally the traditional field boundaries in the *Cultivated Slopes* and the *Marshland Edge*, and the densities (and stockproof condition) were consequently lower.

7.13. From 1993 to 1996, 15% of ditches were found to have changed class, with the majority of this change (97%) being from stockproof to non-stockproof. All change between classes occurred in the *Sheltered Grazing Marsh* and *Exposed Grazing Marsh*, with 22% of all ditches changing in the former and 13% in the latter. Within agreement areas there was a

net deterioration in the condition of 14% of all ditches, compared with deterioration of 11% of the ditches within non-agreement areas.

7.14. It is likely that at least part of the reason for the detected loss of stockproofness of ditches is related to the differences in rainfall in the periods both during and preceding the baseline survey and the resurvey. The baseline was carried out following a comparatively wet period, while the resurvey was carried out after several months of dry weather. It is possible, therefore, that the changes detected are due to influencing factors beyond the control of the ESA.

Fences

7.15. A total of 33.88 km of fences was identified during the baseline survey. Of this, 45% occurred on agreement land. The highest density of fences occurred within the *Cultivated Slopes*, followed by the *Marshland Edge*. The *Exposed Grazing Marsh* contained the lowest density of fences.

7.16. Changes in the total length of fencing within the sample areas are shown in Table 7.3. There was an increase of 0.86 km (2.5%) in the total amount of fencing, and this occurred on non-agreement land in the *Cultivated Slopes*. The new fencing was erected to sub-divide a field into smaller units.

Table 7.3. Change in total length of fencing, from 1993 to 1996.

Agreement status	**Total length (km) in sample**		**Change in total length**	
	1993	***1996***	***km***	***%***
Agreement	15.72	15.72	0	–
Non-agreement	18.16	19.02	0.86	4.7
Total	33.88	34.74	0.86	2.5

Hedgerows

7.17. A total of 2.71 km of hedgerow was identified during the baseline survey, 47% of which was classified as stockproof. By 1996, only 17% (0.45 km) of hedgerows were under agreement, none of which was stockproof in 1993. The majority of non-agreement hedgerows (90%) is in the *Cultivated Slopes* sample areas.

7.18. The highest density of hedgerows in the sample was within the in the *Cultivated Slopes*. The *Marshland Edge* and *Exposed Grazing Marsh* area contained a small amount of hedgerow at a very low density and the *Sheltered Grazing Marsh* contained no hedgerows.

7.19. No change in the total length of hedgerow and no change in stockproofness was detected by the resurvey. Positive management was not found to have been carried out on any of the hedgerows within the sample.

7.20. The assessment of the continuity of all hedgerows in 1996 showed them all to be in moderately good condition (Table 7.4), requiring only limited restoration to make them stockproof and to maintain their wildlife and landscape value. On agreement land, the majority of hedgerows fell in the 60% to 80% class, with none recorded as 100% continuous. In contrast, over half the hedgerows on non-agreement land were 100% continuous.

Table 7.4. Proportion (%) of hedgerow length in continuity classes in 1996.

Continuity class	Length on agreement land		Length on non-agreement land	
	km	***%***	***km***	***%***
0–19%	0	–	0	–
20–39%	0	–	0	–
40–59%	0	–	0	–
60–79%	0.35	78	0.40	18
80–99%	0.10	22	0.57	25
100%	0	–	1.29	57
Total	0.45	100	2.26	100

Trees

7.21. No individual trees were found in the sample areas, but 16 lines and three groups of trees were identified; 14 (74%) of the tree lines occurred within areas of agreement. The *Exposed Grazing Marsh* contained six lines of trees. The *Sheltered Grazing Marsh* contained six lines and two groups of trees, and four lines of trees occurred within the *Marshland Edge*. One group of trees, a small area of relic orchard, was identified within the sample areas in the *Cultivated Slopes*.

7.22. With the exception of a number of elm trees within hedgerows which had died of Dutch elm disease, the resurvey did not identify the loss of any trees. However, a small area of new tree planting had been carried out as part of the various habitat enhancement initiatives being implemented in one sample area on agreement.

Gates and wing fences

7.23. In total, 205 gates were identified during the baseline survey, of which 77% also had wing fences present. A further 16 wing fences were found, without gates present. The highest density of these features occurred in the *Sheltered Grazing Marsh* (Table 7.5) where field size is relatively small and the density of ditches is highest; nearly all (96%) were on land under ESA agreement. Although the proportion of gates with and without wing fences in the *Exposed Grazing Marsh* was the same as in the *Sheltered Grazing Marsh*, the density of features was much lower. In the *Exposed Grazing Marsh*, 77% were on ESA agreement land. The *Marshland Edge* had by far the lowest density of these features, and wing fences were much less prevalent here. No wing fences were recorded in the *Cultivated Slopes*. None of the features in the latter two landscape types was on agreement land.

Table 7.5. Density and types of gates within each landscape type in 1993**.**

Landscape type	Density	Gates with wing fences	Gates alone	Wing fences alone
Exposed Grazing Marsh	1 per 7.5 ha	77%	15%	8%
Sheltered Grazing Marsh	1 per 3 ha	77%	15%	8%
Marshland Edge	1 per 9 ha	40%	60%	0%
Cultivated Slopes	1 per 30 ha	0%	100%	0

7.24. At resurvey, six additional gates were identified. Five of these occurred within the *Sheltered Grazing Marsh* and one within the *Exposed Grazing Marsh*. All these changes occurred on agreement land.

Ponds

7.25. A total of 34 ponds was identified during the baseline survey, of which 20 (59%) were under agreement by 1996. The majority of the ponds (83%) occurred in the *Exposed Grazing Marsh* and *Sheltered Grazing Marsh*, where they serve as watering points for stock. No ponds were found within the *Marshland Edge* and the remaining 17% of ponds were located within the Cultivated Slope. At resurvey, no change was found in the number of ponds.

Farm buildings

7.26. A total of 18 farm buildings were identified during the baseline, of which eight occurred on agreement land. Eleven of the buildings (five on agreement land) were found to be weatherproof. The resurvey identified that there had been no change to farm buildings; nor had any new buildings been erected since the baseline survey.

SUMMARY

7.27. A baseline survey in 1993 identified the number, length and condition of linear and point features considered to be important elements in the landscape of the ESA, and which may be affected by ESA management. A resurvey was done in 1996, and changes to these features were assessed.

7.28. Ditches form the traditional field boundaries within the *Exposed Grazing Marsh* and *Sheltered Grazing Marsh*, where a high proportion were found to be in a stockproof condition. A total of 15% of ditches changed class, with 97% of this change being from stockproof to non-stockproof. It is possible that this change was a result of the drier conditions preceding and during the resurvey.

7.29. Fences and hedgerows were more common outside of the grazing marshes and changes to fencing was recorded on only one study site; this was on non-agreement land within the *Cultivated Slopes*. No changes were found in the extent or quality of hedges.

7.30. Gates and wing fences are another traditional feature of the *Exposed* and *Sheltered Grazing Marshes*. Although some new gates were found at resurvey, these were not associated with wing fences.

8. DITCH VEGETATION

INTRODUCTION

8.1. This section describes the methods and results of the baseline botanical survey of a sample of the ditches in the North Kent Marshes, prior to the implementation of Tier 1A.

8.2. The plant and invertebrate communities in the ditches in the North Kent Marshes ESA are of high nature conservation value, because of their restricted distribution. The range of environmental conditions in the ditches, grading from fresh water through to strongly brackish, supports a variety of highly specialised plant and animal communities. A number of these communities contain scarce species, such as the great silver diving beetle (*Dytiscus marginalis*) and beaked tasselweed (*Ruppia maritima*).

8.3. The botanical monitoring programme for ditches in the ESA was established in 1994. The objectives for this monitoring programme were:

- to determine whether the overall botanical value of the ditches is being affected by Tier 1A management;
- to detect any long-term changes that may be occurring in the vegetation.

8.4. The sample of ditches was taken from areas that were under consideration for Tier 1A. Because of this targeting of a narrowly defined type of land, the sample size was small. Also, because the uptake of this land into Tier 1A was, ultimately, lower than expected, the monitoring programme was unable to address the performance indicator and was, therefore, terminated. However, as the monitoring sites are permanently marked, it will be possible to reinstate the monitoring programme should this ever be considered appropriate.

METHODS

Site selection

8.5. Monitoring sites were selected subjectively, based on the likelihood of the land being accepted by MAFF for entry into Tier 1A. Five sites were selected. Two were RSPB reserves, one was a Kent Trust for Nature Conservation Reserve and the remainder were more typical farms. Within each site, ditches were selected at random from those occurring wholly within the sites. A total of 44 ditches was sampled, with an approximately equal number of ditches from each site.

Survey methods

8.6. The field survey method was adapted from the standard NCC (now English Nature) ditch survey methodology (Alcock & Palmer, 1985), but also incorporated elements of a joint

English Nature/NRA (now Environment Agency) method (Morris *et al.*, 1993) specifically designed for a survey of ditches in the North Kent Marshes.

8.7. Fieldwork was carried out in August 1994. A representative 20 m section of each randomly selected ditch was selected and permanently marked. This was sub-divided into five 4 m sub-sections. A frequency/dominance score for species occurring in the water was recorded for each sub-section: '1' was recorded for species present at less than 70% coverage and '2' for species present at greater than 70% coverage. The five sub-section scores were summed to give an overall frequency/dominance score for each species in the 20 m section. Water conductivity measurements were taken from each ditch section.

Description of the vegetation

8.8. Data from a survey of ditches in the North Kent Marshes carried out by English Nature (EN) and the National Rivers Authority (NRA) in 1993 had been used by Morris *et al.* (1993) to produce a ditch vegetation classification. This was done by running the species frequency/dominance scores from a sample of 449 ditch sections of 20 m through TWINSPAN, a computerised classification programme (Hill, 1979) which grouped the ditch sections on the basis of their vegetation. This process identified nine ecologically distinct endgroups.

8.9. The same technique was applied to the ADAS frequency/dominance scores from the 44 ditch sections surveyed in 1994, and similar results were obtained. It was therefore decided to adopt the EN/NRA endgroup classification for the description of ADAS ditch sections. Ditch sections were thus classified using the keys included in Morris *et al.* (1993). Water conductivity measurements were also used to assist in these descriptions.

RESULTS

8.10. Most of the 44 ESA ditch sections fitted the EN/NRA classification closely, and are described below. There were a few exceptions where one or two of the required constant species were absent, but other species indicated a partial fit.

8.11. Five of a possible nine endgroups described in the EN/NRA report were represented in the sample (Table 8.1).

Table 8.1. Number of ditch sections in endgroups and mean endgroup conductivity values**.**

ESA endgroup	No. of sections	Mean conductivity (µS/cm)
1	4	7,860
2	11	3,008
3	17	2,878
4	1	2,000
5	11	1,815

8.12. The endgroup descriptions below are based on the EN/NRA descriptions; the analogous EN/NRA endgroup identifiers are referred to in the text.

Strictly brackish (Endgroups 1 & 2

8.13. Endgroup 1 (equivalent to EN/NRA group CA2) is typically species-poor, with sea club-rush (*Scirpus maritimus*) and creeping bent (*Agrostis stolonifera*) as constant species. Brackish water-crowfoot (*Ranunculus baudotii*) is present at low frequency. The average conductivity value of this endgroup is indicative of strongly brackish conditions.

8.14. Endgroup 2 (equivalent to EN/NRA group CB1) is species-poor, with constant species being sea club-rush and fennel pondweed (*Potamogeton pectinatus*). Brackish water-crowfoot is abundant. The average conductivity value of this endgroup was considerably lower than endgroup 1, but was still indicative of brackish conditions.

Moderately brackish (Endgroups 3 & 4)

8.15. Endgroup 3 (equivalent to EN/NRA group DC1) has soft hornwort, common duckweed and ivy-leaved duckweed as constants, with sea club-rush and common reed (*Phragmites australis*) at lower frequencies. The average conductivity value of this endgroup indicates moderately brackish conditions.

8.16. Endgroup 4 (equivalent to EN/NRA group CB2) is more species-rich, with common spike-rush (*Eleocharis palustris*) and soft hornwort (*Ceratophyllum submersum*) as constant species. Other frequent species include common duckweed (*Lemna minor*), ivy-leaved duckweed (*Lemna trisulca*), fennel pondweed and brackish water-crowfoot. This endgroup contained only one ditch section and, as soft hornwort was absent, the fit was rather poor.

Fresh water (Endgroup 5)

8.17. This is a strongly fresh water endgroup (equivalent to EN/NRA group DC2), with frogbit and lesser water parsnip (*Berula erecta*) as constant species. The average conductivity value for this endgroup was 1,815 μS/cm, although four ditch sections had values below 1,000 μS/cm, indicating the wide range of water conditions in which this community can occur.

SUMMARY

8.18. A small targeted sample of 44 ditches was surveyed in 1994. Five vegetation types, or endgroups, were identified as occurring in the sample. The endgroups appeared to occur along a gradient of water salinity, which rangeed from extremely brackish to freshwater. Although this work has been terminated, if a requirement to monitor ditches arises in the future, the 1994 survey could be used as a baseline.

9. EVALUATION

INTRODUCTION

9.1. This chapter draws together the results from the monitoring programme, to provide an overall evaluation of the ESA scheme. It assesses how the extent and quality of grazing marsh and field boundaries have changed since the start of the scheme. The impact on the landscape, wildlife and historical value of each of these is evaluated, which enables an assessment to be made of the effect of the scheme on the ESA. The period over which the monitoring has been carried out is very short and, consequently, the results and evaluation should be considered as interim.

9.2. The coastal grazing marshes of North Kent were reclaimed from tidal salt marsh for agricultural use during medieval times, through the construction of sea walls. The land retains much of the former saltmarsh topography, with irregular twisting drainage creeks and shallower low-lying remnant creeks called rills, framed in places by the higher ground of the marsh edge and adjoining slopes. This topography not only contributed to the exposed, flat landscape character, combining a mosaic of habitats present today, it also influenced the types of agricultural practices, principally extensive stock grazing, with arable cultivation confined to higher, better drained land.

9.3. Approximately 80% of the ESA can be described as grazing marsh, which once extended over 14,750 ha (Thornton & Kite, 1990). This had been reduced by over 50% by 1993 to 6,176 ha of semi-natural grazing marsh, as defined by the land cover monitoring programme. The main reasons for this loss have been the change in land use from agriculture to urban development and from permanent pasture to arable. The conversion to arable has taken place mainly from the 1950s onwards. Advances in flood defence techniques and developments in land drainage, coupled with changes in government policy, encouraged a major shift from livestock to arable production.

9.4. The consequences of such a shift have been very serious for the flora, fauna, landscape and historical interest of the North Kent Marshes. The once continuous areas of grazing marsh have been fragmented into smaller blocks, separated by either urban development or drained, levelled and improved grassland and arable land. Such fragmentation leads to a much greater edge effect, which impacts on the species present and the interposing of arable land amongst areas of grazing marsh makes the retention of high water levels on the latter very difficult. The reduced area of these fragmented blocks may also result in the habitat falling below the minimum critical size to support those species occurring within it.

9.5. The conversion of grazing marsh to arable involves underdrainage and in many cases levelling of the area. Such actions destroy the two key features of semi-natural grazing marsh, which contributes to the mosaic of conditions typical of this habitat and the character of the landscape - the retention of surface water in winter and the relict saltmarsh topography. For underdrainage to be successful, the ditches into which these drains feed must be deepened to act as efficient water carriers. Such improvements result in a loss of habitat for many aquatic plant and invertebrate species, and the run off from agricultural chemicals compounds the problems for those species which remain.

9.6. The impact of such agricultural improvements can also be damaging to both surface and buried historical features. Ploughing can damage or destroy these features and lowering of the water table can result in the removal of anaerobic soil conditions which are important in the preservation of palaeo-environmental evidence.

9.7. The ESA addresses these threats by encouraging farmers to protect the remaining areas of grazing marsh through extensive grazing management and sensitive maintenance of ditches under Tier 1. The problems of fragmentation can be reduced by re-establishing grassland on former arable land, followed by extensive grazing under Tier 2. Tier 1 also provides protection for historical features by preventing damaging agricultural operations, while Tier 1A may potentially benefit any archaeological features which may be present. Raising of water levels to provide wetter conditions in winter and early spring, which is beneficial to birds, is encouraged under Tier 1A.

GRAZING MARSH

Extent and distribution

9.8. Despite the loss over the last 50 years of valuable grazing marsh there are still some extensive areas left on the North Kent Marshes. At designation, 89% of the ESA was agricultural land and so eligible to enter into agreement, with 45% being semi-natural grazing marsh, 35% arable and 8% improved grassland. The majority (83%) of the semi-natural grazing marsh occurred in the *Exposed Grazing Marsh* and forms two distinct patterns. In areas such as Cliffe Marshes in the west of the ESA, semi-natural grazing marsh forms large open expanses of grassland. In other areas such as Eastchurch Marshes on the Isle of Sheppey, it is generally confined to narrow linear areas of slightly wetter land adjoining fleets, ditches and areas of lower lying ground. Where the grazing marsh occurs in large blocks, this strengthens the landscape character, as well as providing extensive habitat for waders and wildfowl. Some 3,355 ha of grassland (45% of the eligible area) was under Tier 1 and Tier 1A agreement by the end of 1996. Approximately 74% of Tier 1 and 95% of Tier 1A occurs in the *Exposed Grazing Marsh*, which contributes to the protection of this valuable habitat from further agricultural intensification. Some 22% of Tier 1 land falls in the *Sheltered Grazing Marsh*, with very small amounts present in the remaining landscape types.

9.9. A total of 778 ha of arable land has been reverted to permanent grassland under Tier 2 (16% of eligible land) by the end of 1996, with approximately 95% occurring in the *Exposed Grazing Marsh*. These areas of reversion typically occur as relatively large blocks of land, some being found on the slightly wetter areas adjacent to the fleets. This is helping to restore the grazing marsh as a contiguous area along the fleets and elsewhere maintaining the large areas of existing grazing marsh. This has helped to maintain and strengthen the homogenous, expansive landscape character of the *Exposed Grazing Marsh*, enhancing the wildlife conservation value by reducing fragmentation of the habitat, so benefiting waders and protecting historical features from further damage by ploughing.

9.10. Of the 115 historical features identified, 35% are now protected under ESA agreement. Some 68% of all features occur in the *Exposed Grazing Marsh*, with 17% in the *Sheltered Marsh*. The uptake of Tier 1 has helped maintain the condition of 33 features and arable

reversion has halted damage to a further seven. The remaining 65% of features, however, remain potentially at risk on non-agreement land from inappropriate farming practices.

9.11. The extent and distribution of grazing marsh also has implications for birds. Large areas of grazing marsh, on which the relict saltmarsh topography remains and shallow surface flooding still occurs, attract large numbers of both breeding and wintering birds. Where fragmentation has occurred in the past, through agricultural intensification, bird numbers have fallen considerably. By bringing these remaining fragments, together with the larger blocks, into Tier 1 agreement, the ESA is protecting a large proportion of the existing grazing marsh, including some of the most extensive and important areas.

9.12. Although the habitat for birds is likely to be enhanced on land which is entered into Tier 1A, this tier has not been in operation long enough to allow an assessment of its impact. Similarly, it has not been possible to evaluate the effects of this tier on grassland and ditch vegetation.

Quality

9.13. The quality of the grazing marsh vegetation has been addressed through the monitoring of grassland. Three broad vegetation types were identified in the 1993 survey and these were wet brackish grassland, species-rich dry grassland and relatively species-poor dry grassland. These three communities are representative of the nationally restricted vegetation communities present in the North Kent Marshes. The diversity in sward height and structure characteristic of these grassland communities is maintained by moderate grazing (as prescribed under ESA agreement), providing a range of suitable habitats for breeding waders. Uptake of grazing marsh into the ESA has ensured the continuation of appropriate grazing regimes, which appear to have maintained the populations of breeding and wintering birds across the ESA. Changes in the communities present are likely to be slow, particularly where there has been little change in management pre- and post-ESA, as on much Tier 1 land. As there are no resurvey data, an evaluation of changes in the quality of vegetation cannot be made.

9.14. The retention of characteristic grazing marsh topography is important in maintaining the landscape character of the *Exposed Grazing Marsh* and *Sheltered Grazing Marsh*. The small-scale surface variation, occurring in the form of rills, hollows and undulations and the sense of wetness, is lost when the land is drained, levelled and re-seeded to improved grassland. Such protection of undisturbed grazing marsh also results in the protection of any historical features buried beneath the surface.

FIELD BOUNDARIES

9.15. The field boundaries of greatest importance in the ESA are the ditches. These are the water-carrying drainage channels and are key elements in determining the character of the landscape. They also provide important habitats for aquatic flora and fauna. Other boundaries which have a impact on the landscape character include fences and hedgerows, together with associated features such as trees, gates and wing fences.

Ditches

Extent and distribution

9.16. In total, 128 km of ditches were identified during the baseline survey. The highest density of ditches occurred in the *Sheltered Grazing Marsh*, with lower densities in the remaining landscape types. Some 85% of ditches surveyed were considered stockproof. The vast majority (>87%) of ditches were stockproof in both the *Exposed* and *Sheltered Grazing Marsh* and 59% stockproof in the *Marshland Edge*. Not surprisingly, the figure dropped to 27% in the *Cultivated Slopes*, where such a function is of less importance.

9.17. The resurvey revealed that the total number of stockproof ditches decreased by 15% and that this decrease was similar on agreement land and non-agreement land. All changes in ditch condition occurred in the *Exposed Grazing Marsh* and *Sheltered Grazing Marsh*. Such deterioration can be viewed only as detrimental, as it may result in an increase in fencing to contain livestock, so weakening the landscape character. The reduction of stockproof ditches is also likely to prove detrimental to the wildlife value. It reduces the amount of aquatic habitat available for plants and invertebrates and the extent of suitable feeding areas for waders such as redshank. It is possible, however, that the loss of stockproofness was partly or wholly the result of dryer weather immediately preceding and during the resurvey. Longer-term monitoring will be required to establish whether or not this was the case.

Quality

9.18. The ditch monitoring programme provided a description of a small sample of ditches. Five aquatic vegetation types were identified, ranging from species-rich freshwater communities to species-poor brackish communities. A resurvey was not undertaken; therefore, an evaluation of the effects of the ESA on ditch vegetation quality is not possible. However, as stated earlier, the loss of ditch stockproofness identified in the landscape monitoring is likely to be detrimental to the quality of the nationally important aquatic vegetation and invertebrate communities found in the ESA.

Fences, gates and wing fences

9.19. In total, 33.9 km of fences were identified during the baseline survey, the highest density being found in the *Cultivated Slopes*, where fencing is required to exclude livestock from arable fields. The other landscape types, where ditches are the more typical field boundary, had lower densities of fences. Very little change was detected in the resurvey. The absence of change in the *Sheltered Grazing Marsh* and *Exposed Grazing Marsh* suggests that the ESA is maintaining the open landscape character of these landscape types.

9.20. The gates and wing fences are key features of the landscape character, which stand out against the marshes and sky, particularly in the *Sheltered Grazing Marsh* and *Exposed Grazing Marsh*. The resurvey showed a small increase in the number of gates, all of which occurred on agreement land, and this contributes to the strengthening of the landscape character for these two types.

Hedgerows

9.21. Hedgerows are an important element of the *Cultivated Slopes*, with fewer found on the *Marshland Edge* and *Exposed Grazing Marsh*. No changes were detected in either the length or stockproof characteristics, suggesting that the ESA is maintaining the extent and quality of hedgerows. No evidence of positive management between the baseline and resurvey was identified. Any deterioration of stockproof hedges weakens the distinctive patterns of the landscape and reduces wildlife conservation value.

10. CONCLUSIONS

10.1. The results of the monitoring programme have been presented and evaluated in the previous chapters of this report; this chapter summarises that information to provide an assessment of the success of the scheme in terms of the environmental objectives and overall environmental aim. The ESA has two environmental objectives relating to the wildlife conservation value and landscape quality of the grazing marsh, one specific to the characteristic landscape elements and one relating to the historical resource of the ESA.

10.2. Associated with each objective are a number of performance indicators (PIs) which relate only to land under agreement (see Appendix I). In assessing whether or not the objectives have been met, the performance indicators are also addressed.

ENVIRONMENTAL OBJECTIVES

Objective 1

To maintain and enhance landscape quality and wildlife conservation value by retention of existing grazing marsh and by increasing the area of grazing marsh.

10.3. Despite only 45% of eligible grassland being under agreement in Tier 1 and 1A by the end of December 1996, only 1% of semi-natural grazing marsh has been lost (on non-agreement land) since ESA designation This level of uptake falls short of the 75% target set in PI 1.1. Additionally, 663 ha (14%) of arable land has been reverted to permanent grassland under Tier 2 of the scheme, thereby falling just short of the target set in PI 1.3.

10.4. The protection afforded to the grazing marsh under ESA agreement has helped to maintain the landscape quality of the ESA, and the reversion of land under Tier 2 has enhanced the landscape by strengthening the landscape character, in particular of the *Exposed Grazing Marsh* and *Sheltered Grazing Marsh* landscape types.

10.5. The wildlife conservation value of the grazing marsh and other grassland within the ESA have been described by the botanical and bird monitoring programmes. As there has been no resurvey of the botanical quality of grassland, PI 1.2 cannot be addressed. However, the land cover monitoring detected little or no loss of grazing marsh to improved grassland, suggesting that at least at a coarse level the quality of vegetation has been maintained.

10.6. The results of both bird monitoring activities revealed that there was no statistically significant difference in bird numbers from 1993 to 1996, on either agreement or non-agreement land. Although it is difficult to identify real trends in bird populations over such a short monitoring period, PI 1.4 would appear to have been met.

10.7. In conclusion, this objective has been achieved as far as maintenance is concerned, and there have been has been notable enhancement of the landscape as a result of arable reversion. However, it is too early to assess whether the wildlife conservation value has been enhanced.

Objective 2

To maintain and enhance the wildlife conservation value of grazing marsh without detriment to the landscape by maintaining high water levels in ditches and dykes.

10.8. Tier 1A, to which this objective relates, has been in operation for only a short period and has a fairly low uptake, which does not meet PI 2.1. As discussed in paragraph 10.5 there was no resurvey of grassland, so it is not possible to address PI 2.2. Because of the low uptake of Tier 1A land, and the short period since it was introduced, the bird monitoring was unable to address PI 2.3, and this was also the case for PI 2.4 relating to the quality of ditch vegetation.

10.9. With the low uptake of Tier 1A, together with the short time the tier has been in operation, there is insufficient evidence to address this objective.

Objective 3

To maintain and enhance landscape quality through management of characteristic landscape elements

10.10. No reduction in the total length of ditches and dykes was detected, so PI 3.1 was achieved, thus helping to maintain landscape quality. Some loss of ditch quality, as expressed by stockproofness, was detected. It is too early in the monitoring programme to attribute a cause to this deterioration, although it is likely that climatic variation between baseline and resurvey resulted in some of the change recorded.

10.11. There was no change in the length of hedgerows, but there was also no evidence of positive management of hedgerows. Also there was no loss of gates and wing fences.

10.12. Of the total number of conservation plans, 20% included provision for the reinstatement of abandoned ditches, thus meeting the target set in PI 3.3. However, only 8% of agreements have conservation plans, therefore failing to meet PI 3.2.

10.13. In conclusion, the quality of the characteristic landscape elements has been broadly maintained, but not enhanced, thus the objective has been met in part.

Objective 4

To maintain and enhance archaeological and historic features.

10.14. The ESA scheme has reduced the risk of damage to historical features on agreement land, with 35% of features protected under ESA grassland management regimes. None of the 40 features recorded in the inventory and occurring on agreement land was lost during the monitoring period. Indeed, seven of these features experienced potentially beneficial change as a result of Tier 2 (arable reversion) agreement. Therefore, PIs 4.1 and 4.2 have been met. However, potentially damaging operations on arable land have continued to take place on non-agreement land, and a further three features on non-agreement experienced potentially detrimental change.

10.15. None of the conservation plans taken out by ESA agreement holders included provision for positive management of historical features, thus PI 4.3 has not been met. However, as most of the features are below the soil surface, positive management beyond the requirements of Tier 1 is often inappropriate.

10.16. Taking account of the beneficial and detrimental change that has occurred on agreement and non-agreement land, the historical resource of the ESA has been maintained, and enhanced as a result of arable reversion. Therefore, this objective has been met in full.

ENVIRONMENTAL AIM

To maintain and enhance landscape, wildlife and historic value of the area by encouraging beneficial agricultural practices

10.17. The environmental aim is common to all ESAs and expresses the overall aim of the scheme in influencing the agricultural practices to the benefit of the landscape, wildlife and historical interest of the area. In order to meet this aim in full, the value of all three interests must be both maintained and enhanced.

10.18. The landscape value has been broadly maintained with protection of existing grazing marsh under agreement, minimal loss on non-agreement land and the maintenance of ditch length. There has also been limited but important enhancement through the reversion of arable to grassland. The wildlife value has generally been maintained in terms of breeding and wintering bird numbers, although it is too soon to comment on the impact of the ESA on longer-term trends in populations. There is no evidence at the moment, however, of significant enhancement of wildlife value through raised water levels, but this tier has only been in operation for a relatively short period. The historical value has been maintained by land coming into agreement and further protected owing to reversion of arable land to grass. The threat of damage to known historical features and to those as yet undiscovered has been significantly reduced.

10.19. Thus, the environmental aim has been partially achieved, in that the landscape, wildlife and historical value of the area has been maintained, but evidence of enhancement has yet to be detected.

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APPENDIX I

ENVIRONMENTAL OBJECTIVES AND PERFORMANCE INDICATORS FOR THE NORTH KENT MARSHES ESA

The common **environmental aim** for all ESAs is to maintain and enhance the landscape, wildlife and historic value of the areas by encouraging beneficial agricultural practices. The objectives and performance indicators for each ESA focus on the priorities for achieving the environmental aim.

Specific objectives bring together the particular management options within the ESA scheme that together maintain or enhance the landscape, wildlife or historic value They apply to the whole ESA. The scheme is designed and run to be 'integrated' so that enhancement of wildlife value, for example, does not have a negative impact on the landscape or historic value. This is implicit in the specific objectives. However, if there is a perceived risk that a particular management option may have an adverse effect upon wildlife, landscape or historic value this has been stated in the objective (e.g. *"...without detriment to the landscape."*).

The **performance indicators** specify targets that should be achieved during the **five-year period** following the launch or re-launch of the ESA. The performance indicators cover uptake and environmental impact and include a combination of:

- **overall uptake targets** – usually in the form of a percentage of a type of eligible land that should be under agreement (e.g. *"75% of grassland is under Tier 1 or Tier 1A agreement."*);

- **targets that relate only to agreement land** (e.g. *"20% of conservation plans include provision for the re-instatement of abandoned ditches."*) – only ditches on agreement land are eligible for conservation plans;

- **environmental impact indicators** which relate to the desired result of imposing ESA management agreements on various types of land (e.g. *"There is an upward trend (subject to national trends) in breeding and overwintering populations of birds on land under Tier 1A."*). All environmental impact performance indicators relate specifically to agreement land.

Targets that specify uptake in terms of percent area will be assessed in relation to the baseline area or stock of the feature on **eligible land** at the time of launch or relaunch. Eligible land is any land which can come into a particular option of the scheme. In some cases, land may be eligible to enter a management tier but is unlikely to do so due to competition from other land uses. This land is still considered 'eligible'.

Uptake of conservation plans relates to the number of agreements rather than the number of agreement holders.

ENVIRONMENTAL AIM

To maintain and enhance landscape, wildlife and historic value of the area by encouraging beneficial agricultural practices.

OBJECTIVES AND ASSOCIATED PERFORMANCE INDICATORS

Objective 1: To maintain and enhance landscape quality and wildlife conservation value by retention of existing grazing marsh and by increasing the area of grazing marsh.

1.1 75% of eligible grassland is under Tier 1 or Tier 1A agreement

1.2 Vegetation that is characteristic of grazing marsh does not deteriorate on land under Tier 1 agreement.

1.3 15% of arable land is reverted to grazing marsh under Tier 2 agreement using the specified seed mixture.

1.4 There is no downward trend (subject to national trends) on land under Tier 1 agreement in:

- breeding populations of wading birds, in particular lapwing and redshank;
- overwintering populations of wading birds, in particular lapwing, redshank, golden plover and curlew;
- overwintering populations of wildfowl in particular wigeon and teal.

Objective 2: To maintain and enhance the wildlife conservation value of grazing marsh without detriment to the landscape by maintaining high water levels in ditches and dykes

2.1 1200 hectares of grassland is under Tier 1A agreement.

2.2 Vegetation that is characteristic of grazing marsh increases on land under Tier 1A agreement.

2.3 There is an upward trend (subject to national trends) in breeding and overwintering populations of birds on land under Tier 1A agreement (see 1.4 above).

2.4 Vegetation that is characteristic of ditches at various successional; stages of development and differing salinity does not deteriorate under Tier 1A agreement.

Objective 3: To maintain and enhance landscape quality through management of characteristic landscape elements.

3.1 There is no reduction in the total length of ditches and dykes.

3.2 30% of agreements have a conservation plan.

3.3 20% of conservation plans include provision for the re-instatement of abandoned ditches.

Objective 4: To maintain and enhance archaeological and historic features.

4.1 There is no loss of recorded archaeological and historic features.

4.2 There is no increase in the risk of damage to such features from agricultural operations.

4.3 10% of conservation plans include provision for positive management of archaeological or historic features.

APPENDIX II

MANAGEMENT PRESCRIPTIONS FOR THE NORTH KENT MARSHES ESA

The following tiers and prescriptions have applied since 1993 to land which enters the scheme .

TIER 1

Purpose: To maintain the North Kent Marshes ESA landscape and grassland

Conditions of entry: All or part of existing grassland, including the sea walls, within the ESA boundary.

Management prescriptions:

- Maintain grassland and do not plough, level or re-seed the land. Cultivate only with a chain harrow or roller but do not use a chain harrow or roller during the period 1 April to 30 June.
- Graze with cattle or sheep or both but avoid poaching, overgrazing or undergrazing. Horses may be grazed but only in association with cattle of sheep or both. During the period 1 April to 31 May, do not exceed a stocking density of 0.75 livestock units (LU) per hectare.
- Do not top or cut the grass for hay or silage before 1 July.
- Wilt and turn grass cut for silage before removal and graze the aftermath.
- Restrict supplementary feeding of livestock to areas agreed in advance.
- Do not apply inorganic or organic fertilise except for farmyard manure (FYM) produced on the farm. Do not apply slurry.
- Do not apply more than your existing application rate of farmyard manure and, in any event, do not apply more than 12.5 tonnes of farmyard manure per hectare (5 tons per acre) per year.
- Do not apply farmyard manure during the period 1 April to 31 May and outside this period apply it only as a single dressing.
- Do not apply lime, slag or any other substance designed to reduce the acidity of the soil.
- Do not use insecticides or fungicides.
- Do not apply herbicides except to control nettles, spear thistle, creeping or field thistle, curled dock, broad-leaved dock or ragwort. Apply herbicides by means of a hand-held weed wiper or by spot treatment with a knapsack sprayer.
- Do not fill in any ditches, dykes rills or hollows.
- Maintain existing water levels in ditches and dykes.
- Maintain ditches and dykes in rotation by mechanical means, not sprays. After drying, spread spoil adjacent to the ditch or dyke.

- Do not install any new land drainage system or modify and existing land drainage system to bring about improved drainage.

- Retain and manage ponds and reedbeds.

- Maintain gates, gateways and wing fences.

- Retain and manage any hedges, trees and treelines. Maintain stockproof hedges in a stockproof condition using traditional methods.

- Do not plant any additional trees, hedges or woodland without the Ministry's prior written approval.

- Maintain any weatherproof traditional farm buildings in a weatherproof condition using traditional methods.

- Do not damage, destroy or remove any feature of archaeological or historic value or interest.

- Obtain written advice on siting and materials before constructing buildings or roads or carrying out any other engineering works which do not require planning permission or prior notification determination by the Local Planning Authority.

TIER 1A (WET GRASSLAND)

Purpose: To enhance the wildlife interest of grassland by raising water levels in ditches and dykes.

Conditions of entry: All or part of the grassland may be entered where the specified water levels can be achieved and which have significant wildlife interest or potential. All Tier 1 prescriptions must be followed plus the additional prescriptions set out below.

Management prescriptions:

- During the period 1 December to 30 April maintain water levels in ditches and dykes at not less than mean field level so as to create shallow pools and do not let

  water out of the ditches and dykes until this has been achieved except under flood warning conditions.

- Provide at least 30 cm (12") of water in the bottoms of ditches and dykes from 1 May until 30 November.

TIER 2 (ARABLE REVERSION TO PERMANENT GRASSLAND)

Purpose: To revert arable land to permanent grassland.

Conditions of entry: All or part of land may be entered which was in arable cropping on 31 August 1992 or ley grassland which formed part of an arable rotation on 31 August 1992. Grassland which has been under ley management for 5 years or more is not eligible.

Once under permanent grass the land must be managed under the guidelines in Tier 1. It may be offered for inclusion under Tier 1A. In the first year Certain practices which are 'prohibited' in Tier 1 are allowed to enable a grass sward to establish. These practices are set out below

Management prescriptions:

- Cease arable production or ley grassland production. Within 12 months of the start of the agreement establish a permanent grass sward using suitable species chosen from an approved list.

- During the first 12 months of the agreement do not apply inorganic or organic fertiliser, lime, slag or any other substance designed to reduce the acidity of the soil, fungicides, insecticides or herbicides.

- Cut the grass and remove as hay, but not silage, during the first 3 years following grassland establishment and graze the aftermath. Do not cut the grass before 1 July.

- From the start of the agreement all Tier 1 guidelines must be followed from "Do not fill in any ditches, etc."

PUBLIC ACCESS TIER

Payments are available for creating new public access for walking and other quiet recreation.

CONSERVATION PLAN: ELIGIBLE ITEMS

Protection of historic and archaeological features
Gapping up of hedges
Hedge laying
Restoration of ponds
Hedge coppicing
Restoration of ditches and dykes
Construction of bunds or sluices or other works to control water levels
Construction or reconstruction of culverts
Provision and restoration of gates for public access
Provision and restoration of stiles for public access
Provision and restoration of footbridges for public access.

APPENDIX III

SUMMARY DESCRIPTIONS OF LANDSCAPE TYPES

The North Kent Marshes ESA landscape assessment (ADAS, 1994) identifies four different landscape types, namely:

- *Exposed Grazing Marsh*
- *Sheltered Grazing Marsh*
- *Marshland Edge*
- *Cultivated Slopes*

The *Exposed Grazing Marsh* is the most extensive landscape type of the ESA. It is a simple, spacious landscape and consists of flat open grassland which occurs on alluvial soils in a belt immediately behind the sea defences. Significant patterns have been created by a network of ditches which drain the marsh.. The landscape has a feeling of great openness, remoteness and exposure to the elements.

The *Sheltered Grazing Marsh* occurs on alluvial soils close to higher ground and extends into the adjoining valley floors as part of the main belt of coastal marsh. It is generally flat and dissected by a network of sinuous ditches. The scale of the *Sheltered Grazing Marsh* is determined by the strong regular pattern of the field boundaries and the spatial character ranges from a strong sense of enclosure to a more open expansive appearance. The presence of trackways and buildings indicates the proximity of settlements adjoining the marshland edge and the relatively recent enclosure of the marsh which enhances the managed character of this area.

The *Marshland Edge* occupies a zone of variable width of more freely draining soils between the *Exposed Grazing Marsh* and *Sheltered Grazing Marsh* and the higher ridges that form a main backdrop to the marsh. It is a domesticated landscape typified by a pattern of small grass and arable fields divided by hedges, orchards or tree belts, which are interspersed with dwellings and lanes. Sweeping expanses of intensively farmed arable land and large scale building development interrupt this structured pattern.

The *Cultivated Slopes* occurs as a belt of varying height and width on the ridge of the undulating land inland from the marshes. The majority of this land occurs on elevated parts of the Sheppey and Hoo peninsulas and is commonly associated with London Clay, chalk or brick-earth deposits. The scale and pattern of this landscape vary from a mixture of small grass paddocks, arable fields and richly textured orchards, enclosed by hedges and windbreaks, to bleak slopes and open skylines of areas under intensive arable farming. Field enlargement, and the consequent loss of hedgerows and orchards, have weakened the character of this landscape type. It is this trend, and location that distinguishes this landscape from the *Marshland Edge*.

A colour map showing the distribution of landscape types throughout the ESA is available from: Conservation Management Division (A), Ministry of Agriculture Fisheries and Food, Room 619, Nobel House, 17 Smith Square, London SW1P 3JR (Telephone: 0171 238 3000).

APPENDIX IV

DEFINITIONS OF LAND COVER CLASSES

Land cover class	Definition
Arable	Areas of cultivated land ≥ 0.25 ha in size, either growing an annual harvested crop (such as cereals, oilseeds, pulses, potatoes and sugar beet), ley grasslands forming part of a five year or less rotation, or land in set-aside either in the form of natural regeneration, green cover or industrial crops. Cultivated bare earth, fodder crops, horticultural crops, game cover and outdoor pigs are also included.
Improved grassland	All areas ≥0.25 ha which have ≥20–100% cover of grass species which have been agriculturally improved and/or intensively managed in the recent past, but do not form part of an arable rotation of up to five years (i.e. more than four years old). This class may include up to 50% cover of scrub or woodland and up to 50% cover of swamp and marginal vegetation. Plant species diversity is usually low, the sward is dominated by agricultural grasses, such as perennial rye-grass (*Lolium perenne*) and white clover (*Trifolium repens*), and a few herbs tolerant of intensive management may be present. Improved grassland usually has a bright green, lush and even sward although in dairy and horse paddocks, poaching and dunging is common and often causes a 'patchy' sward structure.
Semi-natural grazing marsh	All areas ≥0.25 ha which have ≥20% cover of semi-improved and unimproved grass, herb, reed and sedge species. This class may include up to 50% cover of scrub or woodland and up to 50% of swamp and marginal vegetation. These grasslands are naturally very low in species diversity (usually no more than 7–8 species in total) and contain only a few broad-leaved herbs. This class is typified by traditionally managed grassland (grazed by cattle and sheep) which may have had some agricultural improvements but retains most of the characteristics of natural grazing marsh, i.e., the presence of an appropriate mosaic of plant communities and/or physical relics of saltmarsh. Often undulating surface, anthills, rills, relict saltmarsh creeks and shallow pools are characteristic. Divided sedge (*Carex divisa*) is a good indicator species and thistles (*Cirsium* spp.) and rushes (*Juncus* spp.) are often present. Bird's-foot-trefoil (*Lotus corniculatus*) is frequently found on anthills and on higher ground. This category also includes grasslands which are not typical grazing marsh, but agriculturally unimproved or semi-improved. They may occur on the higher ground away from any saline influence. Management may be by grazing or they may be cut for hay and the aftermath grazed. Included in this class are the overgrazed and often weedy horse paddocks of the urban fringe.
Swamp and marginal vegetation	All areas ≥0.25 ha which have ≥50% cover of reeds (*Phragmites australis*) or sedges (*Carex* spp.) or stands of tall herbaceous vegetation growing usually in waterlogged situations or along margins of watercourses/ditches/creeks, and within an area of current agricultural use. Includes any neglected or unmanaged vegetation greater than 0.25 ha and ≥10m wide which may include agricultural grasses, woodland and scrub. The class principally comprises vegetation growing in wet or waterlogged areas usually found in strips or blocks adjacent to watercourses/waterbodies.

Land cover class	Definition
Woodland	All areas ≥0.25 ha which have ≥50% cover at canopy level of tree species which are >5 m tall when mature or which form an area of new planting or coppice rotation. This class includes all deciduous and coniferous, native and exotic species. Some shrub species may also be present.
Scrub	All areas ≥0.25 ha which have ≥50% cover of woody species comprising vegetation dominated by shrubs ≤5 m tall, occasionally with a few scattered trees.
Saltmarsh	Any area of land ≥0.25 ha comprising vegetation characteristic of coastal/saline habitats above the mean high water mark.
Open water	All rivers, lakes, ponds, main ditches, creeks and reservoirs ≥0.25 ha and ≥10 m wide. This class may include up to 50% of cover of swamp and marginal vegetation.
Non-agricultural land	Any area of land ≥0.25 ha which is not in current agricultural use. This includes all residential and industrial areas with the associated gardens and yards, farmsteads and surrounding farmyards, amenity areas, allotments, non-farmed parkland and recreational areas, such as campsites, boat moorings, golf courses, scrambling areas, car parks, holiday camps and caravan parks, including former camp sites.
	Roads and tracks and their associated verges ≥10 m wide and railway lines (in use and disused). Also includes active and reclaimed mineral workings (where not in agricultural use), vegetated rubbish tips and areas used for sludge and dredgings disposal. In areas of mineral working, water areas are shown as such where possible. Includes mudflats below mean high-water level.

A colour map showing the distribution of land cover classes within the ESA is available from: Conservation Management Division (A), Ministry of Agriculture Fisheries and Food, Room 619, Nobel House, 17 Smith Square, London SW1P 3JR (Telephone: 0171 238 3000).

APPENDIX V

ACCURACY ASSESSMENT FOR THE 1996 LAND COVER MAP

The 1996 accuracy assessment follows the methods set out in Volume 2 of ADAS, 1995 and is summarised below.

A systematic random sampling scheme was used to obtain 35 accuracy assessment sites, each 1 km × 1 km in size, spread throughout the ESA. An 10 × 10 grid of observation points was superimposed over an O.S. base map of each accuracy assessment site. The aim was to have a minimum of fifty observation points in each land cover classes. An independent surveyor, who had no prior knowledge of the land cover mapped for the site, visited each observation point and recorded the land cover on the basis of the definitions given in Appendix IV. These ground-based records were then taken to be the 'true' class, for comparison with the class shown on the land cover map.

An accuracy assessment matrix was constructed to indicate the number of correctly classified points for each land cover class; the matrix also indicates the class into which each misclassified point had been allocated. The overall map accuracy was calculated as the percentage of all observation points which had been correctly classified. Accuracy for individual classes is expressed as both a 'producer' and 'user' accuracy. The producer accuracy indicates the probability that the true land cover class at any point on the ground has been shown correctly on the map. The user accuracy indicates the probability that the land cover class shown for a given point on the map will be the true land cover on the ground.

An overall map accuracy in excess of 85% is normally considered to be acceptable. Accuracy for individual land cover classes should normally exceed 70%. If a class was not mapped to an acceptable level of accuracy, it was retained if considered important enough to remain as an individual class or was amalgamated with an appropriate class.

The following table gives the accuracy assessment matrix for the 1996 land cover map. The matrix shows the number of correctly and incorrectly classified observation points for each class of land cover. The correctly classified points are given in bold. The overall map accuracy is given in bold in the lower right-hand corner of the matrix.

Accuracy assessment matrix for the 1996 land cover map.

Land cover mapped from aerial photography

		Arable	Improved grassland	Semi-natural grazing marsh	Swamp & marginal veg.	Scrub	Woodland	Salt-marsh	Open water	Non-agricultural	Total no. of observation points	Producer accuracy
	Arable	**578**	4	13	0	0	0	0	1	2	598	97%
	Improved grassland	18	**107**	8	0	0	1	0	0	2	136	79%
Ground-	**Semi-natural grazing marsh**	1	60	**1,087**	4	3	0	2	14	1	1172	93%
recorded	**Swamp & marginal veg.**	0	0	6	**17**	0	0	0	5	0	28	61%
('true')	**Scrub**	0	0	0	0	**3**	1	0	0	1	5	60%
	Woodland	0	0	0	0	8	**6**	0	0	0	14	43%
land	**Saltmarsh**	0	0	1	0	0	0	**7**	0	0	8	88%
cover	**Open water**	0	0	1	0	1	0	1	**24**	0	27	89%
	Non-agricultural	6	4	68	9	3	0	0	2	**101**	193	52%
	Total no. of observation points	603	175	1184	30	18	8	10	46	107	**2,181**	–
	User accuracy	96%	61%	92%	57%	17%	75%	70%	52%	94%	–	**88%**

APPENDIX VI

AREAS (HA) OF LAND COVER CLASSES IN 1993

Land cover class	**Area in landscape type**				**Total**
	Enclosed Grazing Marsh	*Sheltered Grazing Marsh*	*Marshland Edge*	*Cultivated Slopes*	
Arable	3,092	179	777	773	4,821
Improved grassland	346	337	290	188	1,161
Semi-natural grazing marsh	5,133	652	388	2	6,175
Swamp and marginal	163	44	17	0	224
Scrub	9	24	29	12	74
Woodland	3	9	20	12	44
Saltmarsh	66	0	5	0	71
Open water	383	105	23	1	512
Non-agricultural land	331	43	142	117	633
Total	**9,526**	**1393**	**1691**	**1105**	**13,715**

APPENDIX VII

CHANGE BETWEEN LAND COVER CLASSES, 1993–1996

The following table provides a detailed breakdown of the changes between land cover classes, from 1993 to 1996.

The overall change and the change on agreement land are both given.

Change between land cover classes, from 1993 to 1996, in hectares. (Figures in parentheses are changes on agreement land)

TO: Land cover class in 1996

FROM: Land cover class in 1993	Arable	Improved grassland	Semi-natural grazing marsh	Swamp & marginal veg.	Scrub	Woodland	Saltmarsh	Open water	Non-agricultural	TOTAL
Arable	–	614	11	0	0	0	0	3	1	629
	–	(602)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(603)
Improved grassland	63	–	3	0	0	0	0	3	6	75
	(0)	–	(3)	(0)	(0)	(0)	(0)	(3)	(0)	(6)
Semi-natural grazing marsh	20	48	–	22	0	0	0	23	19	92
	(0)	(0)	–	(9)	(0)	(0)	(0)	(13)	(4)	(26)
Swamp & marginal veg.	0	0	2	–	0	0	0	45	0	47
	(0)	(0)	(0)	–	(0)	(0)	(0)	(7)	(0)	(7)
Scrub	0	0	0	0	–	0	0	0	0	0
	(0)	(0)	(0)	(0)	–	(0)	(0)	(0)	(0)	(0)
Woodland	0	0	0	0	0	–	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	–	(0)	(0)	(0)	(0)
Saltmarsh	0	0	0	0	0	0	–	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)	–	(0)	(0)	(0)
Open water	0	0	0	0	0	0	0	–	0	0
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	–	(0)	(0)
Non-agricultural	0	0	0	0	0	0	0	0	–	0
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	–	(0)
TOTAL	83	622	16	25	0	0	0	75	26	847
	(0)	(603)	(3)	(9)	(0)	(0)	(0)	(24)	(4)	(642)

APPENDIX VIII

SUMMARY OF CATEGORIES OF HISTORICAL FEATURES

EARTHWORKS: Includes features which, in the field, are distinguishable from the natural landform, ranging from field systems, deserted settlements and burial mounds to fortifications, mine pits and quarry workings. Includes salt workings and salterns.

BURIED FEATURES & ARTEFACTS: These features are not readily apparent in the field, although they may be evident on suitable aerial photographs, for example as crop marks. Burials and cemeteries, where not associated with earthworks, are also included in this category. Artefacts (including individual 'finds' and 'scatters') may indicate sites of potential significance.

BUILDINGS: All buildings and structures (either intact or relic with evident remains of walls) which are associated with agricultural activities, mine works and past industrial processing areas. Buildings which are used for residential purposes, and are not eligible for inclusion within the ESA scheme, are excluded.

APPENDIX IX

SUMMARY OF METEOROLOGICAL DATA FOR 1992–1996

Minimum temperature (^{o}C) at East Malling, Kent

Grid Reference: TQ 708571 Altitude: 33 m

Growing season	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1992/93	10.8	13.1	13.1	9.9	4.8	4.7	1.5	3.4	2.3	2.3	6.4	9.0
1993/94	11.2	12.0	10.9	9.0	6.8	1.9	3.6	2.9	0.5	5.0	4.7	7.5
1994/95	10.5	14.1	13.0	10.2	6.5	8.2	3.4	2.3	4.8	2.2	5.8	6.5
1995/96	10.3	14.3	14.8	10.1	8.6	4.5	0.9	3.2	-0.1	1.9	4.1	5.4
Average (1961–90)	9.8	11.9	11.6	9.5	7.0	3.6	2.1	1.2	1.2	2.4	4.2	6.9

Maximum temperature (^{o}C) at East Malling, Kent

Growing season	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1992/93	21.1	22.0	20.9	18.5	12.5	12.0	7.5	9.7	6.9	11.2	14.4	16.6
1993/94	20.6	20.8	20.8	17.0	13.0	8.3	9.2	9.1	7.1	11.9	12.7	15.2
1994/95	20.3	24.4	21.9	17.1	14.9	13.2	10.2	8.3	10.5	10.7	14.2	17.9
1995/96	19.4	24.9	25.2	18.4	17.9	11.5	5.4	6.4	6.1	7.6	13.3	13.9
Average (1961–90)	19.5	21.6	21.5	18.9	15.1	10.2	7.8	6.8	7.1	9.8	12.4	16.3

Rainfall (mm) at Elmley RSPB Reserve, Isle of Sheppey, Kent

Grid Ref: TQ 938679 Altitude: 11 m

Growing season	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
1992/93	15.0	-	-	67.1	-	88.0	38.7	31.1	6.3	11.7	51.3	74.4	301.5
1993/94	44.5	42.8	31.8	77.0	76.5	45.6	68.6	55.2	30.8	30.8	50.0	61.2	614.8
1994/95	34.7	22.1	81.0	81.1	63.4	18.1	60.5	126.4	53.8	49.3	14.5	21.0	625.9
1995/96	24.4	41.4	4.8	151.3	6.4	17.4	77.6	34.4	29.2	16.0	7.7	26.3	436.9
Average (1961–90)	44	46	46	55	57	60	55	54	36	44	40	40	617

APPENDIX X

ANALYSIS OF DATA FOR BREEDING WADERS

Table A. The number of wader territories in 1993 and 1996 for each site.

Tier	Site	Area (ha)	Lapwing		Redshank		Both species	
			1993	1996	1993	1996	1993	1996
0	10	123	2	8	3	2	5	10
0	11	128	4	2	5	0	9	2
1	1	97	8	7	20	10	28	17
1	2	127	26	21	48	47	74	68
1	3	107	25	12	25	19	50	31
1	5	83	2	4	11	17	13	21
1	6	106	5	8	2	1	7	9
1	7	132	31	20	22	4	53	24
1	9	154	9	26	6	13	15	39
1A	4	98	12	18	1	3	13	21
1A	8	65	116	61	95	55	211	116

Table B. Results of ANCOVA for lapwing territories.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	1.19	7	1.11	1.0725	0.335
Tier	2	4.69	7	1.11	4.2296	0.062
Year	1	0.02	8	0.24	0.09789	0.762
Tier × Year	2	0.04	8	0.24	0.1828	0.837

Table C. Results of paired t-tests for lapwing in Tier 1.

YEAR	Mean	n	Difference	S.E. Diff.	t	df	*P*
1993	2.487						
1996	2.555	7	0.068	0.223	0.302	6	0.773

Table D. Results of ANCOVA for redshank territories.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	1.17	7	2.79	0.4187	0.538
Tier	2	2.85	7	2.79	1.0222	0.408
Year	1	0.65	8	0.32	2.0355	0.192
Tier × Year	2	0.35	8	0.32	1.0894	0.382

Table E. Results of paired t-tests for redshank in Tier 1.

YEAR	Mean	n	Difference	S.E. Diff.	t	df	*P*
1993	2.694						
1996	2.442	7	-0.252	0.275	-0.915	6	0.396

Table F. Results of ANCOVA for sum of territories for both species.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	0.001	7	1.59	0.0008	0.978
Tier	2	4.30	7	1.59	2.6940	0.136
Year	1	0.10	8	0.33	0.3149	0.590
Tier × Year	2	0.06	8	0.33	0.1736	0.844

Table G. Results of paired t-tests for both species in Tier 1.

YEAR	Mean	n	Difference	S.E. Diff.	t	df	*P*
1993	3.248						
1996	3.224	7	-0.024	0.225	-0.102	6	0.922

APPENDIX XI

ANALYSIS OF DATA FOR WINTERING WADERS AND WILDFOWL

Table A. Site Usage Index (mean number of birds over four visits) for four species of wader.

Table B. Site Usage Index (mean number of birds over four visits) for wildfowl and total species.

Table C. Results of ANCOVA for wintering wigeon.

Table D. Results of ANCOVA for wintering teal.

Table E. Results of ANCOVA for wintering wildfowl.

Table F. Results of ANCOVA for wintering golden plover.

Table G. Results of ANCOVA for wintering lapwing.

Table H. Results of ANCOVA for wintering curlew.

Table I. Results of ANCOVA for wintering redshank.

Table J. Results of ANCOVA for wintering waders.

Table K. Results of ANCOVA for total wintering birds.

Table A. Site Usage Index (mean number of birds over four visits) for four species of wader.

			Golden plover		Lapwing		Curlew		Redshank		Total waders	
TIER	**SITE**	**Area (ha)**	**1993**	**1996**	**1993**	**1996**	**1993**	**1996**	**1993**	**1996**	**1993**	**1996**
0	10	123	39.5	0.00	79.25	18.25	0.00	2.00	0.00	0.00	118.75	20.25
0	11	128	10.00	24.00	8.50	81.50	0.00	0.00	0.00	0.00	18.50	105.50
1	1	97	68.50	28.25	161.25	111.00	95.75	69.00	6.75	0.25	332.25	208.50
1	2	127	20.00	66.00	329.00	498.75	0.00	25.25	0.00	0.00	349.00	590.00
1	3	107	12.00	3.50	250.75	107.25	4.25	9.00	0.00	0.00	267.00	119.75
1	5	83	0.00	4.50	0.75	29.50	4.00	8.25	1.00	1.50	5.75	43.75
1	6	106	3.75	2.75	174.75	142.75	130.30	82.00	1.00	0.00	309.80	227.50
1	7	131	0.00	0.00	254.75	230.25	43.50	10.75	8.25	0.00	306.50	241.00
1	9	154	0.00	0.00	104.50	100.75	1.00	2.25	0.50	0.00	106.00	103.00
1a	4	98	0.00	0.00	14.50	102.25	2.00	1.25	0.00	0.00	16.50	103.50
1a	8	108	0.00	0.00	278.00	7.00	66.75	8.25	15.25	0.00	360.00	15.25
		TOTAL	153.75	129.00	1656.00	1429.30	347.55	218.00	32.75	1.75	2190.10	1778.00

Table B. Site Usage Index (mean number of birds over four visits) for wildfowl and total species.

TIER	SITE	Area (ha)	Wigeon		Teal		Total wildfowl		Total bird species	
			1993	1996	1993	1996	1993	1996	1993	1996
0	10	123	0.00	10.25	1.00	64.75	1.00	75.00	119.75	95.25
0	11	128	0.00	0.00	0.00	0.00	0.00	0.00	18.50	105.50
1	1	97	0.00	0.00	0.50	0.00	0.50	0.00	332.75	208.50
1	2	127	0.00	1.00	0.00	0.50	0.00	1.50	349.00	591.50
1	3	107	0.00	0.00	0.00	1.75	0.00	1.75	267.00	121.50
1	5	83	0.00	0.00	0.50	6.00	0.50	6.00	6.25	49.75
1	6	106	0.00	3.25	4.75	10.75	4.75	14.00	314.55	241.50
1	7	131	0.00	1.50	0.50	1.75	0.50	3.25	307.00	244.25
1	9	154	0.00	1.00	0.75	9.50	0.75	10.50	106.75	113.50
1A	4	98	0.00	0.00	0.75	3.50	0.75	3.50	17.25	107.00
1A	8	108	1,593.00	991.00	196.00	30.25	1,789.00	1,021.30	2,149.00	1,036.50
		TOTAL	1,593.00	1,008.00	204.75	128.75	1,797.80	1,136.80	3,987.80	2,914.80

Table C. Results of ANCOVA for wintering wigeon.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	0.28	7	1.40	0.2033	0.666
Tier	2	3.37	7	1.40	2.4125	0.160
Year	1	0.10	8	0.06	1.7055	0.242
Tier × Year	2	0.03	8	0.12	0.2919	0.754

Table D. Results of ANCOVA for wintering teal.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	0.03	7	0.62	0.0497	0.830
Tier	2	0.94	7	0.62	1.5249	0.282
Year	1	0.37	8	0.16	2.3531	0.164
Tier × Year	2	0.23	8	0.16	1.4784	0.284

Table E. Results of ANCOVA for wintering wildfowl.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	0.16	7	1.34	0.1178	0.741
Tier	2	2.95	7	1.34	2.2113	0.180
Year	1	0.74	8	0.13	5.8432	0.042
Tier × Year	2	0.12	8	0.13	0.9797	0.416

Table F. Results of ANCOVA for wintering golden plover.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	0.68	7	0.73	0.9363	0.365
Tier	2	1.46	7	0.73	2.0092	0.204
Year	1	0.15	8	0.19	0.7692	0.406
Tier × Year	2	0.18	8	0.19	0.9273	0.434

Table G. Results of ANCOVA for wintering lapwing.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	1.14	7	0.38	2.9981	0.127
Tier	2	0.71	7	0.38	1.8721	0.223
Year	1	0.00	8	0.35	0.0107	0.920
Tier × Year	2	0.09	8	0.35	0.2664	0.773

Table H. Results of ANCOVA for wintering curlew.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	0.73	7	0.70	1.0447	0.341
Tier	2	1.36	7	0.70	1.9345	0.214
Year	1	0.00	8	0.17	0.0148	0.906
Tier × Year	2	0.19	8	0.17	1.1283	0.370

Table I. Results of ANCOVA for wintering redshank.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	0.03	7	0.13	0.2347	0.643
Tier	2	0.07	7	0.13	0.5581	0.596
Year	1	0.36	8	0.11	3.2783	0.108
Tier × Year	2	0.09	8	0.11	0.8275	0.471

Table J. Results of ANCOVA for wintering waders.

	df Effect	MS Effect	df Error	MS Error	F	*P*-level
Area	1	0.44	7	0.32	1.3729	0.280
Tier	2	0.65	7	0.32	2.0244	0.202
Year	1	0.03	8	0.27	0.1077	0.751
Tier × Year	2	0.04	8	0.27	0.1517	0.862

Table K. Results of ANCOVA for total winter birds.

	df Effect	**MS Effect**	**df Error**	**MS Error**	**F**	***P*-level**
Area	1	0.62	7	0.62	0.9934	0.352
Tier	2	0.55	7	0.62	0.8829	0.455
Year	1	0.156	8	0.12	1.3309	0.282
Tier × Year	2	0.03	8	0.12	0.2919	0.754

APPENDIX XII

DEFINITIONS OF LINEAR AND POINT FEATURE CLASSES

Class	Definition
Ditch – stockproof	Ditch which due to depth, clarity, of water and or gradient of sides is effective barrier to livestock, specifically mature cattle under normal circumstances, i.e. when adequate fodder available.
Ditch – non-stockproof	Ditch which due to depth of water and or gradient of sides is ineffective as barrier to livestock, specifically mature cattle
Hedgerow – stockproof	A line of continuous woody vegetation which is managed as a fully effective barrier to livestock, specifically mature cattle, i.e. when adequate fodder available, without the need for fencing. In practice this generally means that gaps should be smaller than 300 mm width and 500 mm height in the 300 to 1200 mm range above ground level.
Hedgerow – non-stockproof	A line of continuous woody vegetation which is managed but not an effective barrier to livestock, specifically mature cattle unless combined with ditch or fence
Fence	Post and wire, post and netting, post and rail, or boarded fences
Individual tree/tree group	A single tree (woody species capable of naturally forming a single trunk of more than 3 m) or a non-linear aggregation of two or more trees with a closed canopy (includes orchards).
Line of trees	A tree line, maximum of 3 trees (25 m) wide, with a closed canopy.
Gates with wing fences	Gate with wing fencing at ditch crossing point.
Gates alone	Gate alone at ditch crossing point.
Wing fences alone	Wing fencing without gate at ditch crossing point.
Farm building – weatherproof	Traditional building in agricultural use, with a largely intact roof.
Farm building – non-weatherproof	Traditional building in agricultural use, in need of repair to roof or walls
Ponds	Small wet depression with signs of standing water.