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**The distribution of lowland
wet grassland in England**

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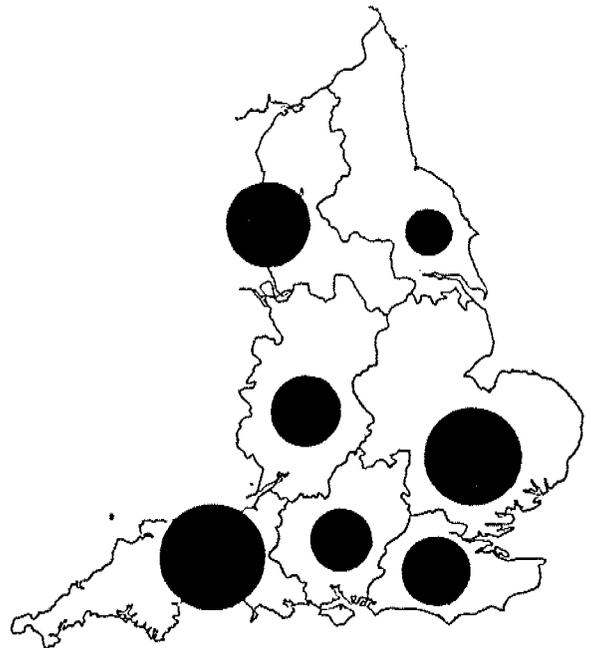
English Nature Research Reports

LOWLAND WET GRASSLAND IN ENGLAND

DISTRIBUTION OF THE RESOURCE

Volume 1 : Project Report

A Report to English Nature
Contract No F72-08-17



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1. STUDY OBJECTIVES AND END PRODUCTS

1.1 Background

This study aims to locate and map areas (>10 ha in size) of lowland wet grassland throughout England. Lowland wet grassland is defined in the contract brief as follows:

"Managed land, periodically inundated by water, predominantly of permanent grassland and fen meadows within a flat area with a network of ditches containing standing water. Such areas may also include some wetter emergent swamp communities, but not extensive areas of emergent hydrophytes (e.g. *Typha* and *Phragmites*). Lowland wet grasslands, including grazing marshes, normally occur in lowland river valleys and behind sea defences. Salt marshes are not included."

The project is part of a modular scheme to produce a comprehensive review of the distribution within England of lowland wet grasslands and of the quality, regional variation and distribution within this resource of each of the following major components:

1. Aquatic and wetland flora.
2. Terrestrial flora.
3. Aquatic invertebrate fauna.
4. Terrestrial invertebrate fauna.
5. Breeding birds.
6. Wintering birds.
7. Passage migrants.

The aim is to obtain a quality profile for lowland wet grasslands in England which will enable them to be placed in a national and international context, improve the management of statutory sites, clarify policy on site selection for this habitat, and allow English Nature to give better advice to government on the effect on this habitat of agricultural, development and coastal defence policies.

1.2 Project aims

This contract covers only the first module of the overall exercise, covering resource localities and their measured areas. No information on current conservation interest is required. The aims of this module are to:

1. Locate all areas in England where there are contiguous blocks of low-lying permanent pasture, divided by water-filled ditches, covering at least 10 ha.
2. Measure the area of each block and obtain the total area of the lowland wet grassland resource in England.
3. Distinguish between lowland wet grassland with a coastal origin and those developed from inland habitats. Inland, areas on peat soils should be distinguished from those on other soil types.

1.3 Methods

The techniques used in this contract follow closely those developed in a pilot exercise (Dargie 1992). The pilot took only South-East Region of English Nature (Kent, West Sussex, East Sussex, Surrey, Greater London) and used the following sequence of methods as a general approach:

1. Locating possible lowland wet grassland

A search of all 1:50,000 and 1:25,000 OS maps for the pilot area (plus Essex, Suffolk and Norfolk) to identify and demarcate on tracing paper overlays very flat terrain containing a ditch network, noting the soil parent materials of each area by reference to the 1:250,000 soil map for SE England (Soil Survey of England and Wales, 1985) to separate areas of coastal origin (i.e. marine alluvium) from other inland types (mainly river alluvium).

2. Locating probable lowland wet grassland

Abstraction of lowland wet grassland location within possible location maps using Phase 1 habitat survey (Nature Conservancy Council, 1990) and SSSI habitat maps (generally at scales of 1:10,000, 1:10,560 and 1:25,000), reducing mapped areas to 1:50,000 and plotting these on 1:50,000 OS outline (black and white) maps to enable clear photocopying. Time was only available to complete this stage for South-East Region and this step was not extended to the possible areas identified in Essex, Suffolk and Norfolk.

3. Spot-checking accuracy

A total of 35 blocks (c. 17% of the overall number of blocks) was selected (at random, apart from a total sample of all Greater London sites) and visited. Assessment as lowland wet grassland was made from adjacent roads or public footpaths, though it was impossible to make a complete check of all boundaries to each selected block due to restricted access and time constraints. Reservations on the accuracy of spot-checking led to modifications on accuracy estimates in this all-England contract.

A full account of methods, together with problems encountered, is given in Chapter 2.

1.4 End Products

The major outputs specified for this contract are as follows:

1. A series of 1:50,000 OS outline maps showing all areas of lowland wet grassland of more than 10 ha.
2. A summary map for each region, and for England, to show in simplified form the distribution of lowland wet grassland.

3. A report including:
 - a. a listing for each region of each lowland wet grassland block, including its area in hectares, centroid grid reference, administrative region(s), soil parent material and source of information;
 - b. an outline of the methodology used and any necessary alterations on a region to region basis;
 - c. an assessment of the likely degree of accuracy with which areas of lowland wet grassland have been identified;
 - d. analyses and interpretation of the database in terms of coastal origin, inland habitats and soil types;
 - e. an estimate of percentage loss (or gain) of lowland wet grassland on a regional and national basis since the original habitat surveys were undertaken;
 - f. an overview of the lowland wet grassland resource in terms of area and distribution in England.

1.5 Organisation of the report

Following this introduction, material is organised in the report in terms of a report on methodology and problems encountered (Chapter 2), an accuracy and loss assessment (Chapter 3), analysis of results (Chapter 4), overview of lowland wet grassland distribution in England (Chapter 5), with conclusions and recommendations in Chapter 6. A summary is also provided. The list of lowland wet grassland blocks is given in Annex 1 (Volume 2) and is organised by region.

2. METHODOLOGY

2.1 Introduction

This chapter discusses in detail the techniques adopted in this project, including problems encountered and, where possible, the necessary changes in approach to overcome them. The broad approach is that adopted for the pilot study in South-East Region of English Nature (Dargie, 1992; see section 1.3). This involved three major steps, with major changes from the pilot exercise only being applied to the final stage of spot-checking. Difficulties arose in several phases of the approach and these are also treated in detail here following the major steps involved. Some of the problems were restricted to one or a few 'county' areas and these are highlighted in addition to more general difficulties.

2.2 Step I - Locating possible lowland wet grassland

This initial step involved a careful search of all 1:50,000 maps of England. Possible lowland wet grassland was defined as very flat terrain containing a ditch network. These were usually low-lying but exceptions included the wider flood plains of inland river sectors and glacial trough valleys in the Lake District (e.g. between Derwent Water and Bassenthwaite), with altitudes rising to c. 200 metres. Likely areas identified on 1:50,000 maps were then examined on 1:25,000 sheets which often had more detail of ditch systems. Ditch network density proved highly varied and for completeness a single marked ditch on a 1:25,000 map was taken as a minimum requirement, in addition to flowing water courses (streams, rivers, tidal creeks).

The boundary of such terrain was taken as one of the following:

- a. the inner side of an outer sea wall for coastal locations;
- b. a line running on the lower side of contours which suggest a marked break of slope and loss of a ditch network (usually the 5 m or 10 m contour on 1:25,000 maps for coastal locations, higher elevations for inland sites on flood plains);
- c. the edge of developed (residential and industrial) land and any woodland present within the flat, ditched terrain.

Locations were marked in black india ink on A3 tracing paper at 1:50,000 scale. The 1:50,000 and 1:25,000 map sheet numbers were also marked, together with sufficient numbered national grid line intersections to enable accurate placing over a 1:50,000 outline OS sheet. The soil parent material of mapped locations was also added after reference to the 1:250,000 soil map for SE England (Soil Survey of England and Wales 1985). This information was incorporated to separate areas of coastal origin (i.e. marine alluvium) from other inland types (recorded as peat, river alluvium and 'other').

For South-East Region and Essex, Suffolk and Norfolk these tracings of possible lowland wet grassland were placed accurately over 1:50,000 OS outline maps and then marked on to the maps as a dashed line on outline maps using india ink. This procedure was not followed elsewhere since there was little interest in the potential extent defined by this method, only in the current extent of lowland wet grassland.

2.3 Step II - Locating probable lowland wet grassland

Most information for this project phase was obtained by visiting English Nature regional and sub-regional offices, plus Local Authority offices and Wildlife Trusts holding Phase 1 type information or its equivalent. Two main information sources (Phase 1 habitat survey maps and SSSI habitat maps) were used for data abstraction, plus a few other map-based sources.

Phase 1 habitat survey maps

These exist for many counties and metropolitan areas in England. They vary considerably in date (from the late 1970s to those in progress and due to finish in 1993, notably Kent, North Yorkshire and Essex). Early studies usually followed an NCC/RSNC classification system for most habitats, later examples following more closely the habitat classification finally published as a full manual (Nature Conservancy Council, 1990). The following categories representing permanent grassland and temporary leys were traced off habitat maps in areas delineated as possible lowland wet grassland in Step I of this project (see 2.2): neutral grassland (unimproved and semi-improved), improved and semi-improved grassland, plus (where appropriate) marsh/marshy grassland and tall ruderal habitat. In a very small number of cases acidic grassland was recorded. These categories ensured that all grassland (including early successional types following abandonment of grazing, represented by the tall ruderal habitat) was mapped within the possible lowland wet grassland area. Several surveys were based largely on air photo interpretation and grassland types were usually aggregated on habitat maps. Each tracing marked the detailed boundaries of each category and in the early stages of data abstraction each habitat component was coded using NCC Phase 1 alphanumeric codes, plus details of drains in blue and contours used to delimit boundaries. Pressure of time in the later phases of the project required that only the boundary of lowland wet grassland was marked with, in some cases, brief notes on grassland type and ditch density. National grid line intersections were also marked, plus the map sheet details. All tracings were made on A2 drafting film or thick A2 tracing paper.

SSSI habitat maps

Some Phase 1 surveys excluded SSSIs from their survey area and it was necessary to check SSSIs present in areas of possible lowland wet grassland. The site survey file of each SSSI (or other storage system, since archiving varies from region to region within English Nature) contains maps based on survey categories close to Phase 1 habitat units. Most are at a scale of 1:10,000, with a few at 1:10,560 or 1:25,000. Relevant categories for lowland wet grassland were traced as for county Phase 1 survey data (see above), confining interest to likely terrain identified in Step I of this project. Areas with no Phase 1 information, or with inadequate Phase 1 information (see 2.5.6), also had SSSI information checked to provide at least some information on the distribution of lowland wet grassland.

Other map sources

Areas with no/inadequate/incomplete Phase 1 survey were checked for alternative sources of information on mapped/mappable grassland distribution. In the case of the Inner Thames estuary a detailed survey of Thames Estuary grazing marshes was available (Thornton & Kite 1990). A 1:75,000 map of grazing marsh extent is included for 1989 and this was used for coastal parts of North Kent outside SSSIs and not completed in early 1992 as part of the current Kent Phase 1 survey. The map was enlarged to 1:50,000 using an accurate zoom photocopier. In a few other cases maps of land use or land cover were found with either a

pasture/meadow or grassland category. Details were abstracted using the same principles as for Phase 1 information. In one case there were doubts on the reliability of one map (Humberside) and it was checked against a further source, Neutral Grassland Survey data. This approach was also followed for areas with inadequate Phase 1 information (surveys which did not include arable land and improved and/or semi-improved grassland) to supplement grassland information, though such surveys rarely examined or mapped all improved grassland. A final important source was recent aerial photography for Wiltshire, Hampshire and Northumberland. These areas had no Phase 1 information outside of SSSIs and other sources were poor. Air photos for Staffordshire were also used to measure the area of grassland in addition to unimproved lowland wet grassland established by 1979 Phase 1-type survey. Air photos covering possible lowland wet grassland areas were rapidly examined by a single, experienced interpreter (T Dargie) and probable grassland was mapped on to tracing paper overlays upon 1:25,000 maps which provided field boundary, ditch and contour information. Change measurement based on air photo and Phase 1-type results was undertaken in Staffordshire, Humberside and Cumbria (see section 3.2).

Abstraction from all these sources meant selective examination of most Phase 1 information available at 'county' scale in England (several thousand individual maps were consulted, together with hundreds of aerial photographs). Drawing boundaries on to maps required precision and concentration at all times, especially in edge-checking to ensure that information continuing on to another map sheet did in fact join exactly with that on the other map.

All mapped grassland within Step I boundaries was considered to be lowland wet grassland. It was mapped at 1:50,000 as follows. In the early project stages maps on tracing paper and drafting film were reduced by superimposing a 250 metre grid pattern on clear acetate (at correct map scale - 1:10,000, 1:10,560 or 1:25,000) and copying boundaries on to an equivalent 250 metre grid at 1:50,000 printed on thick tracing paper. This proved to be very time-consuming and prone to errors in complex cases involving blocks crossing several map edges (e.g. presence on two or more 1:10,000 sheets). The second method involved reducing all maps using an accurate zoom photocopier. Even using thick tracing paper and four successive reductions of a 1:10,000 map to achieve a 1:50,000 result, the final distance between 1 kilometre grid intersections was less than 0.2 mm deviation from the correct 20 mm distance (an error of 1% in position) and this was judged adequate for this study and was free from the gross errors which occasionally occurred with the grid method.

At this stage areas <10 ha in extent were excluded unless prior evidence on grassland quality (e.g. many ditches, entirely made up of unimproved grassland or marsh/marshy grassland) indicated that it deserved inclusion. Exclusion initially used 10 ha templates of different shapes but this system was replaced by Romer dot grids supplied by English Nature.

The boundaries on tracing paper were then transferred to 1:50,000 maps and marked as a continuous line. The exterior was highlighted in blue for rapid visual location of blocks. Inliers for exclusion (e.g. farms, small settlements, woodland blocks, swamp, open water) were marked with a continuous black line boundary without any coding (except in the pilot South-East Region where an 'e' was written to indicate exclusion). Each block was given a unique code to indicate its English Nature region and sequence number.

2.4 Step III - Accuracy checks

Spot-checking was only employed for the pilot exercise in South-East Region of English Nature where 201 blocks of lowland wet grassland had been delimited by work in January and February 1992, distributed as follows:

Kent	92 blocks	(1-61, 72, 167-196)
East Sussex	51 blocks	(62-71, 73-113)
West Sussex	53 blocks	(114-166)
Greater London	5 blocks	(197-201)
Surrey	Nil	

A spot-check of accuracy was made by randomly selecting 10 blocks from each of the Kent, East Sussex and West Sussex sets (using a three digit random number table) and including all Greater London blocks. These 35 locations were visited and assessed as lowland wet grassland from adjacent roads or public footpaths. It was impossible to make a thorough check of the complete area of each selected block due to restricted access and time.

All Greater London sites were confirmed. Only three other random blocks were not lowland wet grassland. All 'errors' were very small areas now converted to winter wheat - they probably were pasture until recently, especially since two were derived from the current Kent Phase 1 survey. Accuracy in terms of number of correct blocks was therefore 90.0% for the 30 randomly-selected samples, or 91.4% for all visited sites (i.e. including Greater London). The spot-check survey included a rough evaluation of grassland and ditch habitat quality, though this information must be treated with great caution as it was collected in mid-February 1992 (too early in the year to be fully reliable, and after a very dry winter). Full details of the spot-check are given in Dargie (1992).

Spot-checking was not employed in this all-England project. A very large number of sites would have required visiting and, to be accurate, all boundaries would have to be checked and compared with those mapped from Phase 1 information. For very large sites (those >100 ha) the time involved would have been prohibitive, both in terms of seeking access permission and field checking of boundaries. An alternative check was made using, where available, recent aerial photography. Maps produced from such aerial photography enabled changes in extent of lowland wet grassland to be calculated between date of Phase 1 survey and air photo flight. This was done only for areas with some form of Phase 1 information and very recent air photo cover (Cumbria, Humberside, Staffordshire). Other areas had more dated air photo coverage, often close to the time of Phase 1 survey and it was felt that any change data calculated would have been of much less relevance, given the perceived rates of arable expansion in some regions in the mid- and late 1980s. No rigorous assessment of change could therefore be made for the majority of counties/districts and 'guesstimates' have instead been used to adjust county/district grassland area for change since Phase 1 survey (see sections 3.4 and 4.1).

2.5 Problems encountered

A range of difficulties was experienced during the project, requiring some changes in approach for various 'county' areas in England. Some have been briefly alluded to in earlier sections (see section 2.2). These problems are organised here in the following sections: habitat definition; Phase 1 survey quality; map scale and date difficulties; map archiving problems; map legend problems; no coverage and partial coverage; block definition; use of COREDATA database.

2.5.1 Habitat definition

A subtle problem encountered throughout this exercise is the range, terminology and definition of habitats included within lowland wet grassland (e.g. grazing marsh, water meadow, culm grassland, semi-improved and improved grassland). No matter how precise a definition is made (e.g. that employed in the brief, see section 1.1), previous work has employed a range other definitions based on habitat limits which vary within and between studies, and this is further complicated by the varied perceptions of staff in English Nature, county wildlife trusts and organisations such as RSPB.

A first example is the varied definition in previous studies of one type of lowland wet grassland, coastal grazing marsh. Much of this work has focussed on South-East England and the following difficulties exist. First, the phenomenon is as much a land use and landscape type as a habitat set. Precise boundaries and emphasis of approach will therefore vary with the perceptions of researchers (agricultural, landscape, biological - the latter divided between the main interests of grassland botany, entomology, ornithology and ditch ecology). Second, the main thrust of grazing marsh study in South-East England has been documentation of change over time in grazing marsh extent. This has required extraction of information from First and Second Land Utilization Surveys and Ordnance Survey topographic maps of different ages, plus aerial photographs. These sources therefore have different scales, contour intervals and land use categories (Green 1971; Sheail & Mountford 1984; Williams & Hall 1987; Thornton & Kite 1990). The definition of 'grazing marsh' necessarily varies according to the information content of each type of data source (e.g. contour interval). This second difficulty affected this study because the most recent boundaries (1989) of Thornton and Kite (1990) were used in the pilot exercise for north Kent (in locations not yet surveyed, in early 1992, as part of the ongoing Kent Phase 1 survey) and south Essex (Dargie 1992), areas which were defined on different criteria from those employed in abstracting data from Phase 1 maps of Kent and Essex. Thornton & Kite (1990) used the 25 foot contour as the inland limit (as opposed to the 5 m contour for Kent in this study). The result, in comparison, is a larger extent for some areas mapped by Thornton & Kite, though these include a marked break of slope and usually a loss of ditches in the higher zone between 5 m and the 25 foot contour. This larger area probably does not include the lowland wet grassland habitat. A review of pilot maps for north Kent by Sandy Toy (English Nature, Wye, Kent) identified two locations which would not be considered grazing marsh, both included on maps from Thornton and Kite (1990) data (on grounds of being too high and too disturbed). The area affected by this problem is comparatively small and is only of local importance.

Second, English Nature staff in different regions have their own different perceptions of what is meant by the term lowland wet grassland. An initial briefing meeting in Peterborough in late October 1992, for example, queried the general definition on two main

grounds: first, a restriction to low-lying land, with a request to examine areas of flat, ditched terrain inland and at higher altitude; second, the relevance of a ditch network for some habitats lacking drains but which might undergo regular seasonal inundation by water and thus be of considerable interest to wildlife. The first query was taken on board but the second could not be included as it was impossible to fulfil using the delimitation rules for lowland wet grassland and thus central to project methodology (i.e. drains had to be present on maps). In regional offices, sub-offices and county wildlife premises this problem recurred and usually required a very careful explanation by the consultants to ensure that all relevant data sources could be supplied.

Third, Phase 1 habitat survey maps vary in definition of habitat categories between counties. Air photo interpretation for Surrey and the Sussexes restricted the definition of grassland types, compared to Kent and Greater London which use methodologies and classifications close to the NCC standard (Nature Conservancy Council 1990, Kent Wildlife Survey Partnership 1991a). In addition, the current Kent survey formally maps a grazing marsh category using the definition 'any grassland which has a demonstrable affinity to earlier salt-marsh by the presence of an appropriate mosaic of plant communities and/or physical relicts of salt-marsh (rills or rillmarks)' (Kent Wildlife Survey Partnership 1991b). This is mapped as a GM annotation and is used as an addition to normal Phase 1 codes. Some Phase 1 surveys have not mapped improved (or even semi-improved) grassland, creating a difficulty which could not be resolved without use of 'guesstimates' (see sections 2.5.6 and 3.4).

Fourth, definition required a rule for defining a tracing boundary on 1:10,000 and 1:10,560 habitat maps for grassland straddling a contour being used as an approximate boundary for the edge of lowland wet grassland (e.g. the 5 m contour in Kent). For maps with good contour information this was straightforward and a line was generally drawn close to and parallel with the contour. A problem occurred in river valleys where the general seaward slope produced contours crossing the valley floor. This was resolved by specifying that contours had to represent land no steeper than a 1 in 100 gradient (i.e. 10 m contours spaced more than 1 km apart) and, in cases of a contour crossing the valley floor, the shortest line to the next highest contour was followed at the valley side. These rules were often difficult to apply to many Phase 1 and SSSI habitat maps, since these were often drawn up on photocopies which did not reproduce contour lines. In these cases maps had to be compared with contoured 1:10,000, 1:10,560 and 1:25,000 maps, often in a different office, and this required a redrawing of boundaries to exclude grassland outside the contour limits. In some 'counties' this involved much extra time.

The overall effect of definition variation is probably not serious. It acted more to raise interest among contacts (e.g. conservation officers of English Nature) about the approach adopted, rather than creating an error source (except in comparison with Thornton & Kite 1990 data). The main data sources (categories mapped by types of Phase 1 habitat surveys) are independent of definition and the definition adopted for lowland wet grassland is close enough to most other surveys to allow comparability. The only gap imposed by methodology and definition is that of former lowland wet grassland converted to arable land, but retaining good-quality ditch ecosystems. Extensive map information on this type of land is not generally available and was thus beyond the scope of this study.

2.5.2 Phase 1 survey quality

At project inception it was not appreciated just how variable Phase 1 habitat surveys are throughout England. The important review of Wyatt (1991a-i) was unknown to consultants and direct contacts in English Nature but was identified very early on in the project and a copy of the overall synthesis and regional reports was made available by Trevor Boyd (English Nature, Peterborough) in early November 1992. Gordon Wyatt's review is comprehensive and applies performance criteria to surveys to make judgements (very poor, poor, fair, good, very good, nil, inadequate data, average, below average, above average) in terms of accuracy, background information, compatibility, consistency, total coverage, monitoring, site evaluation, habitat distribution, statistical information, ease of use, archival storage and overall quality assessment. It is very important to stress here both that Phase 1 surveys show substantial variation in quality and that some are inadequate (in whole or in part) for the purposes of this project. The major inadequacy was no (or incomplete) mapping of improved and/or semi-improved grassland, making it impossible to map the full extent of lowland wet grassland for those counties/districts with this deficiency. Total coverage was therefore the main criterion of interest in Wyatt's review. The counties with completed Phase 1 survey and incomplete grassland data are mapped in Figure 2.1 and these cover a large proportion of England. Of the counties with incomplete data only one county (Staffordshire) had recent air photo cover and therefore it was not possible to add missing grassland by this technique - only 'guesstimates' could be made for total grassland extent in most other counties.

2.5.3 Map scale and date problems

A wide range of map scales was involved in data abstraction (from 1:2,500 to 1:75,000), together with maps of different age. These produced a set of problems:

- a. labelling and tracing storage - careful filing was essential throughout the exercise to ensure that data abstracted at different scales and from different sources could be stored properly and cross-referenced rapidly. This was particularly necessary for habitat map tracings of the same area drawn from Phase 1 county surveys and SSSI habitat surveys. It proved essential to mark on all maps the 100 km national grid reference, plus the 10 km and quadrant (NW,NE,SE,SW) references for 1:10,000 and 1:10,560 sheet tracings, plus the 1:50,000 map sheet number. The latter was complicated by sheet overlaps, particularly in South-East, South-West and North-East England where overlaps are extensive.
- b. considerable variation was experienced in the type of contour information on maps, particularly on 1:10,000 and 1:10,560 OS sheets. The 1:10,560 sheets have contours at 25 feet intervals but 1:10,000 sheets have either metricated 25 feet equivalents or 5 metre intervals. In some cases particular contours (5 and 10 metres) were absent (presumably they were being surveyed at the time of sheet production) from some 1:10,000 maps. All these examples were, for example, found in Cumbria. This created a major difficulty for lowland wet grassland blocks running from one sheet type on to another with different or absent contouring. In very flat terrain the distance between slightly different contours (e.g. 25 feet, 8 metres, 10 metres) can be considerable and in an area almost dominated by grassland a contour-defined boundary might be marked with a large positioning error. Cases where this might have occurred are few

(principally in Cumbria), since ditch presence was usually strongly correlated with contours and these could be used independently to fix a boundary.

- c. reduction to 1:50,000 scale - this required a range of clear acetate 250 m grids for use on 1:10,000, 1:10,560 and 1:25,000 maps. It was originally intended to reduce habitat maps using an accurate pantograph but the 2-5 fold reduction gave poor results and was very time-consuming. The grid overlay method was more rapid, but occasionally generated errors (mainly at 1:10,000 map sheet edges) and proved too time-consuming as the all-England project evolved. It was therefore replaced by reduction by a photocopier with an adjustable zoom lens accurate to 1/1000 of linear distance within a zoom range of 0.640 and 1.420. It was thus possible to reduce even 1:10,000 maps in four successive steps to achieve the final 1:50,000 scale, with national grid intersections correctly positioned to within 0.2 mm on the final reduction at 1:50,000.
- d. Accurate grid overlays frequently did not fit the grid square intersections on tracings, especially for English Nature SSSI habitat maps. This was probably due to photocopier distortion on the SSSI maps and is thus a source of planimetric error. It was rarely a large misfit.
- e. SSSI habitat maps occasionally involved adjacent map sheets of different scales (1:10,000, 1:10,560), making an accuracy check of traced lines on the map edges difficult. This was a recurrent problem in all regions with Phase 1 maps at 1:10,000 and 1:10,560 scales.
- f. Map sources varied in age and created several difficulties. The most important was variation between SSSI habitat maps and county Phase 1 habitat maps for the same area. In such cases the results were integrated to construct, at 1:50,000 scale, a map of maximum lowland wet grassland extent. This might exaggerate such extent but probably not a major error source. A more minor problem was the expansion of development which was not present on 1:25,000 maps used in Step I. The boundary of development on 1:50,000 outline maps was taken as a limit for possible lowland wet grassland.

2.5.4 Map archiving problems

Phase 1 habitat maps are generally archived in numerical sequences according to the OS National Grid, making retrieval straightforward. In two cases (Nottinghamshire and Leicestershire) a different system is used which greatly complicated data abstraction. Maps for Nottinghamshire are coloured/coded and stored as irregular map blocks, each representing work for a single day by a survey team (2-3 km²). Maps for Leicestershire are completed and stored by civil parishes. Lowland wet grassland in both counties had to be traced in meandering river valleys cutting across a large number of archive blocks and this complex form of mapping storage reduced data abstraction rates to less than a quarter of that achieved under normal archiving.

2.5.5 Map legend problems

Three problems were encountered in tracing information from several sets of habitat maps. First, some surveys used legend categories markedly or slightly different from the recommended NCC Phase 1 categories (especially in early surveys such as Humberside). Second, some maps were coloured but the colours used bore no relation to NCC Phase 1 recommendations. In addition, the maps used were colour photocopies and supplied keys were a very poor reproduction of photocopy tones, creating some interpretation difficulties. A third problem with several sets of habitat maps was an absence of contours on photocopies, making it difficult to locate boundaries for lowland wet grassland. Cross-referencing with contoured sheets was needed, often with maps of a different scale, and in several cases contoured sheets could only be consulted at a different location, requiring much map adjustment. To avoid error, tracings were extended well beyond likely limits and the Step I possible wet grassland boundary was used as the limit when tracings were reduced to 1:50,000 scale. This absence of contours therefore wasted time in tracing and reduction stages of Step II of this project.

2.5.6 No coverage and partial coverage

It is important to understand that several counties/districts either have no Phase 1 habitat survey or survey was never completed and only partial coverage is available, or that Phase 1 mapping is still in progress and parts of a county/district remain unsurveyed. Partial solutions to these difficulties were made as follows. Land use and land cover maps from the late 1970s onwards were used in some areas (Humberside and Cambridgeshire) if there was information on grassland or pasture. Areas with recent air photo cover were mapped by photointerpretation (Hampshire, southern Wiltshire, Staffordshire, parts of Northumberland) but in most cases there was no recent aerial photography available. These gaps in coverage represent an important error source (unmapped lowland wet grassland). In the cases of ongoing Phase 1 surveys (Kent, Essex) 1:50,000 map sheets with possible lowland wet grassland are marked (along 1:10,000 map sheet edges) as having no information available (and guesstimates are made for presence using the area of possible lowland wet grassland in the 1:10,000 map area, a 5 km x 5 km square). The majority of gaps in coverage were replaced with some form of alternative data. One major county, Lincolnshire, was left, with no information - there is no Phase 1 survey for the county, no recent air photo cover and no alternative mapped survey source. All of the area quoted for Lincolnshire is therefore a 'guesstimate' (see section 4.5), derived from quantities in South Humberside and Cambridgeshire expressed as a proportion of suitable land.

2.5.7 Definition of blocks

The cut-off size (<10 ha) for excluding blocks, a condition of the brief, meant that many small areas of lowland wet grassland were ignored by this project. It is important to emphasise that sites <10 ha in size can be of very high conservation value (e.g. MG4 *Alopecurus pratensis* - *Sanguisorba officinalis* alluvial flood meadow is very rare and heavily fragmented into single fields or groups of small fields in England) and such habitats require mapping using alternative methods.

Some problems were experienced in defining small areas (<10 ha) for exclusion and marking discrete blocks. Lowland wet grassland is fragmented by sea walls, roads, railways, woodland, open water, swamp and large rivers/tidal creeks. These features were not all marked clearly on tracings (but were drawn accurately as non-grassland area) and needed cross-reference to 1:50,000 maps to identify the cause of fragmentation and decide on a final boundary for a block. This wasted a considerable amount of time. Fragmentation generated by such features created many small patches of lowland wet grassland which could have been excluded, being <10 ha in size. Linear features such as roads, tracks and railways were in general ignored in such cases and fragments were retained as part of a larger block. The linear features are too small to map at 1:50,000 scale and their unmapped inclusion in blocks exaggerates block area to a small degree.

2.5.8 Use of COREDATA database

At project inception for the South-East Region pilot study English Nature supplied computer printouts of area data for neutral grassland, improved and re-seeded grassland, plus standing water in SSSIs (part of the COREDATA database, Smith 1991). This proved useful but was partly incomplete (c. 5,000 ha of SSSI area remains unmapped in the region and thus lacks area data) and took time to assimilate. This data source was eventually discarded because much of the grassland recorded for a selection of Kent SSSIs was found to extend beyond the contour and drain limits of lowland wet grassland.

2.6 Overall project accuracy

The problems outlined in section 2.5 were overcome in many cases and for much of England the mapped information on grassland distribution can be considered a relatively accurate picture, with the qualification that change (mainly further grassland loss) will have occurred since the time of original mapping or recent air photo date. However, there is a residuum of counties for which information remains either absent (Lincolnshire) or poor (inadequate original survey - Humberside, or only prime sites known or full coverage incomplete - Shropshire, Herefordshire/Worcestershire, Warwickshire, Berkshire, Buckinghamshire, Hertfordshire). There are also small areas in other counties (North Yorkshire, Wiltshire, western Norfolk, Kent) where lowland wet grassland is present but for which survey information remained lacking at the time of this project. These locations are marked in Figure 2.2 and total extent is a marked reduction on that defining all possible problematical areas (Figure 2.1).

Maps and data covering these remaining difficult areas must be used very cautiously since there probably important areas of unmapped lowland wet grassland. In other parts of England change since Phase 1-type survey will also have influenced distribution, mainly through further losses of lowland wet grassland. All maps must therefore be viewed as largely indicative in character and should not be regarded as precise locations as existing in late 1992 and early 1993 (the duration of this project). For these reasons a qualifying note is added to the map legend on all 1:50,000 outline sheets: **'Warning: these maps of lowland wet grassland location are indicative only and should not be used to define the exact extent of the habitat'**.

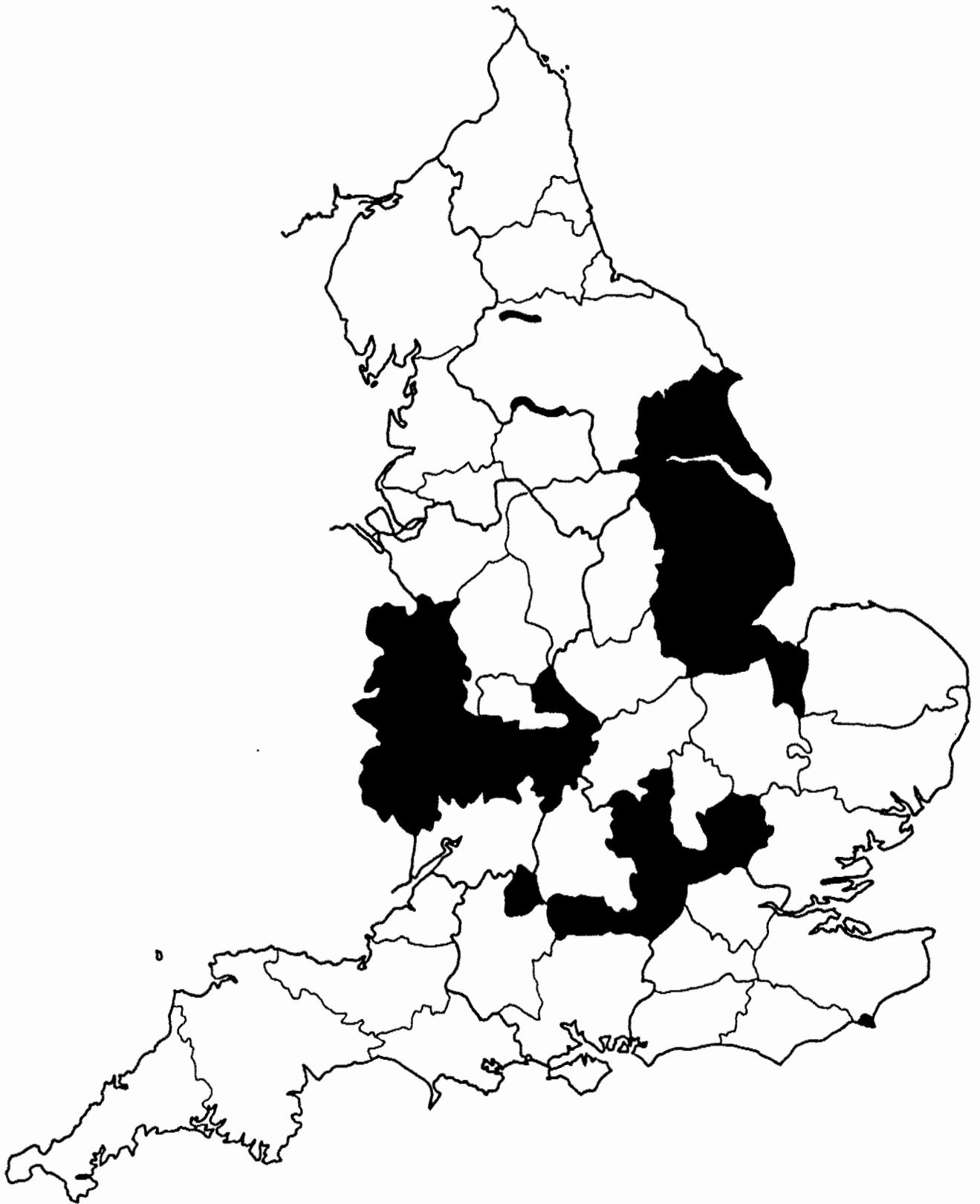


Figure 2.2 Important areas of England lacking any or full information on lowland wet grassland at project completion.