Countryside recreation, the ecological implications : an investigation into the ecological implications of countryside recreation in lowland Britain, with particular reference to the countryside of Lindsey.

COUNTRYSIDE RECREATION

the ecological implications

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An Investigation into the Ecological Implications of Countryside Recreation in Lowland Britain with particular reference to the Countryside of Lindsey

Lindsey County Council
April 1970

"Ecology is the science which seeks to elucidate the principles governing the interactions of the natural processes of land, water and all living things. Conservation involves the application of these scientific principles and a policy of trusteeship. Conservation requires planning of the factors of supply and demand and can itself be meaningful only if it is borne in mind when all human activities are considered."

Robert Arvill

- Man and Environment, Pelican, 1967.

FOREWORD

This report embodies the results of an investigation carried out in the County of Lindsey, Lincolnshire, with the aid of a research grant from the Natural Environment Research Council, and is published in pursuance of the conditions attached to the grant.

The investigation was undertaken as part of the work involved in the Lindsey Countryside Recreational Survey. This is a survey that has been carried out by Lindsey County Council, supported by the Department of Geography of Nottingham University, under the direction of a Steering Committee, of which, I have been Chairman and of which the full membership has been as set out below. The aim of this survey has been a comprehensive study of recreation in the countryside in Lindsey, covering both the demand, actual and expected, and the resources available or capable of being made available to meet that demand.

The Lindsey Countryside Recreational Survey as a whole will be the subject of a comprehensive report shortly to be completed. In that report, it will be seen clearly that the ecological investigation currently reported has made a vital contribution to the build-up of the full recreational picture. The report of the survey will be used as a basis for the development of the County Council's countryside policies to be expressed in the County Structure Plan and in action to be taken and encouraged thereunder. It is also hoped that it will be helpful in the establishment of guidelines for further voluntary activity in the countryside by the Lincolnshire Trust and other agencies, and in assisting the related development of the County Council's educational responsibilities.

This report of the ecological investigation focuses attention on the general problem of reconciling provision for countryside recreation with nature conservation in a county which is intensively farmed. It will be one of the important aims of the survey as a whole to contribute something to the task of developing and maintaining the right relationship between recreation and agriculture, for it must always be remembered that the countryside of Lindsey is the workshop of the County's principal industry.

The members of the Steering Committee have been:-

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W. E. Lane

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April, 1970.

ACKNOWLEDGEMENTS

The assistance given by the following to the Survey is gratefully acknowledged.

The Planning Department, Lindsey County Council.

J.W. Blackwood, Assistant Regional Officer for Lincolnshire, The Nature Conservancy.

Members of the Lincolnshire Trust for Nature Conservation Ltd.

R.B. Wilkinson, Field Officer, Lincolnshire Trust, Gibraltar Point Field Station.

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INTRODUCTION

Recreation is becoming an increasingly important element in the British way of life. Today there are far greater opportunities for leisure persuits than ever before - the number of hours which make up working week continues to fall, albeit slowly, homes and gardens are more and more labour saving, while, as a nation, we are more affluent. Probably the most significant event of all however is the great increase in motor car ownership. Today many families own or have access to a motor car and so, with this greater mobility, recreation is more and more frequently countryside orientated. The motor car has provided an easy means of escape from the urban environment.

The crux of the matter is that the demand for recreation and particularly this demand for countryside recreation is still rising, and rising at an ever increasing rate. The problem is how to meet this demand with the resources available and in harmony with other land uses, particularly agriculture, forestry and wildlife conservation.

Some idea of the scale of the problem can be obtained if the projections for car ownership, population and working week are examined. In 1955 there were 3½ million cars in Britain, in 1965 the figure was 7 million and it is estimated that by the year 2000 there will be no less than 30 million cars on our roads. Meanwhile the present population of 53 million will have expanded to 70 million and the working week will have fallen still further, from about 42 hours in 1965 to probably as few as 30 hours at the end of the century, though overtime may still be worked extensively.

What then are the problems in meeting this demand?

The first is one of a lack of available resources, particularly in the intensively cultivated lowlands of eastern England of which Lindsey forms a part. There has been a considerable revolution in agriculture and to a lesser extent in forestry. Areas of semi-natural vegetation, waste ground, small copses and woodlands are all tending to disappear as more land is reclaimed for intensive cultivation. The acreage of land which might be set aside for recreational pursuits is consequently falling. Recreation therefore must be concentrated in smaller and smaller areas or be developed in association with other land uses.

There is a second and perhaps more significant problem, particularly from the ecological view point. Modern agricultural methods have reduced the value of farmland as a refuge for wildlife thereby concentrating wildlife in the very areas where recreational pressures will be felt most strongly. Wildlife conservation in these remaining natural regions is now vital and thus any conflict with recreation serious.

Finally the wildlife and natural features of the countryside contribute greatly to the enjoyment and benefit of those seeking recreation there; over-use of these areas for recreation can easily destroy those very features.

The purpose of this report is to focus attention on the ecological implications of countryside recreation, particularly in the countryside of Lindsey.

Chapter 1
Lindsey – its structure and Wild Life

GENERAL APPRAISAL

1.1 Lindsey can be divided into several distinct physical regions (Map 1) determined largely by their component geological structure. Each region has its own characteristic landscape as a result of varying relief and land use and has a natural vegetation closely related to its geological and pedological components. These regions are:-

The Western Plain, the Cliff and Heath, the Central Lowland, the Wolds, the Fens, the Marsh and the Coast.

GEOLOGY

1.2 If a transect is taken from west to east across the County this will include representatives of all the major strata from the Triassic era to the Cretaceous era in strict geological conformity with the younger rocks outcropping to the east. In general the strata, as elsewhere in eastern England, are dipping to the east and major scarp slopes facing west will be encountered wherever harder rocks are crossed. The scarps from west to east are the Lias Scarp, the Limestone Scarp, the Spilsby Sandstone Scarp (in South Lindsey only) and the Chalk Scarp. These features are illustrated in sketch geological sections (Fig. 1) the locations of which can be found by reference to Map 2.

1.3 The solid geology has determined the major relief features of the County but much of the strata is now covered by areas of glacial and post-glacial drift, mainly boulder clays and blown sands (cover sands), or by tracts of alluvium or small pockets of peat. Table 1 outlines the complete geological succession in Lindsey while Map 2 illustrates the location of the major geological formations, indicating those regions where glacial drift is present.

1.4 Landscape is an amalgam of many features including relief and land use and for a fuller appreciation of the latter it is essential to examine the soils of Lindsey. Soil structure has a direct bearing on both agriculture and natural vegetation.

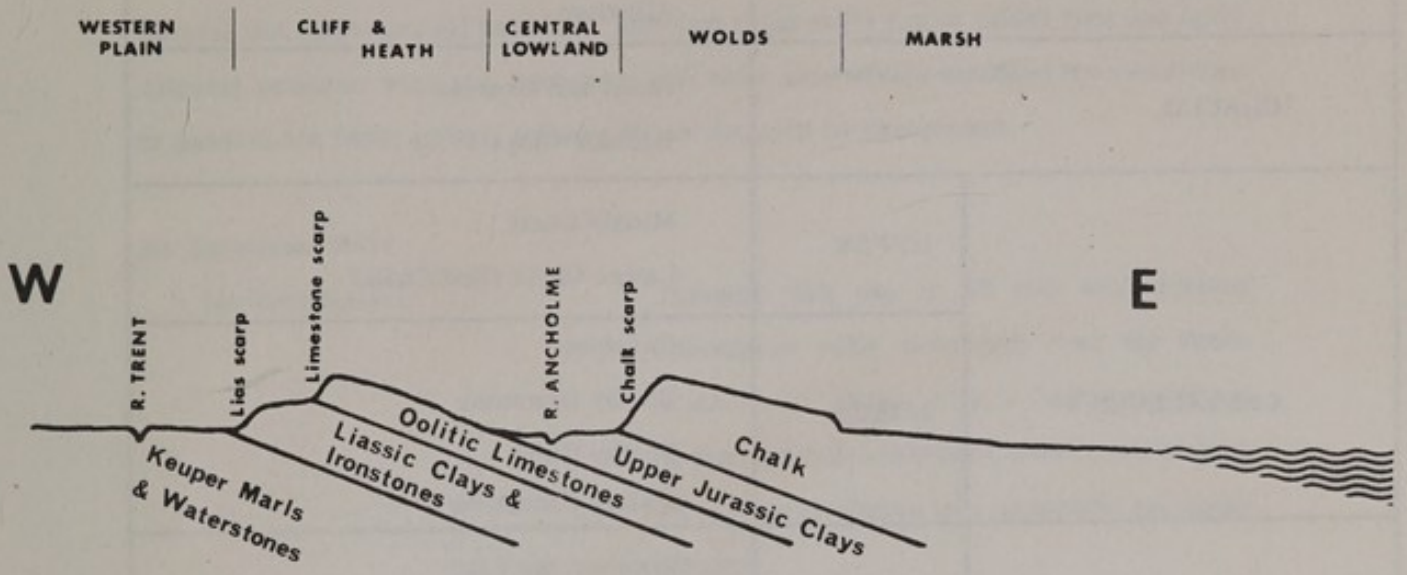
Fig. 1

Geological Sections (Major Divisions)

– Diagramatic & Not to Scale

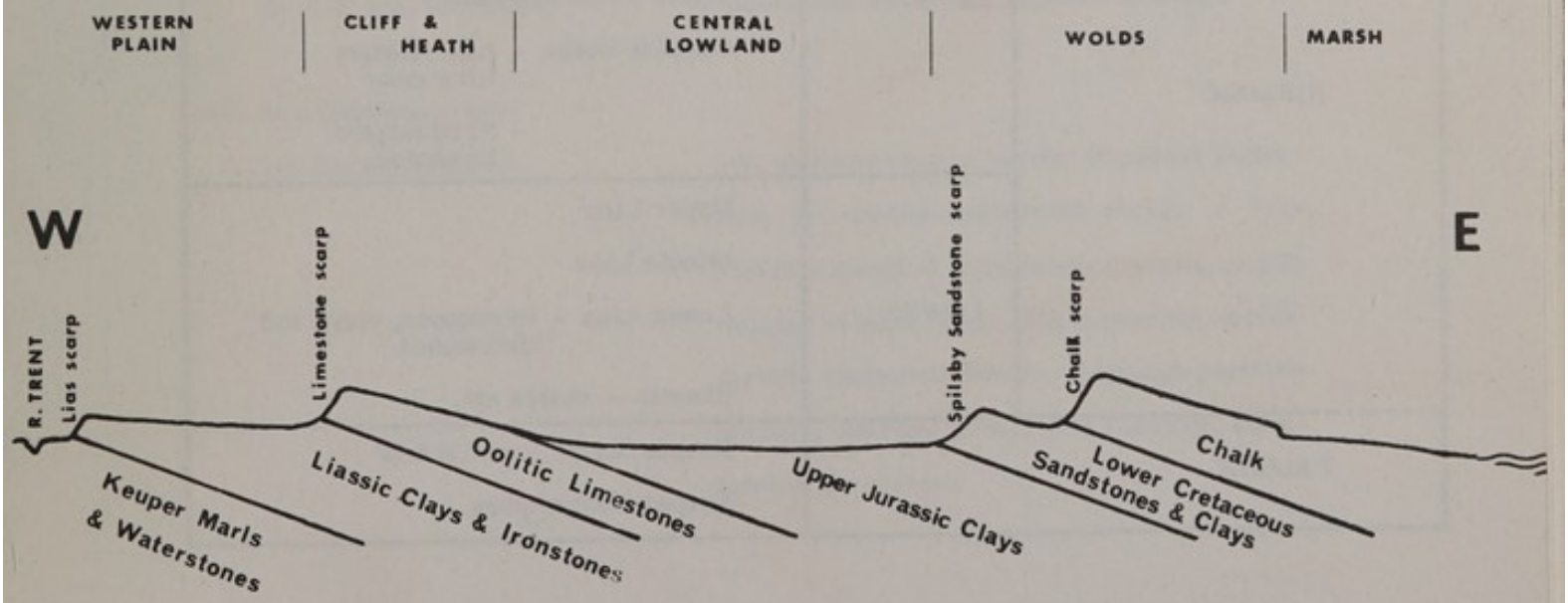
(A) North Lindsey

Section X–X



(B) South Lindsey

Section Y–Y



SEE GEOLOGY MAP FOR LOCATIONS

TABLE 1
GEOLOGICAL SUCCESSION IN LINDSEY

POST GLACIAL AND RECENT		Blown Sand Alluvium
GLACIAL		Sands and Gravels Boulder Clays
CRETACEOUS	UPPER	Middle Chalk Lower Chalk (Red Chalk)
	LOWER	Carstone Claxby Ironstone Tealby Clay Spilsby Sandstone
JURASSIC	UPPER	Kimmeridge Clay Oxford Clay
	MIDDLE	Cornbrash Great Oolite - white limestone, marls and clays Upper Estuarine Beds Inferior Oolite - Lincolnshire Limestone - Northampton Ironstone
	LOWER	Upper Lias Middle Lias Lower Lias - ironstones, clays and limestones Rhaetic - shales etc.
TRIASSIC		Keuper Marls - red marls Keuper Waterstones

PEDOLOGY

1.5 Soil composition is determined largely by the parent rock material from which it is derived. Much of the solid geology of Lindsey is masked however by drift and wherever this occurs there is a marked change in soil type. The following major soil groups are represented in Lindsey (Straw, 1969) and each can often be associated with a characteristic agricultural land use and specific natural and semi-natural habitats. Although many soils are of mixed type and agricultural practice over the centuries will have extensively modified the remainder in general the basic groups outlined below can still be recognised.

(i) Calcareous Soils

(a) Rendzinas:- Thinnish (10 cm to 45 cm) well drained calcareous soils developed over the limestones and chalk, with a high percentage of free calcium carbonate. Usually encountered on steep slopes and generally markedly alkaline.

(b) Brown Calcareous Soils:- Similar to Rendzinas but thicker and partially leached of calcium. Usually found on gentler slopes.

(c) Calcareous Gleys:- Calcareous soils with impeded drainage.

(ii) Non Calcareous Soils

(a) Brown Earths:- Soil derived from a variety of parent materials, but rarely calcareous rocks. A very variable group of soils, freely drained, usually neutral to moderately acid in reaction and frequently extremely fertile. Although partially leached, nutrient reversal is possible, maintaining the system.

(b) Podzols:-- Where the soil is of low base content and very well drained complete leaching of minerals often takes place leaving an extremely acid soil surface of low nutrient status. No nutrient reversal is possible. Breakdown and incorporation or organic litter is very slow, leaving a layer of partially decomposed acid humus (Mor) on the soil surface. Podzols are typically found on blown sand and, east of Woodhall Spa, on Fen edge sand.

(c) Non Calcareous Gleys:- Non calcareous soils with impeded drainage.

(d) Peaty Soils:- Organic soils, largely alkaline in reaction, once generally waterlogged, now mostly drained and where drained extremely fertile. With cultivation the organic content of such soils declines and the soils become modified to take on the character of brown earths.

1.6 Maps 3 and 4 indicate the occurrence of the major soil types in Lindsey. Map 3, an outline classification, is based on a map in a paper on Lincolnshire Soils (Straw, 1969) and Map 4 is an attempt to classify the soils by soil reaction. The latter map delimits the main ecological zones of the County, namely acid, neutral and calcareous habitats.

The inter-relationship between Soils, Agriculture & Forestry & Natural and Semi-natural Vegetation:-

1.7 There is a complex inter-relationship between these factors but in general it is often possible to broadly correlate both agricultural and forestry practice, and natural and semi-natural habitats with specific soil types; tables 2 and 3 are an attempt to make such a classification.

VEGETATION

(A) THE HABITAT FACTORS OF PLANTS

1.8 "In dealing with the plant life of any area and in trying to understand its composition and history it is essential to consider not only the plants themselves but also the conditions under which they live" (Turrill, 1948[1]).

TABLE 2. THE RELATIONSHIP BETWEEN AGRICULTURE, FORESTRY, AND SOIL TYPE

(i) Agriculture

Land Use	Location
Arable	Now extensive in Lindsey, requiring well drained fertile soils - typically found on Brown Calcareous Soils, Brown Earths, and Peaty Soils.
Grass	Typically now restricted to less well drained Brown Earths and to Gley Soils.

(ii) Forestry

Land Use	Location
Coniferous plantations	Typically found wherever Podzols occur, - the only commercial use to which most of these soils can be put.
Hardwood plantations	Found in varying quantities on all soil types including Podzols.

TABLE 3. THE RELATIONSHIP BETWEEN NATURAL AND SEMI-NATURAL HABITATS, AND SOIL TYPE.

Habitat	Location
Acid	Podzols
Neutral	Brown Earths and Non Calcareous Gley Soils.
Calcareous	
(i) Grassland	Best developed on Rendzinas and shallow Brown Calcareous Soils.
(ii) Woodland	In Lindsey, now mainly confined to the Calcareous Gley Soils of the Central Lowland and to scattered sites on Brown Calcareous Soils.

1.9 Even a cursory glance at our countryside will reveal that plants are generally grouped into communities with many distinct species characteristic or particular habitats such as woodland, moor, heath, meadow, dune etc. The factors promoting the development of such communities are extremely complex but can be usefully divided into 3 main groups as follows:-

(i) Climatic:-

1.10 Over a wide area or in an area where great changes in relief occur this factor plays a large role in determining the total spectrum of vegetation but in Lindsey it is unlikely that climatic variation from one part of the county to another is sufficiently large to promote any major vegetational differences.

1.11 The climate of the British Isles and indeed that of all of the western coastland of Europe may be termed oceanic because the dominant climatic factor is the prevalence of winds off the sea, in this case south west winds off the Atlantic (hence the climate is often termed Atlantic).

1.12 In Britain, as elsewhere, regional diversities may be recognised. The extreme oceanic climates are found in the west - Western Scotland, South West Ireland, South West Wales and Devon and Cornwall, while the rest of the British Isles, perhaps excluding parts of North East England and Scotland where the climate has northern affinities, has a suboceanic climate (Tansley, 1947).

1.13 Lindsey exhibits a characteristic suboceanic climate* with fairly mild winters and warm summers. The natural vegetation of the county is typical of this climatic pattern and climaxes to broad-leaved deciduous forest. Within this framework there are areas of local climate determined by physiographic factors such as proximity to the sea, hill ranges and valleys, and at the very local level, microclimates, which are largely governed by such factors as shelter and aspect. These local variations produce minor changes in the broad vegetation pattern but such changes are often extremely difficult to discern.

*Intermediate between true oceanic (mild winters and warm summers, fairly wet throughout the year) and continental (cold winters and hot summers with summer precipitation).

(ii) **Edaphic** (Geological and Pedological factors):-

1.14 Geological and pedological factors determine the medium in which the plants grow and are particularly significant in Lindsey where there is a wide range of soil types both in texture and acidity (Para. 1.5).

(iii) **Biotic:-**

1.15 Biotic factors include plant competition - the inter-relationship between the plants themselves, and the effects of animals, including man. The natural climax vegetation of Lindsey, as elsewhere in southern Britain, broad-leaved deciduous forest would undoubtedly be re-established if the land were left untilled. Many habitats, particularly grassland habitats, are essentially artificial, maintained only by man's intervention, the normal plant succession being interrupted and an intermediate community established.

(B) THE HABITATS OF LINDSEY

1.16 The main habitat types (ecosystems) are acid, neutral and calcareous habitats. These can be sub-divided into a number of distinct natural and semi-natural plant communities; those communities occurring extensively in Lindsey are listed in Table 4 together with the major artificial plant communities.

1.17 Lindsey is not reputed as a region rich in natural history but nevertheless the County still possesses a considerable wealth of wild life, particularly in variety, as reference to Table 4 will show. Few large tracts of natural and semi-natural vegetation, however, still remain.

1.18 There are 53 scheduled sites of biological interest in Lindsey, (at October, 1968) (Map 7). These are areas notified by the Nature Conservancy as National Nature Reserves (1), Proposed National Nature Reserves (1), Local Nature Reserves (2) and Sites of Special Scientific Interest (58), which include 9 sites mainly notified for their geological importance. The statutory significance of these designated areas is outlined in Appendix I, Para. 6.

TABLE 4. THE HABITATS OF LINDSEY

Natural and Semi-natural Plant Communities*

WOODLAND AND SCRUB

- Acid
- Neutral
- Calcareous

LOWLAND GRASSLAND AND HEATH

- Dry Acid Grassland and Heath
- Neutral Grassland
- Calcareous Grassland

WETLAND

- Wet Acid Heath
- Carr and Marsh
- Open Water
  - Still Water
  - Rivers and Streams

COASTAL HABITATS

- Salt-marsh
- Sand-dune

* Classification based on a scheme compiled by The Nature Conservancy (Ratcliffe, 1968).

Artificial Plant Communities

- Commercial Woodland
- Park Woodland
  - over arable
  - over pasture
- Artificial Grassland (short term leys)
- Arable Farmland
- Hedges
- Ruderal Communities (waste places)

THE NATURAL AND SEMI-NATURAL HABITATS OF LINDSEY

(A) ACID HABITATS

1.19 The most extensive areas of semi-natural vegetation in Lindsey comprise acid ecosystems developed primarily on podzolised or other nutrient deficient soils, located over blown sand, over Fen edge sand and gravel and over the Keuper shales of the Western Plain.

The natural vegetation has survived here because of the unsuitability of these soils to support an intensive agriculture, though forestry has become increasingly significant in recent years.

(i) Woodland and Scrub:-

1.20 "Natural" acid woodland is characterised by the presence of birch, both *Betula verrucosa* and *B. pendula*, and oak, usually *Quercus petraea*, though this species is uncommon in Lincolnshire with *Q. robur* and the hybrid *Q. robur* x *petraea* less frequent. The canopy is typically rather open with an extensive field layer usually dominated by bracken *(Pteridium aquilinum)*. Rhododendron is occasionally planted (as at Twigmoor) and is well suited to these soils and will spread naturally.

(ii) Dry Acid Grassland and Heath:-

1.21 This habitat developed on well drained soils is still extensively represented in Lindsey in the blown sand regions. The heathland is usually dominated by bracken *(Pteridium aquilinum)* or by ling *(Calluna vulgaris)* while other characteristic species include bell heather *(Erica cinerea)*, cross leaved heath *(E. tetralix)* and occasionally gorse *(Ulex europaea)*. The acid grassland is typified by the presence of wavy hair grass *(Deschampsia flexuosa)* and sand sedge *(Carex arenaria)*. A feature of some of the heathlands is the presence of such lime loving plants as the carline thistle *(Carlina vulgaris)*, this indicating that soil patches derived from calcareous materials are also present - as at Risby Warren where the underlying Oolitic Limestone is close to the surface.

(iii) Wet Acid Heath:-

1.22 A very important but decreasing habitat developed on ill drained acid soils. Agricultural drainage measures have destroyed many areas - notably at Waddingham Common (ex S.S.S.I.) and other areas are threatened through a lowering of the water table on adjacent agricultural land (as at Epworth and Haxey Turbaries) - again

through drainage measures. Predominant wet heath species include purple moor grass *(Molinia caerulea)*, cotton grass *(Eriophorum angustifolium)* and over the boggy areas *Sphagnum* moss. Local and rare plants characteristic of wet acid heath which occur in Lindsey and are of the utmost conservation importance include sundew, both *Drosera rotundifolia* and *D. intermedia*, marsh gentian *(Gentiana pneumonanthe)* and bog asphodel *(Narthecium ossifragum)*.

(B) NEUTRAL HABITATS

1.23 There are few areas of natural and semi-natural vegetation remaining on the neutral soils. Such habitats would typically be found on the Brown Earth and Gley soils and in localities throughout the County though mainly east of the Wolds, in the Central Lowland and on the Western Plain - Brown Earth soils may be produced on any parent rock if conditions are favourable.

(i) Woodland and Scrub:-

1.24 It is doubtful whether any semi-natural woodland remains, though managed hardwood regions on these neutral soils will have, over the years, developed a characteristic neutral flora and fauna. Such woodland would be characterised by the presence of oak, mainly *Quercus robur*, ash *(Fraxinus excellsior)* and hazel *(Corylus avellena)* and probably sallow scrub *(Salix cinerea)*. It is only the shrub and herb layers which distinguish these woodlands from similar woods found on calcareous soils.

(ii) Grassland:-

1.25 Most neutral grassland is in managed fields or on road verges and the latter have assumed increasing importance in terms of conservation as more permanent grass is ploughed up. Lindsey is now relatively poor in permanent grassland and it is likely that further areas will be lost in the future. Map 5 illustrates the distribution of permanent grassland and rough grazing in 1966 and is based on the researches of Blackwood. The figures are drawn from Ministry of Agriculture statistics for that year. It can be seen that the lowest concentrations of grassland are to be found on the Isle of Axholme and in the Fen country while the highest levels occur on the coastal Marsh between Saltfleet and Skegness. An account of the distribution of permanent grassland in Lincolnshire may be found in a paper by Blackwood in the Newsletter of the Lincolnshire Trust for Nature Conservation, October 1968.

1.26 Agriculturally the best pastures are largely dominated by perennial rye grass *(Lolium perenne)* and white clover *(Trifolium repens)* though cocksfoot *(Dactylis glomerata)* and meadow foxtail *(Alopecurus pratensis)* are often abundant.

1.27 Many flowering plants are characteristic of meadows. The buttercup, mainly *Ranunculus acris* and *R. repens*, is well known but in several Lincolnshire meadows the local green winged orchid *(Orchis morio)* is found. The neutral grassland community as a whole is of considerable interest and the conservation of representative samples of this habitat is now of considerable importance in Lindsey.

(iii) Carr and Marsh:-

1.28 Marsh as distinct from bog and fen is taken to refer to wetland areas developed on mineral soils, the latter two communities are associated with organic soils (peat). Marshes are usually located on the edge of ponds and lakes or on undrained flood plains of rivers and streams and typically are neutral in reaction and rarely markedly acid.

1.29 Scrub invasion of marshland results in the production of a carr. The invaders are frequently sallows, crack and white willows *(Salix fragilis* and *S. alba)* and characteristically alder *(Alnus glutinosa)*. The ground flora is diverse with such species as kingcup *(Caltha palustris)*, sedges *(Carex spp.)*, rushes *(Juncus spp.)*, yellow flag *(Iris pseudacorus)* and water mint *(Mentha aquatica)*.

1.30 Carr and marsh is not widely represented in Lindsey but there are a few scattered marshland sites and a series of small alder carrs located where streams flowing across Spilsby Sandstone have cut through to the impervious Kimmeridge Clay beds below. Some of these carrs are of particular interest ecologically and the local alternate leaved golden saxifrage *(Chrysosplenium alternifolium)* is represented.

(C) CALCAREOUS HABITATS

1.31 Strongly calcareous conditions prevail over parts of the Wolds (over chalk) and over parts of the Cliff and Heath (over Oolitic limestones) while mildly

calcareous conditions are encountered on the Liassic and the Jurassic (Oxford and Kimmeridge) Clays.

(i) Woodland and Scrub:-

1.32 There are two main groups of calcareous woodlands in Lindsey; a large group, predominantly Forestry Commission owned, on the boulder clays overlaying the Jurassic clays of the South Central Lowland; and a series of woods on the boulder clays flanking the chalk land of the South Wolds. Both groups support oak, ash and hazel with coppice but the former are famous for the occurrence there of small leaved lime *(Tilia cordata)*, often in considerable quantity. Many of the woods are damp and the ground flora includes water avens *(Geum rivale)* while scarcer and under dryer conditions herb paris *(Paris quadrifolia)* and the butterfly orchid *(Platanthera chlorantha)* may be found. All three plants are characteristic of calcareous soils.

1.33 Escarpment beechwoods (hangers), typically found on the chalk lands of Southern England - on the North Downs, South Downs, Salisbury Plain and the Chilterns - and on the Oolitic Limstones of the Cotswolds, are very poorly represented in Lindsey; where beech does occur it is rarely in pure stands. There is some doubt whether beech is indigenous as far north as Lincolnshire.

1.34 Calcareous scrub rapidly invades ungrazed calcareous grassland and is intermediate in succession between grassland and climax calcareous woodland. Many of the species represented, which typically include dogwood *(Thelycrania sanguinea)* and privet *(Ligustrum vulgare)* are found in woodland as a scrub layer in addition to their occurrence in distinct scrubland communities. Many of the chalk and limestone quarries on the Wolds and Cliff and Heath show all the successional stages from grassland through chalk scrub to woodland and have an excellent educational value for this reason.

(ii) Grassland:-

1.35 The chalk and limestone grassland is perhaps our most attractive grassland community being particularly rich in flowering plant species many of these extremely beautiful. The richest communities are found on steep slopes where the soil is particularly thin, well drained and rich in free calcium carbonate (i.e. on

Rendzina soils). This habitat, found on the limestone Cliff and Heath and on the chalk Wolds, is now restricted and limited mainly to road verges and to man made areas such as pits and quarries. However, a few "natural" grassland areas do remain and these nearly all now have S.S.S.I. status. These grasslands were formerly sheep grazed but this has largely ceased and with the reduction in rabbit populations through myxomatosis scrub encroachment of the remaining grassland areas is rapid. Conservation of representative samples of good calcareous grassland is now of the utmost importance in Lindsey.

1.36 The dominant grasses are typically sheep's fescue *(Festuca ovina)* and red fescue *(Festuca rubra)*, especially where grazing is intense, though taller species, mainly upright brome *(Zerna erecta)* and quaking grass *(Briza media)* are common. Tor grass *(Brachypodium pinnatum)*, a very coarse species and apparently unpalatable to grazing animals, has become increasingly widespread in recent years and is reducing the floristic interest of many grassland areas.

1.37 It is the flowering plants which have made these grasslands well known. They are famous for their orchids - the spotted orchid *(Dactylorchis fuchsii)* and the pyramidal orchid *(Anacamptis pyramidalis)* are often common while rarer species include the attractive and unusual bee orchid *(Orphyrs apifera)*. Yellow vetches, notably horse shoe vetch *(Hippocrepis commosa)* and kidney vetch *(Anthyllis vulneraria)* are often widespread though scarce in Lindsey and blue campanulas such as the clustered bellflower *(Campanula glomerata)*, again scarce in Lindsey, may be found.

(D) OPEN WATER

(i) Still Water:-

1.38 Oxygen supply and the nature of the substratum are the all important factors involved in the development and maintenance of still freshwater habitats.

1.39 Many of the ponds in Lindsey are typically surrounded by areas of reedswamp with reed *(Phragmites communis)*, reedmace *(Typha latifolia)* and sedges *(Carex spp.)*. These extensive reedswamp communities provide excellent cover for Warblers, Duck and Coot and for other birds and thus in addition to their own ecological interest the community has considerable ornithological significance.

1.40 Open water, if fairly shallow, may contain pondweeds *(Potamogeton spp.)*, Canadian waterweed *(Elodea canadensis)*, water starworts *(Callitriche spp.)* and duckweeds, especially *Lemna minor* and occasionally the attractive water violet *(Hottonia palustris)*.

(ii) Rivers and Streams :-

1.41 Rivers and streams show a range of vegetation types according to their rate of flow or stagnancy and according to the amount and composition of the silt covering the bed.

1.42 In slow moving rivers, as exemplified in the drainage dykes of the Fens and Marsh the vegetation approximates to that of a pond. The nature and extent of the silt bed is again the all important factor. Some of the fen drains have produced a luxuriant aquatic vegetation and contain such species as arrowhead *(Sagittaria sagittifolia)*, yellow water lily *(Nuphar lutea)* and submerged pondweeds such as Canadian water weed *(Elodea canadensis)* and several species of Potamogeton and the floating aquatic, duckweed *(Lemna minor)*. Slow moving streams usually develop extensive reedswamp communities with reed *(Phragmites communis)*, bur reed *(Sparganum erectum)*, flote-grass *(Glyceria fluitans)* and sedges *(Carex spp.)*, and marsh communities with kingcup *(Caltha palustris)*, brooklime *(Veronica beccabunga)* and water figwort *(Scrophularia aquatica)*.

1.43 In rivers with a moderately swift current silt accumulation is limited and the river bed usually consists mainly of stones. The upper reaches of several of the rivers of the Wolds, The River Bain and the River Lymn, for example, show this feature and have developed the typical vegetation associated with this type of stream, characterised by the presence of water crowfoot *(Ranunculus fluitans)* trailing in long streaks downstream, the roots anchored between the stones.

(E) COASTAL HABITATS

(i) Sand-dunes:-

1.44 The sand-dunes ecosystem, well represented along the Lindsey coast, is essentially a mobile habitat - dunes are constantly created on the seaward side and grassland or scrub develops on the landward side. For the biologist

sand-dunes are particularly interesting as they are one of the few places where the whole series of stages in the colonisation of a bare habitat can be studied.

1.45 Sand-dune formation and stabilisation is essentially dependent on the agency of plants and marram grass *(Ammophila arenaria)* is generally the main species involved, this plant thriving in loose sand. Sand blown landward accumulates against the grass forming a low ridge, but marram can grow up through this forming yet another barrier and encouraging further sand accumulation - this is a continuous process. Often the marram spreads seawards thus advancing the line of the dunes and this is well seen at Saltfleetby where coastal accretion is occurring, the dunes there advancing at a rate of several feet per year.

1.46 The dune system formed by the marram is known as a Mobile Dune as it is unstable. It is only when plants such as red fescue *(Festuca rubra)* and sand couch *(Agropyron pungens)* begin to colonise that the dunes become stable. From thence they are termed Fixed Dunes and at this stage other plants, typically mosses such as *Tortula ruraliformis* (almost confined to dunes) and species of *Bryum* become established.

1.47 Eventually the Fixed Dunes become colonised by large numbers of grasses and flowering plants and lose their maritime character. These dune grasslands are often grazed or mown, though this is not practised in Lindsey, but if they are left uncut rapidly become invaded by scrub - in Lindsey typically sea buckthorn *(Hippophae rhamnoides)* and elder *(Sambucus nigra)*.

1.48 Where accretion is still occurring Fore-dunes are frequently encountered in front of the main dune ridge, the sand here trapped by sea couch *(Agropyron junceforme)*, a plant which can tolerate occasional immersion in salt water; this is well seen at Saltfleetby.

1.49 The whole plant succession is diagrammatically represented in Fig. 2.

1.50 The original sand forming the dunes in Lindsey is rich in calcium carbonate and hence many of the plants found on the Fixed Dunes and Dune Grasslands are typical calcicoles such as the pyramidal orchid *(Anacamptis pyramidalis)* and the carline thistle *(Carlina vulgaris)*. Dunes rich in calcareous materials are often termed white dunes in contrast to dunes rich in siliceous materials (yellow dunes), these acid in reaction.

Fig. 2
Sand-dune succession

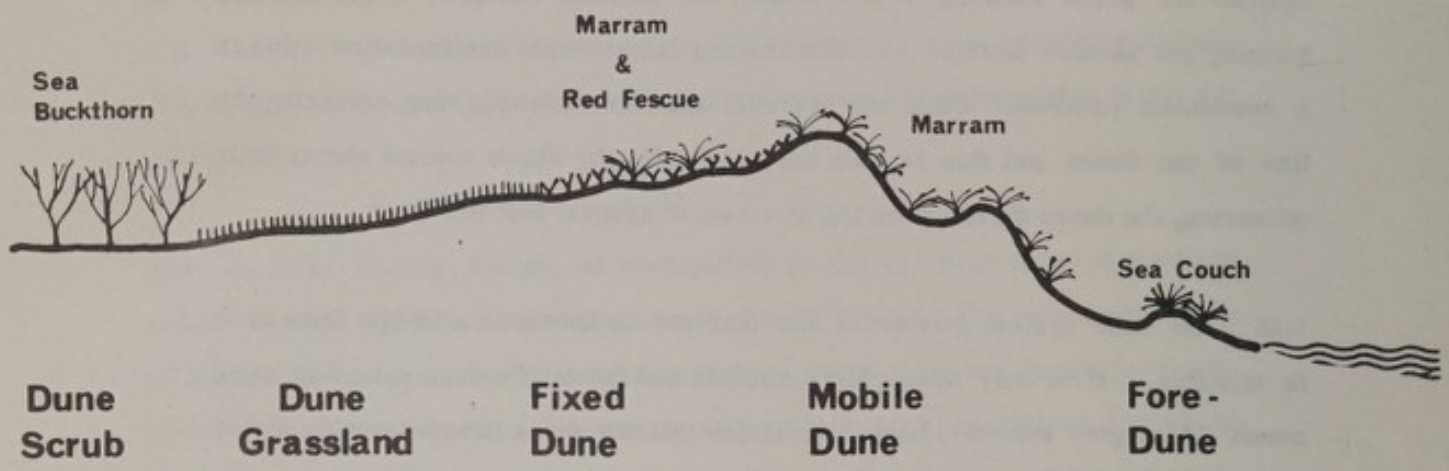
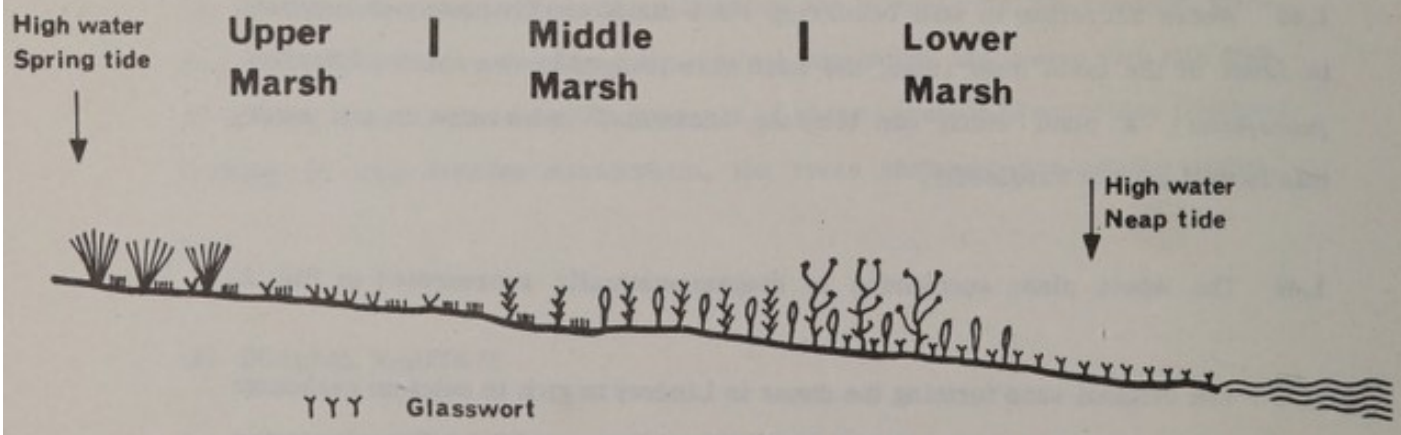


Fig. 3
Salt-marsh succession



(ii) Salt-marshes:-

1.51 Salt-marshes are typically encountered on the mud and sand of those marginal estuaries and bays which are protected from swift tidal races and currents. This habitat is characteristically found wherever coastal accretion is taking place, in Lindsey north of Mablethorpe and south of Skegness and is absent on exposed coasts where, of course, rooted plant can not become established.

1.52 Salt-marshes, like dunes, are mobile habitats. There follows a succession of distinct communities as one passes from the lowest ebb tide levels towards the land. As accretion proceeds new areas of primeval salt-marsh form on the seaward side and "old" marsh gradually takes on the character of a terrestrial habitat. Three major zones may be recognised - lower, middle and upper marsh.

1.53 The lowest zone is subject to submergence by the tide for more than 50 hours a month and is typically colonised by glasswort *(Salicornia europaea)*, often found in pure communities, though frequently associated with sea manna-grass *(Puccinellia maritima)* and sea aster *(Aster tripolium)* especially on the upper edge of the zone. Frequently, however, glasswort is replaced completely by cord grass *(Spartina townsendii)*, a male-sterile hybrid *(S. alterniflora X maritima)* which was first recorded in Southampton Water in 1878 and has since spread rapidly.

1.54 The plants of the lower marsh act as a trap for silt and debris and the ground level is gradually raised to produce the middle marsh, where the soil is often uncovered totally for long periods between the highest spring tides (March and September). Two species are dominant in the middle marsh, the sea lavender *(Limonium vulgare)* and thrift *(Armeria maritima)* (though thrift is not common in the salt-marsh at Gibraltar Point) while sea manna-grass *(Puccinellia maritima)* and sea spurrey *(Spergularia media)* are usually frequent.

1.55 The upper marsh is frequently characterised by the presence of a maritime form of red fescue *(Festuca rubra)* and by the maritime rush *(Juncus gerardii)*; often a zone of sea rush *(J. maritimus)* is also encountered.

1.56 The zones are usually quite distinct and thus salt-marsh communities are extremely valuable for educational purposes, demonstrating well the factors

and stages of plant succession. The complete succession is diagrammatically represented in Fig. 3.

ARTIFICIAL PLANT COMMUNITIES AND THEIR IMPLICATIONS ON WILD LIFE CONSERVATION

Commercial Woodland

1.57 "Planted woodlands are, to the ecologist, experiments with artificial climax communities or constituents of such", (Turrill, 1948[2]). Native tree species grown as a commercial crop and introductions such as sycamore, turkey oak and sweet chestnut can reproduce and locally spread but the plantations of spruces, larches, douglas fir and various pines usually do not extend their boundaries and remain solely as cultivated crops. In general, commercial plantations of native species can develop as diverse a wild life content as a natural wood but the coniferous plantations usually have a poorer flora, partially caused by the greater shade cast by many of these trees and partially through an accumulation of litter, mainly conifer needles, beneath the trees, these, especially from spruce and pine, releasing toxins as they slowly decay which are often unfavourable to the production of a luxuriant ground flora.

Park Woodland

1.58 Although of great amenity value park woodland is generally of little note ecologically though individual trees may be of interest. Park woodland over arable crops is of the least value but that over grassland is usually associated with long established permanent pasture, this often having a considerable ecological importance as further grassland areas are ploughed up.

Artificial Grassland (Short term leys)

1.59 Artifical grassland is usually considered as part of the arable crop rotation and is of little interest in the context of wild life conservation.

Arable Farmland

1.60 Modern farming techniques involving use of intensive cultural methods and treatment of the land with herbicides, fungicides, insecticides and articial fertilisers have greatly reduced the value of arable land as a wild life refuge (Paras. 2.137 to 2.144).

Hedges.

1.61 Hedges represent an extension of the woodland habitat into open country and are vital for wild life. They contain plant and animal species characteristic of both field and woodland and with intensive field cropping and intensification of commercial principles in woodland their value has been considerably increased, yet they are rapidly being grubbed up (Para. 2.131).

Ruderal Communities: (Waste places)

1.62 Waste places have assumed an increasing importance in the role of wild life conservation and management as agriculture and forestry has become more intensive and further areas of natural and semi-natural vegetation have been lost. Disused pits and quarries, abandoned railway lines and industrial tips soon become colonised by a host of plants and animals and these sites are often free from human interference and pollution.

In Lindsey chalk and limestone quarries provide the County with a good range of calcareous habitats while many gravel and sand pits have produced interesting water communities often valuable for wild fowl.

Disused railway lines are frequently of note. In Lindsey the Louth to Bardney line closed in 1956 has already developed a wide and diverse wild life and a section near Benniworth Haven, where successional changes can be studied, is occassionally used for teaching purposes.

DETAILED EVALUATION – by Natural Region

1.63 Each physical region of the County, as delimited on Map 1, is considered in turn and its structure and natural history described. The main areas of natural and semi-natural vegetation are depicted on Map 6 with Scheduled Sites of Scientific Importance shown, in addition, on Map 7. The numbers adjacent to some of the locations correspond to areas described in the text below. Many of the scheduled areas are now owned or leased by the Lincolnshire Trust for Nature Conservation and managed as nature reserves.

The Western Plain

Structure and Landscape:

1.64 This region compises that part of Lindsey west of the Cliff and Heath and includes the whole of the Isle of Axholme.

1.65 Immediately west of the Cliff is the Lias Plain which descends to the Trent Valley by a marked scarp over much of its length. The Plain is about 11 Kilometres (7 miles) wide in the south but narrows to about 3 Kilometres (2 miles) north of Scunthorpe where the scarp face is considerably more pronounced, up to 60 m. (200 ft.). This area (Burton Hills) and the Scunthorpe area is usually, for convenience, included with the Cliff and Heath region but technically is not part of the same geological series. Boulder clays overlay much of the Lias and there are extensive tracts of blown sand which notably affect the natural vegetation wherever they occur.

1.66 West of the Lias the countryside is generally flat and low lying and much of the area is covered by post glacial deposits, mainly of alluvium but in the Isle of Axholme of peat. Outcrops of the Triassic Keuper Sandstones also occur in the Isle of Axholme and along the east bank of the River Trent south of Gainsborough and in Axholme these outcrops are responsible for the notably higher land, up to 30 m. (100 ft.) in the south of the Isle.

1.67 The lower Jurassic rocks, except where overlain by blown sand, generally give rise to mildly calcareous heavy soils. In contrast, neutral brown earths occur over the zones of Triassic strata, these characteristically red in colour, though podzolic soils are represented in some areas, notably at Naylor's Hills and Broom Hills.

Vegetation and Wild Life

1.68 The highly fertile soils of the Isle of Axholme, now under intensive cultivation, are the product of drainage of large tracts of peat moor, fen and bog, which once extensively covered this region. Very little of the original vegetation survives but the two "best preserved" stretches at Epworth Turbary (S.S.S.I.) (1) and Haxey Turbary (S.S.S.I.) (2) are now managed as nature reserves by the Lincolnshire Trust and this should ensure their continued existance. Both sites are of immense scientific value and contain a wealth of interesting plants and animals. At Crowle Waste (3) there is a large area of peat moor and scrub and peat is still extracted for commercial purposes.

1.69 The Forestry Commission have planted up a considerable area of the blown sands north and west of Laughton (Laughton Forest) (4) and this area possesses

much of interest. There are three separate water areas in the forest, Laughton (one area) and Scotton (two areas) Forest Ponds (5) and these now have S.S.S.I. status. The ponds are noted for the wealth of bird life which they harbour, including Black Headed Gulls at Laughton Pond, and for interesting marginal wet heath vegetation.

1.70 16 hectares (40 acres) of semi-natural blown sand heath at Scotton Common (S.S.S.I.) (6) is managed as a nature reserve by the Lincolnshire Trust. This site contains a number of bog plants uncommon in the County and harbours a very rich insect population. The area is also noted as a location for the Red Squirrel and a number of localised breeding birds, including Nightjars and Kestrels nest there.

1.71 Road verges have assumed increasing importance in the conservation of representative samples of natural and semi-natural vegetation and selected verges now receive special treatment in an attempt to maintain and conserve their valuable wild life; one such area (7) adjoins the Scotton Common Reserve. The areas for special treatment are selected through the Lincolnshire Trust and are protected through a management agreement with the Highway Authority under which the use of herbicidal sprays is avoided and the time and method of cutting selected to provide optimum conditions for the preservation of those features of special interest on the verge.

1.72 At Messingham Heath (S.S.S.I.) (8) the best remaining example of dry acid heath in this region is to be found. A wide range of habitat types is represented including, in addition to dry heathland, areas of wet heathland, sand-dunes and acid bog. The site, of exceptional importance, is the only significant locality in Lincolnshire for the Grayling butterfly but the value of the area has been much reduced in recent years through sand extraction and attempts to reclaim parts of it for agriculture, and these threats remain.

1.73 The 40 hectares (95 acres) of wet heathland at Manton South (9) given S.S.S.I. status in 1968, are used for rough grazing, but this site is still one of the best examples of its type in the County and contains many rare species including the marsh gentian. There are several other smaller areas of blown sand heathland in this part of the county all of which possess some interest.

1.74 South of Gainsborough there are 2 notable areas of heath on the sandy Keuper soils, at Naylor's Hills (10) and at Broom Hills (11).

The Cliff and Heath

Structure and Landscape

1.75 This region is defined as the north to south running tract of higher land, up to 76.5 m. (251 ft.) at Dragonby, in the west of the County, structurally comprising the Jurassic Limestones (Oolites) known as Lincolnshire Limestone. In the Scunthorpe area and northwards the Cliff and Heath is usually considered to include the Liassic deposits, and these comprise clays, limestones and the Frodingham Ironstone beds on which the Scunthorpe iron and steel industry was based (Para. 1.65). The Limestone is dipping to the east and presents a marked scarp slope to the west (The Cliff) and a more gentle slope to the east (The Heath).

1.76 Blown sands overlay much of the solid geology in the Scunthorpe area and particularly the Frodingham Ironstone beds producing extensive areas of podzolised soils, but elsewhere the Limestones give rise to calcareous soils, mainly Calcareous Brown Earths.

Vegetation and Wild Life

1.77 The calcareous soils which cover most of this region are well suited to intensive agriculture and except where the gradients are too steep (as along the Lias Scarp) are under complete cultivation. Thus the calcicole vegetation survives in only a few scattered areas, mainly confined to roadside verges and to other man made areas such as pits and quarries.

1.78 North of Kirton-in-Lindsey there are several disused limestone quarries (12) and these are noted for a very rich calcicole flora and a wealth of insect life. Indeed the best limestone flora in North Lincolnshire is found in a quarry at Broughton, at Clapgate Pits (S.S.S.I.) (13) where many rare species are recorded.

1.79 There are few areas of permanent grassland on the Limestone but one such area at Cliff House, Waddingham (14) retains a considerable botanical interest and has been given S.S.S.I. status.

1.80 The Lias produces only mildly calcareous conditions and in general a less varied flora. There is a considerable area of semi-natural vegetation on the Lias Scarp, north of Burton-upon-Stather, (15) and this site, of moderate interest, is the only locality in Lincolnshire where a scarp slope descends to maritime conditions.

1.81 It is the blown sand regions, mainly overlying the Lias, that provide the most valuable wild life areas in this part of the County. Where the blown sands are particularly thick only small areas are under agriculture and there still exist quite large expanses of semi-natural vegetation. Much of the remaining land is either under commercial woodland (mainly coniferous plantations), or is being worked for iron ore. Many of the semi-natural areas are of exceptional interest and large areas have S.S.S.I. protection.

1.82 The largest remaining tract of blown sand heath in the County is at Risby Warren (S.S.S.I.) (16), north of Scunthorpe, and this occupies about 170 hectares (420 acres). Research is being carried out here on the effects of atmospheric pollution on Lichens - much damage to vegetation had been recorded following pollution from the nearby steelworks.

1.83 The extensive workings for iron ore in the Scunthorpe area have produced many interesting sites where successional changes can be studied as the virgin areas are recolonised and one such area, at Crosby Warren (17), is of exceptional value and would make an ideal educational nature reserve.

1.84 Other well-known blown sand locations are at Manton Warren (18) and Twigmoor Woods (19). Manton Warren and Twigmoor are noted for uncommon insects and a wide variety of breeding birds in addition to their fine flora. The Warren is mainly blown sand heath but Twigmoor Woods is a fine mixed woodland with a lake and a scrub layer containing rhododendron. The woods are private but are open to the public when the rhododendrons are in flower. These two sites, both of S.S.S.I. status, together occupy about 300 hectares (750 acres).

The Central Lowland

Structure and Landscape

1.85 This region, lying between the Limestone Cliff and the Wolds, is a region of flat land of mainly glacial and post glacial origins. The solid geology, predominantly Jurassic Clays of the Oxford and Kimmeridge series, is masked by tracts of alluvium in the valley of the Ancholme and by extensive areas of boulder clays in the south, while immediately west of the Wolds, almost from the Humber Bank to south of Market Rasen, areas of blown sand drift are present.

1.86 The alluvial regions of the Ancholme Valley once supported an extensive marsh but drainage measures have produced extremely fertile soils, mainly neutral in reaction and highly suited to an intensive arable farming. The boulder clays, generally wet and heavy, give rise to Calcareous Gley Soils and the extensive blown sand zones to Podzols. In the Woodhall Spa district there are small areas of Fen edge sand and gravel and these give rise to podzolic soils though often with some calcareous elements.

Vegetation and Wild Life

1.87 The Calcareous Gley Soils in the south support a series of fine deciduous woodlands, centred around Wragby. These woodlands, both high forest and coppice with standards, have long been famous for the occurrence of small leaved lime. Lime woods are usually particularly rich botanically and harbour a large insect population (especially Lepidoptera) and these woods are no exception; Great West Wood (20), Cocklode Wood (21), Hatton Wood (22), Newball Wood (23), Scotgrove Wood (24), Spring Wood (25) and Stainton Wood (26) have S.S.S.I. status but Fulnetby Wood (27), Gatecliff Wood (28) with its heronry, Glad Wood (29), Goslings Corner Wood (30), Hardy Gang Wood (31), Minting Wood (32) and Southrey Wood (33) also contain many features of considerable scientific interest. Among the butterflies and moths recorded are the Chequered Skipper, Brown Hairstreak, Purple Hairstreak, Pearl Bordered Frittillary and Comma, all localised species in Lindsey.

1.88 The blown sands of the Central Lowland, particularly east of Market Rasen, on the edge of the central Wolds, have been extensively exploited for timber production as they have been at Laughton and east of Scunthorpe on the Western

Plain and Cliff. The Forestry Commission owns a good deal of the land east of Market Rasen and many acres have been planted up with conifers, but the whole area is still of great natural history interest.

1.89 An extensive tract of natural blown sand heath remains at Linwood Warren (34) and the area of S.S.S.I. status is managed as a nature reserve by the Lincolnshire Trust. This site, very rich botanically and entomologically has long been famous for its Lichen flora and the Red Squirrel, still quite common on this reserve, is an added interest.

1.90 Linwood Golf Course (35), opposite Linwood Warren, is also of note with much of the natural vegetation still remaining. The verges along the adjoining road (36) are valuable and under agreed management with Highway Authority.

1.91 The Fen edge sands and gravel support a series of important woodland and heathland communities centred on Woodhall Spa and Tattershall.

1.92 At Kirkby Moor (S.S.S.I.) (37) dry and wet acid heathland is found together with fen, woodland and a reservoir rich in plant and animal life. This site, recently acquired as a nature reserve by the Lincolnshire Trust, is of the greatest interest and is entomologically one of the richest areas in the county.

1.93 There is a further good example of acid heathland at Woodhall Spa Golf Course (S.S.S.I.) (38) and other similar heathland areas may be found at Roughton Moor (39), and Tower on the Moor (40). At the Woodhall Spa Golf Course site small zones containing base rich communities also occur.

1.94 The Fen edge woodlands, typified by Troy Wood (S.S.S.I.) (41) and St. Helen's Wood (42) are of considerable interest. Troy Wood, well-known for its large heronry, has a rich insect population and is the only locality in Lincolnshire where the Wood Ant may be found; St. Helen's Wood is of note mainly for its varied flora. There are two small pieces of woodland near Tattershall known as Tattershall Carrs (43) which have ecological affinities with Troy wood and both were given S.S.S.I. status in 1968.

1.95 There are extensive gravel workings in the Tattershall/Woodhall area and some of the abandoned pits have developed a varied flora and fauna and successional changes can be followed. The area is especially noted for its bird life, breeding birds including several species of Warbler and the Black Headed Gull. 48 hectares (118 acres) (44) have been given S.S.S.I. status.

1.96 Reads Island (S.S.S.I.) (45) in the Humber, might be considered here. This island with its extensive sand and mud-flats is an important winter feeding ground for many birds, including several species of ducks and geese.

The Wolds

Structure and Landscape

1.97 This region of higher land in the east of the County, running parallel to the coast, up to 170 m. (550 ft.) on Nettleton Scarp, includes all the Chalk lands (the Wolds proper), the Claxby Ironstones, Tealby Clays, and the Spilsby Sandstone belt - all Cretaceous strata. The chalk, dipping to the east, rests on ironstones, clays and sandstones, and presents a scarp face to the west. In the south of the county the Spilsby Sandstones are fully exposed producing a second scarp face west of the chalk. The eastern edge of the Wolds is marked by an ancient chalk cliff overlooking the wide coastal plain but much of this margin is now masked by extensive tracts of boulder clays, while in the Brocklesby area of the North Wolds zones of blown sand drift are encountered.

1.98 The chalk lands mainly give rise to calcareous soils, predominantly Calcareous Brown Earths, but on steep sided valley slopes and on the scarp face the soils are particularly thin and very chalky and would be classified as Rendzinas - it is these latter sites which produce the most interesting base rich habitats. The blown sand regions as elsewhere in the County, tend to give rise to podzolic soil types but here the sands are not particularly thick and thus Podzol development is not extensive.

Vegetation and Wild Life

1.99 The region is one of great physical diversity and contains a considerable wealth of wild life, including a great many habitat types.

1.100 The Chalk Wolds were typified in medieval times by rolling calcareous grassland, much of it sheep grazed, but by circa 1830 these grassland areas had almost completely disappeared and intensive arable cropping now takes place. The grassland sites which remain are often still threatened with ploughing, or spoilt through scrub encroachment now they are not grazed. Only fragments of these once extensive areas of chalk grassland now remain, the most valuable of these being probably at Wold Newton (46), Belchford Hill (47), Binbrook (Walk House Pit) (48), in the Farforth Valley (49), at Gaumer Hill (50), High Barn (Oxcombe) (S.S.S.I.) (51), Horkstow Scarp (52), Red Hill (Goulceby) (L.N.R.) (53), Rowgate Hill (54), Skendleby Psalter (S.S.S.I.) (55), in the Swaby Valley (S.S.S.I.) (56), at Swallow Wold (S.S.S.I.) (57), and at Tetford Hill (S.S.S.I.) (58) with the Red Hill site now managed as a nature reserve by the Lincolnshire Trust.

1.101 Road verges have assumed increasing importance in the conservation of representative samples of chalk grassland and several chalk grassland verges are now protected through management agreements with the Highway Authority including verges at Binbrook (59), on the Bluestone Heath road (60), in Dawber Lane (61), on the Nettleton/Rothwell road (62), at Red Hill (63), Rowgate Hill (64) and at Tetford Hill (65).

1.102 There are a great many disused chalk pits on the Wolds and some of these contain much of wild life value. Quarries at Candlesby (S.S.S.I.) (66), and Claxby (S.S.S.I.) (67), containing particularly rich floras are now managed by the Lincolnshire Trust as nature reserves and it is proposed to open a field museum at the Claxby site, now used for educational purposes.

1.103 The various woodland areas on the Wolds are of some interest. The extensive plantations on the Brocklesby Estate near Great Limber (68) on the blown sands, although of no great ecological value, are of great visual attraction and have a considerable scope for educational purposes.

1.104 There is a great variety of scenery on the Spilsby Sandstones with many deep valleys cutting into the Kimmeridge Clays below; some of these valleys have special biological significance. A series of alder carrs is found on this system, the most interesting of which include Ashby House Carr (69), Cliff Carr(70),

Salmonby Carr (71), Somersby Carr (72), Jenkin's Carr (73) and Keal Carr (74), the last two having S.S.S.I. status.

1.105 There are several small areas of woodland on the western edge of the Wolds, many of these possessing interesting biological features, and at one such locality at Benniworth Haven (S.S.S.I.) (75) there is a fine mixed woodland with marsh and swamp communities and two areas of open water.

The Marsh

Structure and Landscape

1.106 This is a region of flat land bordering the coast, of glacial and post glacial origin. Boulder clays fringe the Wolds and give rise to the somewhat hummocky landscape of the Middle Marsh, but the coastal belt proper (the Outer Marsh), of alluvial and marine origin, is flat and featureless. There are small areas of glacial gravel and a region of blown sand deposits near North Somercotes.

Vegetation and Wild Life

1.107 South of Louth, on the boulder clays of the Middle Marsh, is to be found a series of fine woodlands some of considerable ecological interest. Burwell Wood (76), Hoplands Wood (77), Welton Wood (78) and Willoughby Wood (79) are all particularly noteworthy and Willoughby Wood (S.S.S.I.) is probably the best remaining example of a "typical" boulder clay woodland in East Lincolnshire, with hazel coppice and standards of oak and ash. This wood harbours a considerable wealth of wild life including a very rich flora and insect population and a large and flourishing heronry. Hoplands Wood managed by the Lincolnshire Trust as a reserve is also a very rich site, meriting S.S.S.I. status and again contains fine oak and ash standards with coppice hazel. The practice of coppice woodland management is rapidly dying out as it is now uneconomic. Coppice management with rotational cutting often provides the ideal conditions for the development of a luxuriant woodland flora and fauna and thus the preservation and conservation of good examples of coppice woodland is highly desirable.

1.108 A series of disused brick pits now water filled, extending from west of Barton-upon-Humber to east of New Holland (80) have a great natural history

value, particularly for bird life and those from Barton-upon-Humber to Barrow-upon-Humber have been given S.S.S.I. status.

1.109 North of Chapel Point are a series of five water filled borrow pits (81) created when the marine defences there were constructed. These pits and a marshy area, known collectively as the "Sea Bank Clay Pits", are of particular value to bird life, especially water fowl, and are now owned or leased by the Lincolnshire Trust and managed as reserves; all have S.S.S.I. status.

1.10 Humberston (82) and Tetney Blow Wells (83) are artesian springs rising from the underlying chalk through the boulder clay capping. The former consists of two groups of blow wells about 92 metres (100 yards) apart in ley pasture, the meadow flora of considerable note. At Tetney, given S.S.S.I. status in 1968, the water areas support a considerable wealth of animal and bird life and a rich aquatic flora.

1.111 In the southern marshes, south of Alford, a few floristically rich neutral meadows are still to be found. In a county where permanent pasture is rapidly being eliminated conservation of these sites is of the utmost importance if a representative sample of this type of habitat is to be preserved. The pastures at Bratoft Meadow (84), Gunby Meadow (85) and Willoughby Meadow (86) are particularly valuable, containing very rich floras, including a number of local and rare species; all three sites have S.S.S.I. status and Bratoft Meadow is now owned by the Lincolnshire Trust.

The Fens

Structure and Landscape

1.112 This region is part of that area of England known as Fenland which in Lindsey comprises the flat land to the south-east of the County, abutting the Wash and the County of Holland.

1.113 Fenland includes the large expanses of flat land in the basins of the Rivers Witham, Welland, Nen and Ouse, land of recent origin comprising marine silts and areas of peat. The region was formerly a wide shallow lake but accretion has reduced the area of water until only a small part (the Wash) remains. In

the initial stages of accretion areas of fresh water were formed behind the newly settling silt, allowing the formation of peat. Much of the region remained swampy until drainage began in earnest in the seventeenth century.

Vegetation and Wild Life

1.114 The Fen country is now typified by an intensive agriculture based almost entirely on arable cropping. The extremely rich and fertile soils are the product of drainage of the once waterlogged marine silts and peat. Apart from a considerable ecological interest in the numerous drainage ditches and dykes which criss-cross the area, of which a branch of the Old River Lymn (S.S.S.I.)(87) is probably the most noteworthy, the Lindsey Fens are now of little value for wild life, save for a few small areas of relict woodland, the most significant probably being Friskney Decoy Wood (S.S.S.I.) (88). This wood contains an abandoned duck decoy pond and is managed by the Lincolnshire Trust as a Nature Reserve.

The Coast (Cleethorpes to the Wash)

Structure and Landscape

1.115 The Lindsey Coastline is essentially a coast of accretion. The original coast is represented now by the cliff line at the eastern edge of the Wolds. The boulder clays in this region were deposited as ice retreated after the glacial period but the land now to be found between this area and the present day coastline is the product of accretion and accretion is still taking place to the north of Mablethorpe and to a lesser extent to the south of Skegness and silt accumulation is rapid. Between Mablethorpe and Skegness, the process is now reversed (probably since circa A.D. 1200), erosion is taking place and long stretches of fine sandy beach are exposed.

Vegetation and Wild Life

1.116 The Lindsey Coastline possesses a wealth of interest for the biologist. Some of the coast is of national renown and much is now under some protection through Nature Reserves and areas designated Sites of Special Scientific Interest.

1.117 The extensive area of sand-dunes, sandy beaches, mud-flats and salt-marsh south of Skegness is of exceptional interest for its wealth of plants and animals, including many rare species. About 400 hectares (1,000 acres) at Gibraltar

Point (89), now owned by Lindsey County Council, are managed as a Local Nature Reserve by the Lincolnshire Trust and a Field Research Station, a Field Museum and a Bird Observatory have been established. The reserve, declared in 1952, was the first Local Authority Nature Reserve to be set up in England. It is now under very heavy public use (180.000 visitors were recorded in 1968) and has been the subject of an extensive study on the effects of public pressure on coastal environments (Para. 2.53). An adjoining area to the north, about 80 hectares (200 acres), was designated a Nature Reserve by Skegness Urban District Council in 1953 and is managed by the Lincolnshire Trust on the same basis as the Nature Reserve at Gibraltar Point. Both sites form important landfalls for migrating birds.

1.118 There is an extensive stretch of mature and well-developed sand-dunes from Mablethorpe North End to Donna Nook and associated with these dunes are areas of salt-marsh, sand-flats, mud-flats and a fresh-water marsh. Much of the area has a rich and varied flora and fauna and many local and rare species are represented including the Natterjack Toad, in its only Lincolnshire locality. 442 hectares (1,090 acres) at Saltfleetby/Theddlethorpe (90), previously afforded S.S.S.I. protection have been recently aquired by the Nature Conservancy and declared a National Nature Reserve; a further 462 hectares (1,140 acres) of land adjoining has Proposed National Nature Reserve status. The Ministry of Defence still owns much of the land which is used extensively for bombing practice for the R.A.F. and public access is controlled. Since 1955 some of the land owned by the Ministry of Defence has been leased to the Lincolnshire Trust who manage the area in conjunction with the Nature Conservancy and Lindsey County Council.

1.119 There are extensive zones of mature and developing salt-marsh at Horse Shoe Point (91), Skidbrooke North End (92), and particularly at Tetney Fitties (93), Grainthorpe Haven (94) and south of Gibraltar Point in the Wash (95); the Grainthorpe Haven site was given S.S.S.I. status in 1968. The sites at Tetney, Grainthorpe and in the Wash are of great botanical interest and are also of particular value as over-wintering points for large numbers of migratory birds. All three areas would appear vulnerable to possible land reclamation schemes.

1.120 In Chapter I the physical structure of Lindsey has been outlined and it has been shown how this has influenced the natural vegetation and the development of an intensive agricultural industry.

1.121 The natural and semi-natural habitats of Lindsey are now restricted; wild life has been pushed into smaller and smaller areas as arable agriculture and to a lesser extent urban and industrial development has increased. It is in these areas, so vital to wild life, that recreational pressures will be felt most strongly, yet conservation of the most valuable of these habitats is now of the highest importance.

1.122 The problems of marrying the demands of agriculture and forestry with those of countryside recreation and yet, at the same time, conserving what is best of our natural heritage of wild life are formidable but must be tackled.

1.123 The effects of recreational pressures on the "natural" countryside are discussed in Chapter II and it is shown how the changes in agricultural methods are making the conservation of these remaining wild areas all the more important. Management techniques to minimise adverse effects of public use are discussed in Chapter III.

Chapter II
The Ecological Implications of Countryside Recreation in Lowland Britain

2.1 This review is primarily concerned with the ecological implications of recreational use of the countryside; there are biotic effects of recreational pressure and these are considered in this chapter.

2.2 It is clear that the pattern of the countryside has been changing through recent developments in agricultural and forestry technique, developments which are rarely beneficial either to landscape or to wild life. Recreation in the countryside is essentially dependent on the nature of that countryside so that any adverse effects of changes in forest and farm practice should be outlined.

2.3 Clearly wild life is to an increasing extent being pushed out of farm land altogether to take refuge in those wild places which are still relatively free from pollution and human interference. This loss of natural and semi-natural vegetation to a more efficient agricultural industry is coinciding with the ever increasing demand for open space and access to the countryside by an ever increasing number of people and there is a real chance that the potential of these remaining "wild" areas as a refuge for wild life will be endangered through over exploitation for recreation.

2.4 The first priority when considering recreational activities in the countryside must be for the maintainance of the natural environment in which they are pursued; ecological carrying capacity, that degree of usage over which ecological values are destroyed, must not be exceeded - flora and fauna are essential components of our environment and wild life and wild places are a natural resource of irreplaceable value.

THE LOCATION OF RECREATION

Informal Recreation (Walking, Picnicking etc.)

2.5 Visually attractive surroundings would appear to be a major requirement of the informal visitor to the countryside and this usually implies recreational use of areas of semi-natural vegetation.

2.6 Coppock (1967) states that there is confirmation from his own observations and from other sources that even in popular areas the great bulk of recreational activity is concentrated in a very limited part of the total space available, especially where there is easy access by road. Lines of contact between land and water or between one kind of vegetation and another, e.g. on the margins of woodland or at the junction between heath and grassland, are of the greatest popularity for recreation and this is where the highest concentrations of recreational use seem to occur.

2.7 Forman (1968) has similar views and has observed that pressure tends to be the greatest at habitat boundaries, again at the woodland edge, in clearings, along rides, at the junction of grassland and heath and on the edge of streams - unfortunately, however, just at the point where the wildlife interest also appears to be greatest.

2.8 There is also a very close relationship between pressure and motor car access, pressure tending to be inversely proportional to the distance from the car park.

Formal Recreation (Water Sports, Motor Sports etc.)

2.9 The supply of facilities such as a suitable water area or an airfield is of course the prime consideration and the surroundings in which these formal activities are conducted are usually of minor importance to the participants. Nevertheless, although such a recreation as water skiing may take place in an unattractive location, these sites frequently still have a significant ecological value.

THE EFFECTS OF PUBLIC USE OF THE COUNTRYSIDE

2.10 The effects of public pressure can be divided into two quite distinct categories - inevitable effects such as wear and tear on vegetation, disturbance to wild life and soil erosion, effects which can often be minimised by positive management; and unnecessary threats to environment and amenity such as the dropping of litter and vandalism, problems which might be almost eliminated through education.

(A) THE INEVITABLE EFFECTS OF PUBLIC PRESSURE

2.11 Recreation in the countryside at any level must produce some adverse effects to the environment through sheer physical contact; vegetation may be modified and at higher levels of use literally worn away, exposing areas of bare ground, which are then open to subsequent erosion. The degree of damage can be clearly related to the total number of people involved and to the type of recreation but even at the lowest user levels some wear and tear is inevitable. The degree of disturbance to animal life is also clearly related to the prevailing levels of recreational activity in any area though the effects are far less easily measured.

2.12 There is little information on the effects of recreational use on vegetation and almost none of the effects on fauna; of the few studies that have been made on either problem only a fraction of the data is of a quantitative nature. In the following review the major studies and observations in this field to date are outlined, these indicating, at least to some degree, the kind of problems involved.

GENERAL OBSERVATIONS

2.13 McCarthy (1968), in a paper on Malhamdale, feels that there is sufficient indirect and circumstantial evidence, including results obtained from species distribution analysis, to justify the presumption that much of the general degradation in environmental quality in this area, with its associated lowering of scientific value, is attributable to the relatively recent increases in public recreational use, especially at the foci of activity. These observations would fit almost any popular "beauty" spot in Britain.

2.14 McCarthy also points out that excessive public use may force a modification, or even a cessation in extreme cases, of agricultural practices because these are no longer economic. A typical case would be the leaving of hay meadows uncut because of trampling. Scientific interest is often dependent on the maintenance of traditional farming methods and such changes may cause a degradation in scientific interest as well as a loss to agriculture.

2.15 It is usually possible to correlate levels of recreational use with the degree of wear and tear recorded; Figs. 4 and 5, graphs based on footpath studies at Hengistbury Head, Hampshire (Brooke, 1967), would be typical.

FIG. 4. THE EFFECT OF TRAMPLING ON VEGETATION DEPTH

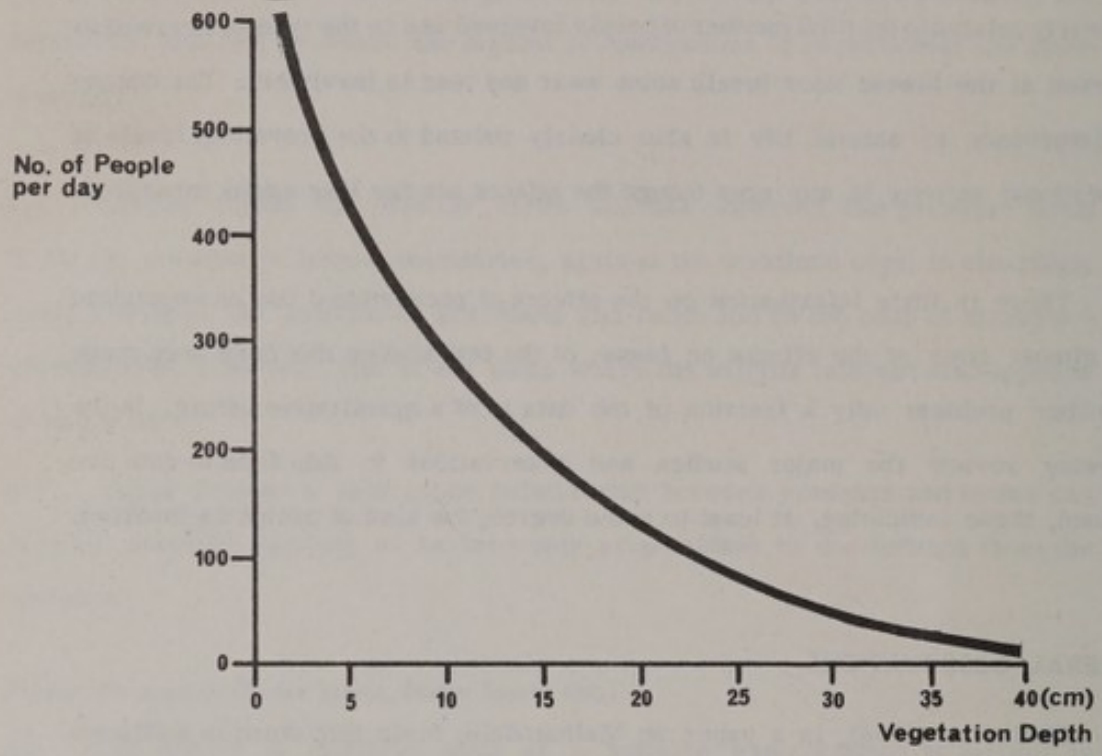
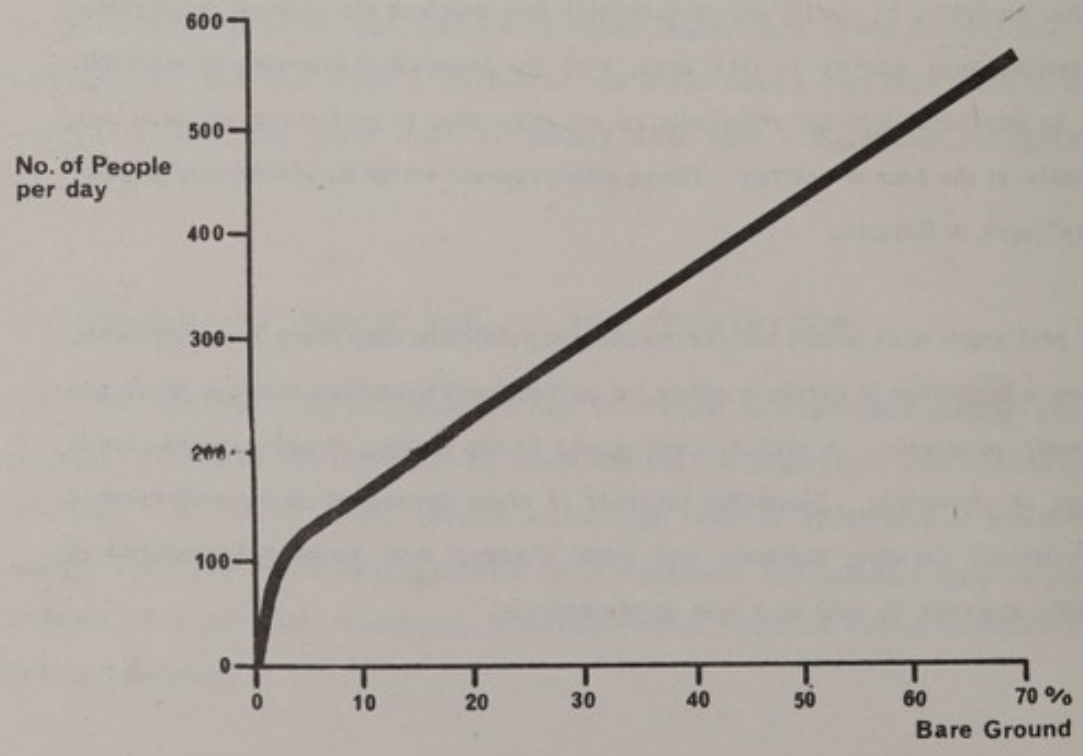


FIG. 5. THE EFFECT OF TRAMPLING ON VEGETATION COVER



2.16 Reduction in speciation in grassland and woodland may occur under quite low levels of usage. Many species appear to be particularly sensitive to trampling while others, though more resistent, disappear before visible wear is apparent. There are a few very resistent species, usually plants characteristic of waste ground, which survive a considerable battering and only disappear after extreme wear is apparent.

2.17 Bates (1935) suggests that there is a mechanical effect of treading which exerts a selective influence, eliminating those species not structurally adapted to withstand injury; it is those species adapted by virtue of their life form and leaf and stem structure which are able to persist - typically herbs (mainly grasses) whose dormant buds lie below the soil surface (i.e. Geophytes).

2.18 Waterlogging would also seem to be important. There appeared to be a close correlation between the state of saturation of the ground and the rate of wear and tear and modification of the vegetation; under dry conditions species content did not appear to be affected at all.

2.19 Further studies of this type may be found in two reports on the effects of public pressure on grassland sward in the New Forest (Keeling, 1967 and Speight, 1966).

The Concept of Carrying Capacity

2.20 Environmental carrying capacity is a complex amalgam of two distinct processes. Any particular area is subject to two different pressures, both of which have maximum theoretical levels above which the value of the area begins to be impaired, thus two distinct carrying capacities may be recognised (Greaves, 1967).

(i) Ecological Carrying Capacity

2.21 People and their activities have a positive effect on the environment around them. Above a certain level of use wear and tear on the vegetation becomes such that the habitat begins to deteriorate seriously and ecological diversity is reduced - the present study is mainly concerned with this factor.

(ii) Psychological Carrying Capacity

2.22 Environment clearly can have an effect on people; there comes a level of usage when the combination of people, their activities, their noise, becomes such that annoyance and stress is created for others. Clearly the psychological carrying capacity of that site has then been exceeded.

2.23 Different types of habitat will have different ecological and psychological capacities.

2.24 Sand-dunes, sand heaths, woodland and wetlands are all fragile areas and even a relatively small amount of concentrated recreational use can begin to harm the ecosystem. These areas, therefore, have a low ecological carrying capacity though the psychological carrying capacity may well be high, especially in woodland areas where a very large number of people can be absorbed.

2.25 Calcareous heaths conversely have a comparitively high ecological carrying capacity and probably the psychological capacity would be exceeded first at such locations.

2.26 Greaves postulates the concept of a third carrying capacity, **Economic Carrying Capacity.** The level of use for which an area is managed obviously depends upon the overall objectives. If an area is important ecologically, as well as for recreation, then it may be necessary to limit numbers, rather than accept a lower ecological quality and large-scale conservation measures such as hardstanding. If, on the other hand, an area is heavily used and demand is increasing, some action must be taken to repair the vegetation and accommodate more people by such measures as gravelling all paths, tree planting, rotation of use or restocking lakes with fish.

THE EFFECT OF RECREATION ON SPECIFIC HABITATS

Deciduous Woodland

2.27 Deciduous woodland would appear to be a fragile habitat and even at very low user levels damage, at least to the ground flora, can often be considerable.

2.28 Barker (1967) records that at Old Winchester Hill National Nature Reserve a single party of 50 people wore a distinct track through dog's mercury which lasted from June until the autumn. Much higher levels of recreational use are needed before obvious damage to the trees is apparent, though natural regeneration is often impaired.

2.29 User levels sufficient to cause permanent damage to mature trees have been reached in some parts of the country and particularly in popular areas such as the New Forest and Epping Forest. Forman (1968) records that in the New Forest crown die-back is appearing in some locations, probably caused by soil compaction between the trees which is a problem accentuated on heavy soils and apparently principally caused by the passage of vehicles.

2.30 Removal of large amounts of dead and dying timber from woodland for camp fires etc. must affect the ecosystem and this may be a cause of the marked reduction in the populations of some woodland birds such as woodpeckers, redstarts and wood warblers, which has often been recorded where there is extensive recreational use of woodland.

2.31 To some extent recreational pressures in woodland are limited. Barker (1967) records that damage to the ground flora in many deciduous woods is often mitigated by the fact that people tend to keep to the paths to a greater extent than they do in open grassland; although a path may receive heavy usage, areas only a few yards either side often remain untouched.

Coniferous Woodland

2.32 The damage to this habitat is generally small when compared with that caused to deciduous woodland. The ground flora initially is usually less diverse and fragile, and problems of vehicles driving between the trees and compacting the soil less frequent; most coniferous woodland is in fenced, well managed plantations and on light soils. It is also likely that coniferous woodland is deemed less attractive for recreation than deciduous woodland and thus is often under lower user levels.

2.33 In the natural yew woods of the chalk lands of southern England there is almost no ground vegetation to harm but erosion around the trees (usually on steep

slopes) is greatly increased where extensive public pressure is evident and heavy use could threaten this unusual habitat (Barker, 1967).

Acid Heathland

2.34 The vulnerability of acid heathland to recreational pressure would appear to depend on the nature of the underlying strata.

2.35 Generally, heathland developed over sands of recent origin, i.e. over glacial and post-glacial drift or over mature sand-dunes is very vulnerable to use. The blown sand areas of Lindsey fall into this category and here, even at a low level of recreational activity, surface vegetation is rapidly destroyed and the underlying sands exposed, which, by their very composition, are particularly vulnerable to erosion. The results of recreational pressure over a blown sand heathland can be clearly seen at the Willingham Forest Picnic Area where soil erosion is very much in evidence (Phot. 1). In contrast, however, heathland developed over hard sandstone can often stand a lot of wear (Helliwell, pers. comm.).

2.36 Over the heathlands of Hampshire it has been shown that although soil erosion may not occur under a given level of recreational pressure a radical alteration in soil structure may take place (Barker, 1967) and this is probably the case in other areas. Trampling, instead of compressing the soil as one would expect, appears to have the effect of breaking it up. This result can be achieved under quite low levels of recreational use and occurs very rapidly indeed if motor vehicles are allowed on the heaths.

2.37 At Frensham Common, Surrey, a popular heathland area with a large pond, pressure is considerable and wear and tear has been severe. The pond attracts up to 500 cars at a fine weekend and heavy wear has resulted in the loss of vegetation wherever vehicles have access to the water's edge, with a result that much of the area is now a desert of loose sand (Phot. 2) (Reynolds and Sankey, 1967).

2.38 Observations have shown that where pressure is removed, e.g. by diverting a path, recolonisation of bare sand is very slow (Barker, 1967).

1. Erosion of Heathland

Willingham Forest Picnic Area, Lindsey

partial loss of surface vegetation and the creation of numerous pits and hollows in an area of moderate public pressure and uninhibited vehicle access

2.39 In general, however, the areas so affected by wear and tear are small. As in deciduous woodland with a rich herb layer people tend to keep to the paths and thus adjacent areas are largely unaffected by use.

2.40 Where recreation does take place but not to the level at which erosion occurs there is a tendency for bushy species such as ling and gorse to be replaced by grassland. This effect can occur under the pressure of motor vehicles and has been observed in the New Forest where cars are allowed to cross *Calluna* heath (Forman, 1968).

Calcareous Grassland

2.41 A survey of chalk downland in Hampshire (Barker, 1967) showed that at a low level of use trampling had little or no effect, even on individual plants. At a moderate level the soil was compressed with injury to the plant roots and the plants themselves were almost literally worn away until the area took on the appearance of a lawn; with further user intensification the plants were destroyed, the soil exposed and erosion the inevitable consequence. On every downland site investigated these three levels of wear were represented.

2.42 Where channelling of people took place along paths or over stiles considerable damage to the turf was apparent. "Lawns" were created where the level of picnicking was high and/or cars allowed on the grass. Soil type, aspect, frost and rainfall all appear to affect the degree of wear and tear encountered under given user levels and no two sites would appear alike in this respect.

2.43 A detailed study by the University of Sussex (Streeter pers. comm.) on the qualitative and quantitative effects of visitor pressure on Box Hill, Surrey, is now underway (see note at end of chapter) and this should provide information that will enable the planning of facilities at Box Hill and similar areas to be placed on a sounder basis; Box Hill experiences one of the heaviest recreation pressures in the south-east and damage to the vegetation has been severe in places (Phot. 3).

2.44 The work is yet in a very early stage but initial qualitative observations show that on the south facing scarp slope at least, the effect of use produces

Photo. Nature Conservancy

2. Erosion of Heathland

Frensham Common, Surrey

total loss of surface vegetation and exposure of the roots of silver birch trees in an area of heavy public pressure and uninhibited vehicle access on the edge of Frensham Great Pond

the following changes.

"characteristic" chalk sward → grassland dominated by *Lolium perenne* and *Cynosurus cristatus* → bare ground

There is a progressive reduction in the ratio of broad-leaved species to grasses. The main point of interest would appear to be the replacement of the slow growing undemanding species characteristic of chalk downland by the more vigorous, nutrient demanding grasses. Therefore, as well as being resistent to trampling their appearance may be indicative of nutrient enrichment of the soil resulting from increased visitor use.

2.45 A survey by Perring (1967) on the effect of galloping on chalk grassland was in broad agreement with the observations of Streeter. At this site (Newmarket Heath) chalk grassland was rapidly replaced by a sward containing species characteristic of pasture as user intensification increased. *Lolium perenne* again became the dominant grass, together with *Agrostis stolonifera; Cynosurus cristatus* was present in the most heavily used areas.

2.46 Some recreational use of downland may well be highly desirable as a means to check the spread of hawthorn and dogwood scrub which is advancing over many downland areas now that grazing is no longer practised. On the whole, downland sites would seem to be able to tolerate quite a high level of usage without undue impairment though the composition of the grassland sward will be modified.

Coastal Habitats

(i) Sand-dunes

2.47 Coastal dunes constitute one of the most vulnerable European ecosystems (Westhoff, 1966).

2.48 A vegetation cover stabilises sand-dunes and protects them from wind erosion. Removal of the vegetation can therefore hinder dune building and threaten the continued existence of dunes already formed (Wright, 1967). Once bare sand surfaces are produced in a dune system through erosion these, especially on a slope, are eminently suitable for games involving jumping and falling about in the sand and for digging activities with or without a spade and such activities further harm the existing vegetation and check recolonisation.

Photo. University of Sussex

3. Erosion of Chalk Downland

Box Hill (S.S.S.1), Surrey

total loss of surface vegetation in an area of heavy public pressure

2.49 Once erosion has started the exposed areas are very easily enlarged through wind blow-out (Phot. 4). This sequence has clearly been shown at Gullane Bents (East Lothian), where the coastline now shows all the consequences of unchecked dune erosion.

2.50 The dunes at Gullane were acquired by East Lothian County Council in 1931 and at that time consisted of a high coastal dune with a long sheltered grassy valley behind and a 15 m. (50 ft.) high raised beach beyond that. In 1963 the whole area presented the appearance of a coastal desert with no shelter, no features, just loose blown sand. This devastation had been caused by the wind working away at bare sand patches, these created by holiday-makers, by the thoughtless placing of beach huts and by the commercial winning of the sand. Army use during the 1939-45 war heightened the problem but erosion has been even more rapid since then and by 1953 the fore-dunes had been completely stripped of grass and millions of tons of sand had blown into the valley behind completing filling it (East Lothian County Council Planning Department, 1963[1]). An extensive dune rehabilitation programme is now in hand (Para. 3.64).

2.51 Recreational use of the mobile dunes produces the most rapid effects of wear (Phot. 5). This part of the dune ecosystem is still relatively unstable and quite a modest amount of recreational use can easily cause visible damage.

2.52 At Ainsdale Sand-dunes National Nature Reserve, experience over 5 years has suggested a very definite limit be applied of some 3,000-4,000 school children per season on any given nature trail in the sand-dune system if severe wear on the vegetation and erosion is to be avoided (Mc.Carthy pers. comm.).

2.53 At Gibraltar Point Local Nature Reserve an extensive survey on the effects of public use there (probably the first comprehensive study of its kind in Great Britain - see also note at end of Chapter) is soon to be published - it is regretted that the detailed results and conclusions are not yet available for inclusion in this report. Interim figures there indicate that 7,500 people per season walking off a concrete path onto a salt-marsh can cause complete loss of vegetation cover and a similar density walking over the mobile dunes can completely eliminate marram, sea-couch and prickly saltwort and result in considerable dune erosion. Complete recovery of plant life in such eroded areas would appear to require about 4 years.

4. Dune Blow-out

Saltfleetby/Theddlethorpe (N.N.R.), Lindsey

On the fixed dune systems approximately 3,500-4,500 people can cause a local exposure of soil and sand (Schofield, 1967).

2.54 On the Eastern Sands of the South Haven Peninsula, Dorset (adjacent to the Studland Heath National Nature Reserve) the effects of extensive use there are now evident. Measurements show that dune front is being rapidly eroded away; marine encroachment has averaged 1.57 metres (1.72 yards) per year over the last 55 years but the rate in recent years, coinciding with vastly increased public use, has been greatly increased (Teagle, 1966).

2.55 Dune grasslands appear to be able to stand up to recreational pressures to a far greater extent and many such areas around the coast of Britain are now developed into golf courses. Nevertheless, at Cassock Hill, Cornwall, it was shown that where a path had been developed through thick dune turf the result was to decrease the height of the vegetation, to reduce species diversity and to reduce the amount of cover of the soil (Wright, 1967). Ultimately a single species sward of red fescue *(Festuca rubra)* was produced through which sand could be seen, the sand lying almost flush with the surface - bare sand follows this if trampling continues.

2.56 Although pedestrian use has a serious affect on maritime turf this effect is small when compared with that produced by motor vehicles. It is generally known that damage to turf by motor vehicles is rapid, especially on a sandy soil - witness the Willingham Forest Picnic Area - and maritime grasslands are particularly vulnerable in this respect. This problem has been encountered at Slapton Sands (S.S.S.I.), South Devon, where the pressure of vehicle numbers is such that recovery of the turf is not possible within the time available between holiday seasons.

2.57 It seems clear from observations made at Slapton (Mercer, 1968) that the natural establishment of a solid turf from a state of sparse maritime vegetation is a lengthy process to be measured at least in decades.

2.58 It appears that the process of turf removal is not confined to the margins of grassed areas but is often initiated as "holes" (Phot. 6), usually caused by

5. Dune Erosion

Mablethorpe North End, Lindsey

severe dune erosion in an area of heavy public pressure

specific events such as heavy vehicles sinking into the turf. Normal motor car use would appear to wear away the edges of grassed areas, particularly at the roadside and frequently enlarges the "holes" started above. The crux of the matter is that once erosion has begun it rapidly spreads and rehabilitation is unfortunately a very slow process.

2.59 The effect of recreation on sand-dune vegetation has been outlined. Almost equally important but far less well documented is the effect of recreation on sand-dune fauna. Bird life is particularly open to disturbance and nesting birds, some of which nest in the dune systems, are especially vulnerable.

2.60 Recreational use of many of the coastal dunes of Lindsey has been strictly limited. The dunes, especially between Mablethorpe and Skegness, have assumed a special role as sea defence works, and following the extensive 1953 floods were fenced by the Lincolnshire River Authority and public access limited as far as possible to the least vulnerable areas.

(ii) Salt-Marshes, Shingle, Mud-Banks and Sea Cliffs

2.61 Vegetation in these zones is little affected by recreational use though the growing sport of sea cliff climbing may cause damage to cliff vegetation and even minor cliff erosion in some areas (Countryside Commission, 1969). It is disturbance to bird life which causes the greatest problems.

2.62 Many estuaries and enclosed waters which are attractive for sailing and other water based activities are also important winter feeding grounds for birds. Disturbance at feeding sites is caused principally by noise from powered craft; nesting and roosting sites are generally based on firmer ground but neither are immune from this problem. Again noise from powered craft can prove detrimental but disturbance from the shore based public is serious in some areas. Nesting sites on cliffs can be disturbed by climbing activities while shore nesting birds are vulnerable both to disturbance and to the trampling of their eggs.

2.63 These problems have been met at Gibraltar Point; at this Reserve Little Terns, Ringed Plovers and Oystercatchers nest on the shingle and these birds have been subjected to disturbance, by humans and by dogs, and to the trampling of their eggs. Predation of eggs by increasing numbers of Foxes is now an additional problem (Para. 2.81).

Photo. R.P. Troake

6. Erosion of Maritime Grassland

Slapton Sands (S.S.S.I), Devon

partial loss of surface vegetation following car parking

Fresh Water Habitats

2.64 There is little detailed information on the adverse effects of recreation on fresh water habitats but a very useful summary may be found in the Report on Broadland (Nature Conservancy, 1965[1]).

2.65 Wash from power operated boats can cause considerable erosion of the banks of rivers, canals and still-water areas (Phot. 7) with consequent disturbance and damage to wild life. Non-powered craft may also cause similar problems, though usually on a smaller scale, but these craft may penetrate areas where large craft cannot reach - areas often important for wild life, especially nesting birds some of which require absolute seclusion during the breeding season.

2.66 Fishing may also cause bank erosion (Phot. 8). Anglers may break down reeds fringing water areas to gain access to open water and then habitually return to the same point. Constant trampling of these sites gradually wears the bank down making it more susceptible to erosion by wash from passing water craft.

2.67 Problems of pollution are discussed in Paragraphs 2.83 to 2.90.

Road Verges

2.68 Roadside verges are becoming increasingly vulnerable to physical disturbance through car parking and picnicking and the wide verges of the Lincolnshire Wolds, now well used in places for recreation, suffer to some degree from this fate. (Phot. 9).

2.69 Many verges now assume important roles in the conservation of grassland habitats and damage to these poses special problems. Unless other areas are made available for recreation, pressure on the roadside verges can only increase.

(B) UNNECESSARY THREATS TO ENVIRONMENT AND AMENITY

2.70 A thorough analysis of the effects of extensive public use of a National Nature Reserve at Studland Heath, Dorset, has been made (Teagle, 1966) and most of the observations would appear to be applicable nationally. These observations and observations from other sources are outlined below.

Photo. East Suffolk and Norfolk River Authority

7. River Bank Erosion– by Wash

Norfolk Broads

a heavy fall of earth which has cut 2 feet into a footpath alongside the River Ant

LITTER AND RUBBISH

2.71 Litter and rubbish is unsightly and often potentially dangerous and must be removed to preserve the amenity value of the countryside.

2.72 Waste paper, the commonest form of litter left about, disintegrates rapidly but plastic, cloth and metal objects have a longer life. Pieces of hardware such as old prams, bedsteads, bicycles and even mattresses and frequently today abandoned cars are often encountered in the countryside, especially in pits and quarries, in woodland and in streams and even on road verges. All these larger objects are particularly unsightly and frequently dangerous and their removal can cause considerable problems and expense.

2.73 A fairly new problem, which has been growing rapidly in recent years, concerns the dumping of agricultural waste in all its forms, from plastic fertiliser bags and empty canisters which once contained insecticides and herbicides, to rotting potatoes. In addition to creating unsightly features in the countryside agricultural waste can pose considerable problems of pollution.

2.74 Litter in situ, particularly old cans and pieces of corrugated iron, may provide shelter and a good deal of protection for small mammals and reptiles and a host of invertebrates but on the whole litter must be considered totally undesirable - and unnecessary.

2.75 Clearly broken glass is potentially the most dangerous form, though it is usually man or his dog who are injured by it,but empty bottles present a significant fire hazard and can be a lethal trap for many small animals who crawl in but then cannot escape. Polythene can also be a considerable danger in the countryside. It is reputed that a Follow Deer died in Greenwich Park after swallowing a polythene bag and death to cattle from this cause is not uncommon.

2.76 Oxidation of metal objects, usually iron, must add mineral nutrients to the soil, but whether these are of sufficient quantity to affect the ecosystem is not known.

Photo. Nature Conservancy

8. River Bank Erosion– by Fishermen

Norfolk Broads

2.77 Dropping of litter and rubbish and the deliberate dumping of larger objects in the countryside is now an offence under criminal law - see Appendix II, but enforcements and prosecutions are rarely made.

2.78 A particularly severe problem is the littering of the countryside with empty beer and soft drink bottles and cans, recently made all the more serious by the introduction of "No Deposit Bottles". In West Virginia (U.S.A.) and in some other States it is illegal to sell soft drinks other than in bottles on which there is a deposit, so ensuring that tins and plastic containers are not littered all over the countryside and that children will return empty bottles - this idea may well be appropriate in Great Britain (Chataway, 1966).

2.79 Another American idea, also well worthy of serious consideration, concerns the abandonment of old cars which is a rapidly growing problem in Britain. It has been suggested that it may be desirable to add say, 100 dollars to the purchase price of a new car, this money being recoverable when the car is delivered at the end of its life to a scrap merchant or authorised dump (Chataway, 1966).

WASTE FOOD

2.80 Picnickers frequently leave scraps of food and this clearly must attract many birds, particularly Sparrows and at the coast Gulls while at Studland Heath Jackdaws are known to scavenge the car park.

2.81 Mammals too are often scavengers. Foxes are known to be attracted to waste food (it has been suggested that this might be the cause of an increase in Foxes at the Gibraltar Point Nature Reserve - Para. 2.63) while at Old Winchester Hill National Nature Reserve an annual summer movement of brown rats (50 to 60 of them) from a chalk pit filled with farm refuse to food sources in the car parks, over a quarter of a mile away, has been observed (Barker, 1967).

2.82 Various insects are frequently associated with food remains; flies are invariably found on decaying food and beetles are not uncommon while scores of small black ants, presumably attracted by food scraps, are often found in litter sacks.

9. Damage to Road Verges

Red Hill (L.N.R.), Lindsey

road verges under special management to maintain their floristic interest. Car parking has destroyed much of the vegetation at this location

POLLUTION

2.83 Pollution of the environment by the leisure seeking public can be a serious problem and in some situations may have far reaching consequences.

Terrestrial Pollution

2.84 Toilet facilities are not always provided even in the more popular recreational areas and visitors tend to make use of what cover is available. In consequence many areas especially near lay-bys on routes to the popular holiday resorts become very badly polluted by the end of the summer.

2.85 Urination increases the nitrogen content of the soil and may eventually lead to a change in the flora in extensively used areas but there is no positive evidence of this. It is defaecation which poses the greatest problem and health hazard; excrement provides a temporary habitat and source of nutriment for countless small organisms but unfortunately also attracts many germ carrying flies.

Aquatic Pollution

2.86 The pollution of rivers, canals and lakes by sewage discharged from water craft has become a problem in some areas and has reached serious proportions on the Norfolk Broads (Nature Conservancy, 1965[2]). Oil and petrol discharges from powered craft are also a major source of pollution and action to check both problems is urgent.

2.87 The ecological balance in fresh water, especially still water, is very delicate and even a small amount of contamination can alter the equilibrium. Large increases in the organic matter content of water, an inevitable result in still water if sewage is discharged, causes a rapid increase in the biochemical oxygen demand (B.O.D.); micro-organisms are responsible for the "digestion" of organic waste and these multiply rapidly. The end result could be the complete depletion of oxygen from the water and a change in ecological status from a "rich" area with abundant aquatic life, including large numbers of fish, to a stagnant area supporting only a few organisms capable of living in an anaerobic (oxygen free) environment.

2.88 Fortunately the water areas used for cruising etc., are usually of sufficient size to ensure that this extreme situation does not arise, nevertheless pollution is serious and these water areas are frequently made unfit for swimming or for the extraction of water for domestic water supplies, even with purification.

2.89 Although problems of pollution caused by recreational activity are very real and must be tackled, the extent of the problem is still limited and as yet can not be regarded as serious in Lindsey.

2.90 By far the greatest source of environmental pollution is industry; industrial effluents have created severe pollution in rivers, fishing is impossible in the Trent, North of Gainsborough, for this reason, while atmospheric pollution can damage vegetation. Lichens are rapidly destroyed by Sulphur Dioxide, as at Risby Warren (Para. 1.82) and many trees are susceptible including beech and most conifers. These problems however are outside the scope of this review.

VANDALISM AND COLLECTING

2.91 Apart from the wanton destruction of fences, gates, notices and walls, in which members of the public are not unknown to indulge, destruction of wild life through various forms of collecting ought to be included here as an act of vandalism, though few of the millions of offenders are even aware that they are doing untold harm to our wild life through their actions. Collecting (unless executed for some scientific purpose) is really vandalism, and wild life can rarely be replaced; once a species is lost from an area it is often lost for ever.

2.92 It is clear that collectors have been responsible for the diminution and loss of much of our wild life in many areas and especially near large towns, though today with the greater mobility conferred by the motor car no area is completely safe.

2.93 There is evidence that egg collectors were responsible for the decline and extinction of the Osprey in Scotland between 1840 and 1920 and for the reduction in numbers of many of our native birds (Ratcliffe, 1967), but egg collecting, damaging though it obviously is, is clearly far less serious than habitat destruction and environmental pollution; birds are mobile creatures and can easily recolonise an area if conditions again become favourable.

2.94 Butterflies and moths are also endangered; varieties such as the Purple Emperor, Large Blue, North Dart, Kentish Glory and Rannoch Sprawler are all well-known to have suffered through the hand of the collector and the extinction of the large Copper is reputed to be almost entirely due to this cause, though here overzealous collection of the larvae for sale rather than collection of the imago was probably the reason (Ratcliffe, 1967). The Lepidoptera too are mobile and unless the habitat is particularly restricted recolonisation is frequently possible.

2.95 It is the plant collector who has certainly done the most permanent damage.

2.96 Flower picking, if carried out to excess, can cause a considerable reduction in the flora as few plants ever reach the stage of seed production. With rarities, where only a few plants are present, if the process is continued year after year, extinction of the species is probably inevitable.

2.97 The greatest threat, however, comes from the wholesale removal of the plant (vandalism at its worst). Many well known species are now threatened with virtual extinction in many areas through over-collection. It has been stated that the common primrose is now almost extinct within a 50 kilometre (30 mile) radius of London for this reason, while many of our native orchids, several attractive shrubs such as the mezereon, and ferns such as the royal fern are now very scarce.

2.98 Wholesale "stripping" of areas of flowers by gypsies for sale in the streets of many towns still occurs; wild daffodils from Newent are sold by the thousand in the streets of Gloucester and the local and beautiful fritillary, a plant more or less confined to the Thames drainage area, is sold in the streets of Oxford.

2.99 At Durnsford, in the Dartmoor National Park, Local Bye Laws and a voluntary warden service have been introduced to prevent the public removing the wild daffodils which grow beside the River Teign.

2.100 Somehow the public must be made aware that the countryside is not theirs to be used or misused at will. Total legislation against collecting is probably impractical and largely unenforceable, though a Bill was placed before Parliament in 1968 (see Appendix II). We must look to education as the answer to this problem

(Paras. 3.70 to 3.78); perhaps people can be educated that it is unethical and most undesirable to collect. An active interest in our native wild life is to be valued and should be fostered and no-one could object to photography and sound recording. Surely wild life is best seen in its natural surroundings and we must encourage visitors to leave things as they find them for others to enjoy afterwards.

2.101 Collecting of plants, birds eggs and butterflies etc. by the uninformed public has been discussed. Although probably not strictly a recreational pressure, equally important and often far more serious is the problem of deliberate destruction of wild life.

2.102 Willful destruction of bird life through shooting or the taking and smashing of eggs is common and the hunting and killing of such animals as the otter and badger still occurs, while it is certainly not unknown for fires to be deliberately started, both on heathland and in woodland, and these can have a devastating effect on wild life (Paras. 2.106 to 2.117). It is almost impossible to deal with this sort of problem.

2.103 Finally, it is clear that it is not just the uninformed public who are guilty of destroying wild life. A rapidly expanding role of the countryside is education and field studies of one kind or another feature largely in this role. Biological field work frequently involves the collection of specimens and there is a danger that permanent ecological damage will be caused in extensively used areas through over-collection and through the continual trampling of delicate habitats.

2.104 It is essential that field work should not threaten the most valuable habitats and thus ideally this work should be conducted wherever possible on sites of secondary importance as most field work can be accomplished quite successfully on these areas.

2.105 Guidance on the use of areas in Lindsey for field work can be obtained from the County Education Department through the Advisor for Countryside Studies.

FIRE

2.106 Fires are all too common on downland, heathland and in coniferous woodland and often the cause is clearly carelessness by visitors. Discarded cigarette ends

are probably the most frequent source of a conflagration but increasingly today the reason is an accident with a primus or calor gas stove etc. and organised barbecues are a particularly dangerous hazard. The problem is now serious and with the great expansion in outdoor recreation taking place, can only increase unless more care is exercised by visitors.

2.107 The greatest threat to wild life occurs in the summer when accidental fires are most likely. Controlled burning of grassland and heath is only allowed during the winter months (November 1st to March 31st) to ensure some protection for wild life, as damage to wild life during this season would be minimal (The Heather and Grass Burning (England and Wales) Regulations, Statutory Instrument No. 386, 1949).

2.108 There would seem some need for prohibition of access to areas of particularly high fire risk, such as heathland and coniferous woodland, when the dangers of accidental fires are greatest.

2.109 Controlled burning is probably essential to the maintenance of habitats in many instances and is regularly practiced on acid heathland and over areas of calcareous grassland, but accidental fires must be prevented.

The Effect of Fire on Specific Habitats

Acid Heathland

2.110 Although fire is of immediate danger to a host of wild animals and plants the long term effects on ecosystems are probably of more significance.

2.111 On Studland Heath it has been observed that ling *(Calluna vulgaris)* makes very slow growth after fire yet the grass *Molinia* rapidly recovers and at one site after a Whitson fire in 1966 had regrown sufficiently to give the area a green, rather than a blackened appearance, within two months. In the long term ling is often totally replaced by *Molinia* and by bracken *(Pteridium aquilinum)*. While frequent burning will usually eradicate ling, bracken with its subterranean dormant buds would seem almost indestructible. Clearly there may well be long term ecological changes as a result of fire; the short term effects are well-known but the long term results have been little studied.

2.112 It is known that the organic soils associated with heathland communities can be almost completely destroyed by fire, surface humus being literally burnt away so removing the "insulating layer" of the soil and destroying its cation exchange capacity. Frequently the soil surface becomes compacted and drainage reduced with consequential increased surface run-off and danger from erosion. Although plant nutrients are released into the soil these are usually rapidly leached. Plant ash would contain soluble bases such as potassium, calcium and magnesium, but nitrogen, sulphur and carbon would be lost in the smoke.

Calcareous Grassland

2.113 Fires on calcareous grassland are also common, particularly in March when last season's dead vegetation is tinder dry. The effect here appears to be to temporarily remove competition so that germination and rapid growth of shrub and tree seedlings freely takes place over the burnt areas. This was clearly seen to be the case in a study undertaken on an area of Oolitic grassland at Painswick Hill Camp, Gloucestershire (Lloyd, 1966).

Woodland

2.114 The burning of woodland vegetation and associated litter again causes loss of carbon, nitrogen and sulphur in gaseous form and the production of an ash containing soluble potassium, calcium and magnesium - again the soil structure is often adversely affected (Carlisle and Brown, 1967).

2.115 The long term ecological effects of burning would appear to arise from the physical alteration of the soil structure and the loss of plant nutrients. Sulphur will be replaced through precipitation but the loss of nitrogen could be a limiting factor if the nitrogen fixing capacity of the soil micro-organisms or any nitrogen fixing higher plants is low.

2.116 In the case of rare or local birds the loss of habitat could be disastrous but fire does create temporary new habitats to the advantage of some species. Many Bryophytes and a few Fungi appear to flourish for a few years after a fire and several higher plants are typically associated with burnt areas.

2.117 For the forester, fires present a serious economic problem as it is not just wild life and amenity at stake but also a financially valuable timber crop.

THREATS TO THE ENVIRONMENT THROUGH CHANGES IN AGRICULTURE & FORESTRY PRACTICE

2.118 Both the quality of the landscape and wild life are threatened through recent changes in agricultural and forestry practice and any degradation in landscape or wild life interest will have a consequent effect on the value of the countryside for recreation and for nature conservation, tending to concentrate both in the same areas - the remaining areas of semi-natural vegetation.

2.119 In the following review the main changes in farm and forest practice are outlined and the ecological implications of these changes discussed; some suggestions on how the impact on wild life and landscape might be lessened are also made.

2.120 Much of the traditional English countryside, as we know it, with its complex chequer-board pattern of field, hedgerow and copse, has been lost for ever to a "new style" agriculture, more intensively worked and highly mechanised, and this is particularly so in Lindsey.

2.121 Hedges and hedgerow timber have been removed to facilitate efficient working of agricultural machines. Indeed, in Lincolnshire as a whole, this loss of hedges, equivalent to about five yards per acre per year, is about five times the national average (Hooper, 1968).

2.122 There is now a widespread use of insecticides, herbicides and artificial fertilisers and these take their toll on wild life.

2.123 The character of much of the remaining woodland is changing, conifers with their sterile underfloor are the order of the day, hardwoods are little planted and small copses and spinneys are increasingly being grubbed up.

2.124 All these changes are tending to produce monotony in the landscape; the aesthetic qualities of the countryside are reduced and its attraction for recreation probably lessened.

2.125 This rapidly changing agricultural scene must continue if the new farming techniques and machines which are being developed are to be fully exploited. The tendency towards larger and larger fields and towards crop mono-culture will continue.

2.126 Food production must be the first and prime consideration in the countryside but not to the exclusion of everything else; increasingly it must be realised that the countryside has other important things to offer, particularly in the fields of amenity and recreation.

2.127 It is not always appreciated that the pattern of the countryside as we know it today is essentially man-made, a product of the Enclosure Movement in the 18th and 19th Centuries. Landscape must be an expression of land use and thus the passing of much of the characteristic chequer-board pattern of the countryside regrettable though this may be in many ways, is inevitable.

2.128 Replacing it is a new landscape, expressing the land use of the 60s and 70s, but this new landscape need not and ought not to be sterile; there is a considerable scope and need for small scale tree planting on our farms, particularly as shelter belts and wind-breaks and in the corners of large fields where machinery cannot reach. This new style landscape could, like its predecessor, have its own aesthetic attractions and we need not see the countryside reduced to a monotonous "prairie".

2.129 It is encouraging to learn of a considerable public awareness of the need for positive action in this field and mention must be made here of the admirable work now being done in Lindsey to promote aesthetic quality in our countryside through the medium of the "Lindsey Project for the Improvement of the Environment", an exercise sponsored by the Carnegie Trust and supported by the County Council.

2.130 An attractive countryside is a heritage we can ill-afford to lose; change is inevitable, but change need not always be for the worst.

DETAILED ANALYSIS

Removal of Hedges and Hedgerow Timber

2.131 The immediate effect is a reduction in landscape quality but the long term consequences to the natural history interest of the areas concerned are con-

siderable. The hedge may be considered an extension of the woodland habitat into open country as it contains so many woodland plants and animals. Where woodlands are sparse, as in much of Lindsey, widespread hedgerow destruction can have a considerable effect on the flora and fauna of those areas.

Removal of Copse and Spinney

2.132 Removal of copse and spinney again causes a considerable reduction in the quality of the landscape and a loss of wild life potential.

Change from Hardwood to Softwood Forestry

2.133 Many people would consider that the change from hardwood (deciduous) to softwood (coniferous) forestry has caused a reduction in the quality of woodland landscape, and this may often be the case. Increasingly, however, the Forestry Commission and private foresters are paying attention to the aesthetic and amenity value of woodland. An "amenity belt" is often provided around new coniferous plantations, either in the form of new deciduous planting or by retaining existing trees, and planting is frequently contoured to fit in with the landscape.

2.134 A survey conducted by Yarrow (1966) showed that in mountainous areas conifers were totally acceptable to visitors but generally hardwoods were to be preferred for lowland Britain.

2.135 It was considered that mono-culture of large areas of conifers in straight-rowed plantations was sometimes a particularly undesirable feature of modern forestry practice and in Lindsey the main woodland blocks would unfortunately appear to fit this description, particularly in Laughton and Willingham Forest; however it would be fair comment to say that in Lindsey, where woodland is so under-represented, straight rows of conifers are certainly to be preferred to no trees at all.

2.136 Coniferous plantations are frequently associated with a poorer flora. The needle-like leaves often contain materials toxic to many plants and these are released into the soil on leaf decay (Para. 1.57).

Use of Insecticides

2.137 The use of insecticides in modern agriculture has undoubtedly played a very large part in increasing food production but it has also posed serious conservation problems.

2.138 Many insecticides are non-specific in their mode of action and thus organisms other than those for whom the treatment was intended are also killed; but even more serious is the problem of toxic residues. Many insecticides, particularly the chlorinated hydrocarbon insecticides, such as aldrin, dieldrin and D.D.T., are broken down into products often as deadly as the parent compound. These residues may persist in the soil for many years only to be washed into rivers and streams and so pollute the whole environment. Animals eating contaminated material may be eaten by others and so the poisons are tranmitted along the food chains. Predatory birds are particularly vulnerable to this process and levels of residues sufficient to cause a reduction in breeding success have been reached in several species. The rapid decline in the numbers of Peregrine Falcon recorded in England over the last 20 years has been attributed in particular to D.D.T. residues though recently numbers have recovered to some extent as the use of this compound has been cut back.

2.139 There is now a considerable awareness of the potential hazards of the uncontrolled use of insecticides with a recent total ban on the use of D.D.T. in Sweden and in certain of the States of the U.S.A.. Pesticide use in Britain is to some extent controlled by the Pesticide Safety Precaution Scheme set up in the early 1960s. Under this scheme some uses of the chlorinated hydrocarbon insecticides have been voluntarily ended. New restrictions in 1969, particularly on the use of D.D.T., should mean that the use of this compound will have been reduced by 50% since 1962. See also Appendix II.

Use of Herbicides

2.140 There can be little or no objection to the use of herbicides on farm land and particularly on the use of selective hormonal weed-killers as these appear to have few known side effects.

2.141 Spraying of roadside verges as a cheaper alternative to cutting would, however, appear to be totally undesirable, greatly reducing the amenity value of the verges affected and considerably reducing their value as a wild life refuge.

2.142 Verges have assumed increasing importance in the conservation of wild life and their maintenance should have a high priority.

Use of Artificial Fertilisers

2.143 Artificial fertilisers, like insecticides, have been a great aid in the intensification of agricultural production but there can be problems.

2.144 Rain washout, particularly of nitrates and phosphates, into still water areas can cause considerable ecological changes. The result of this boost in the nutrient status of the water (a process known as eutrophication) is often a rapid growth of algae which under extreme circumstances can cause a complete removal of oxygen with a consequent death to fish etc. The problem has presented itself increasingly in recent years and could easily become serious in Lindsey where artificial fertilisers are extensively used and there are many areas of valuable still water.

Drainage for Agriculture

2.145 Drainage of land for agiculture has been a widespread feature of the English landscape for many centuries and particularly so in lowland Eastern England. In Lindsey, much of the Isle of Axholme and the "Fen" country was once marsh and bog.

2.146 Today natural wetland zones are now scarce and further drainage can only reduce still further these interesting and vital habitats. Further drainage measures would represent a loss of wild life and amenity.

2.147 Canalisation of rivers to facilitate drainage can only reduce the wild life interests of the watercourses and promote monotony in the landscape.

Reclamation of Land

2.148 Reclamation of land from the sea for agriculture is, in general, a desirable measure but in some cases there may be conflict with nature conservation where interesting and valuable coastal communities are threatened. This might be particularly so in Lindsey where several fine stretches of coastal salt-marsh and mudflat - important habitats for countless sea birds - could be reclaimed.

2.149 In such cases reclamation would represent a great loss of wild life and considerable reduction in amenity. Where coastal accretion is rapid, as along much of the Lindsey coastline, this loss, however, might only be temporary.

RECREATIONAL DEVELOPMENT
SELECTION OF AREAS FOR USE

2.150 In this Chapter the ecological effects of recreational pressures in the countryside have been reviewed and it has been shown how recreation can have serious implications for wild life, these implications particularly significant in a county such as Lindsey where areas of natural and semi- natural vegetation are so restricted.

2.151 It is clear that with the continuing and ever increasing pressure for countryside recreation further facilities must be provided to satisfy at least some of this demand but consideration of the needs of wild life conservation and of the general implications of recreational use of open spaces could ensure that the conflicts between recreation and wild life are kept to a minimum - some zonation of use is therefore essential.

2.152 It is clear that it would be ill-advised to develop extensive recreational facilities or allow uncontrolled use of existing facilities in either **Areas of particular value in terms of wild life conservation** or in **Areas where recreation would cause rapid wear and tear.** The former areas will include the Statutory Nature Reserves at Saltfleetby/Theddlethorpe, Gibraltar Point and Red Hill - some conflict between conservation and recreation is already apparent at all three sites - and the Scheduled Sites of Special Scientific Interest; in all of these areas the needs of wild life conservation must have first priority and recreation must be strictly limited if this seriously conflicts with conservation. The latter areas will include those parts of the County where habitat factors are such that recreation would cause rapid wear and tear - i.e. in areas of low Carrying Capacity such as the sand-dune system and areas of heathland developed over blown sand.

2.153 Where recreation is permitted and/or encouraged or extensive facilities developed the areas concerned must be properly managed to maintain their ecological status and to minimise any adverse effects of recreation as far as possible. This aspect of countryside recreation is considered in Chapter III.

Comprehensive surveys now in progress to measure the effects of recreation on vegetation and on wild life.

(1) Studies at Gibraltar Point Local Nature Reserve, Lindsey
- Lincolnshire Trust for Nature Conservation/ Nature Conservancy.
- to be published in 1970.

(2) Studies at two sites in the Peak District
- Midland Region of the Nature Conservancy

(3) Studies at Box Hill, Surrey (S.S.S.I.)
- a detailed project involving research into the effects of public use on
  (a) composition of the vegetation
  (b) productivity of the sward
  (c) soil compaction
  (d) soil pH
- University of Sussex/Juniper Hall Field Centre/ Surrey Naturalists' Trust

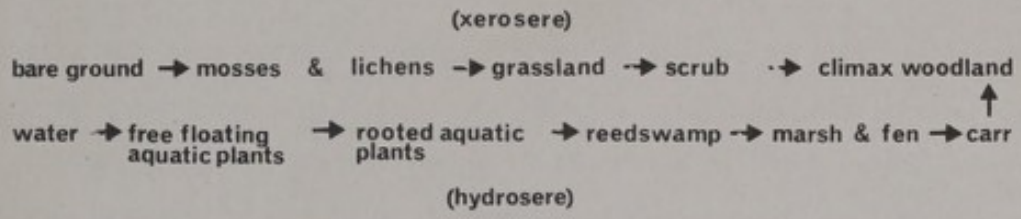
(4) Studies on the Devil's Punchbowl, Hindhead, Surrey
- King's College, London. Rogate Field Centre

Chapter III
Management

3.1 Management of areas for recreation must be directed towards two ecological objectives - habitat conservation and management to minimise the adverse effects of public use.

Habitat Conservation:-

3.2 The natural climax vegetation of Lindsey is broad leaved deciduous forest and all other ecosystems may be regarded as intermediate communities in a successional chain (sere). These communities are gradually evolving and positive management is required if the status quo is to be maintained. Whether the succession begins in water (hydrosere) or on dry land (xerosere) the final climax is the same - broad leaved deciduous woodland - and this is shown diagramatically below.



Minimisation of the Adverse Effects of Public Use

3.3 Recreational use will generally have a detrimental effect on vegetation but wear and tear can often be minimised by positive management. In some circumstances recreation may be quite compatible with and even beneficial to management for nature conservation.

MANAGEMENT OF SPECIFIC HABITATS

3.4 In the following paragraphs specific ecosystems are considered in turn and literature on techniques to manage each is reviewed, distinguishing between management to maintain the habitat and management to minimise any adverse effects of recreational use.

WOODLAND

Management to Conserve the Habitat

3.5 The recommendations for the management of the woodland of Sutton Park, Warwickshire (S.S.S.I.) have more than a local significance and are outlined below (Pritchard & Thompson, 1965[3]).

3.6 In management of natural and semi-natural woodland, the prime aim should be to ensure the continuation of the present woodland regime, perpetuating those species which are indigenous to the wood. Attempts should be made to secure natural regeneration wherever possible, supplementing this, if necessary, by planned planting. To aid natural regeneration, areas where this is to be encouraged must be fenced to exclude grazing animals and the public.

3.7 It is important to retain in woodland an assortment of dead, dying and fallen trees as these are necessary to the existence of mosses, fungi, insects and birds and help to maintain the natural appearance of the wood. Dead trees should be left standing, except in positions where they are an obvious danger, and fallen trees should be allowed to lie unless they are valuable as timber or cause obstruction. The practice of removal of wood for camp fires etc. should not be encouraged.

Management to Minimise the Adverse Effects of Recreation

3.8 In large woodland areas it is quite common to see motor vehicles driven deep into the woods, a practice which usually detracts from the amenity value of the woodland and frequently causes considerable damage particularly in wet weather. The practice can be discouraged by creating earth mounds at the entrance to motorable tracks (Phot. 10). This solution to the problem has been regularly employed, for example, by the Gloucestershire Trust for Nature Conservation over the extensive woodlands managed by them in the Cranham/Birdlip area, and would appear applicable to any woodland area or other habitat where it is desirous to prevent vehicular access. The mounds can be quickly moved if access is required for forest maintenance or logging etc. and can easily be replaced afterwards.

10. Recovery of Vegetation Following Prevention of Vehicle Access

Red Hill (L.N.R.), Lindsey

a turf barrier has prevented persistant unauthorised vehicle access to a disused quarry

3.9 Where vehicles are allowed freely under the trees in open woodland rotation of use is valuable in limiting turf damage but injury to the trees by soil compaction - thought to be a cause of crown die-back in areas of the New Forest (Para. 2.29) - can probably only be reversed by prohibiting car parking or strictly limiting its extent. It might be advantageous to break up the soil at such locations thereby improving drainage and aeration though there is a danger that tree roots close to the soil surface would be damaged.

3.10 In woodland with a rich herb layer, careful siting and maintenance of paths within the woods is probably the best method to ensure that damage to the ground flora is minimised, but it is clear that if the woods contain attractive wild flowers, such as primroses, bluebells and lily of the valley, etc., these paths will not be followed. Ecological diversity is rapidly reduced by trampling and recreational use should not be encouraged at such locations.

ACID HEATH

(i) DRY HEATH

3.11 This habitat is often of value for recreation and the public enjoy free access to many large areas of heath in many parts of the country - well known for example are Sutton Park, Warwickshire; Cannock Chase, Staffordshire; Frensham Common and Chobham Common, Surrey; Wimbledon Common, London, and the New Forest Heathlands, Hampshire.

3.12 Excluding the coast, the major proportion of all natural "open space" in Lindsey is probably of the acid heath type but here public access is strictly limited over many of the heathland areas, including the two largest tracts at Manton Warren and Risby Warren.

3.13 The acid heath ecosystem is frequently very susceptible to change and, unless properly managed, scrub and eventually woodland will soon develop while extensive recreational use can seriously damage the vegetation and cause considerable soil erosion.

3.14 A rotation of burning and grazing has probably been the major factor maintaining the open heathland of Dorset and the New Forest (Tansley, 1939; Moore, 1962 and Tubbs, 1963). Moore suggests that to maintain heathland without serious loss of species two requirements only are necessary, namely to burn the areas concerned systematically in such a way that a mosaic of small areas is fired each year while, at the same time, ensuring that accidental and uncontrolled fires are prevented as far as possible.

3.15 Controlled burning was suggested as a solution to the management problems involved in maintaining the dry heathland of Sutton Park, Warkwickshire (Pritchard and Thompson, 1965[1]). The problem there, and elsewhere, is to maintain *Calluna* in a vigorous and fertile condition and to prevent its suppression by competitors such as gorse and bracken. Burning of heaths improves the habitat for germination of *Calluna* seeds, and existing plants may regenerate from stem bases if the temperature experienced during burning does not exceed 290°C. In either case rapid re-establishment of a vigorous and fertile heath ensues (Whittaker and Gimingham, 1962). Detailed management proposals were made for Sutton Park and these are outlined below. They could well be applicable to some of the heathland areas of Lindsey where *Calluna* occurs.

3.16 It was suggested that rotational burning of the heaths under controlled conditions would maintain a vigorous growth of heather and a 15 year rotation was proposed for Sutton Park. The total area of heather dominated heathland was calculated and divided by 15 this giving a figure to be burned annually. In any one season the object should be to burn small units scattered all over the heathland, this ultimately resulting in a heathland consisting of a patchwork of heather areas up to 15 years old, and should produce optimum conditions for wild life and hamper the spread of any accidental fires. Clearly the rate of growth of heather will vary from area to area and from county to county. The 15 year rotation figure was specific for the Sutton Park site; shorter or longer rotations may be applicable to other areas and these must be determined on the basis of the local conditions prevailing.

3.17 Bracken control is often a desirable measure if the heathlands are not to become dominated by this plant, thus losing their value as an open space. The techniques suggested for heather management go a long way to reducing the spread of bracken but will not eliminate it. Experiments are being con-

ducted at Cannock Chase to investigate physical methods of bracken control on heath. Mechanical cutting of the fronds repeatedly - at least twice during the growing season and for a number of years would seem one solution to the problem.

Prevention of Scrub Invasion:-

3.18 The methods outlined above to control bracken and encourage a vigorous growth of heather generally effectively slow down the invasion of scrub vegetation but once scrub becomes established it is very difficult to prevent it spreading and from finally developing into woodland. By the time this stage is reached it can only be reversed by manual clearance - a costly procedure. It was suggested that young trees and bushes up to 5 or 6 ft. might be removed with a "Swipe" or similar tool, but older trees must be cut out individually. A chemical brushwood killer can be used to stop new growth from cut stumps.

Control of Fire:-

3.19 Fire is a particular hazard of dry heathland communities, both dry heather and dead bracken being very combustible materials and fires once started spread rapidly.

3.20 The spread of accidental fires can be prevented to a large degree by the creation of fire breaks. Mowing and cutting the heather and bracken to at least a 10 metre (33 feet) width is a very effective fire break and the resultant close grassland areas are valuable for public recreation providing good paths and adequate picnic areas. Secondly such action may be a means to channel public use away from the more valuable areas ecologically.

Management to Minimise the Adverse Effects of Recreation

3.21 Dry acid grassland and heath is often very vulnerable to recreational pressure - surface vegetation is rapidly removed and erosion an inevitable consequence. The nature of the sub-soil largely determines the amount of use any area can tolerate and unfortunately the blown sand heathlands of Lindsey would seem particularly fragile. Where the sub-soil is very sandy and dry erosion once started is often accelerated by natural factors such as wind and rain and attempts must be made to repair the habitat.

3.22 Heavily eroded areas could be fenced off to allow recovery of vegetation and, if regeneration is then slow, there may be scope for direct sowing of seed - usually heather seed. In Sutton Park it was suggested that branches from vigorously growing heather plants could be cut when in seed and the sprigs placed in areas where regeneration is to be encouraged, anchoring them, if necessary, using long staples made from fencing wire. If this failed direct sowing of seed in the spring was put forward, using collected seed, growth possibly aided by cultural techniques such as harrowing the soil.

3.23 Some of the blown sand regions of Lindsey can become extremely dry, this leading to mobilisation of the sand in a few areas with consequent dune formation - as at Manton Warren and Risby Warren. At the latter site marram grass *(Ammophila arenaria)* was planted about 50 years ago in an attempt to stablise the continually blowing sand. If these areas were to be made available for public recreation it is likely that wear and tear would be considerable and rapid. The use of marram to stablise mobile sand areas is a recognised method of coastal dune maintenance (Para. 3.55 to 3.60) and could well be applied to inland dune areas where appropriate (as was practiced at Risby Warren), and to other areas of loose sand, but small eroded areas are probably best stablised by infilling with good top soil, rolling and reseeding. In any rehabilitation programme exclusion of the public is a desirable if not essential follow up operation if any action is to be successful.

3.24 Some of the heathland areas in Lindsey are fairly large and there ought to be scope for some zonation of use and more especially rotation of use thereby ensuring that no areas are over-exploited and that the vegetation in heavily used sections has a reasonable chance to recover.

(ii) WET HEATH

3.25 Areas of wet acid heath are somewhat restricted in Lindsey and these few areas appear to be very vulnerable to adverse change. Some are threatened by direct agricultural reclamation while others are endangered through drainage measures on adjacent land, this tending to lower the water table over the whole area. The wetland areas associated with the tracts of dry heath in the county, while immune from reclamation and drainage, may deteriorate through recreational

pressures or through natural succession and attempts should be made to conserve the most interesting of these.

Management to Conserve the Habitat

3.26 Wetland zones tend to become drier through the accumulation of plant litter and debris, this tending to raise the soil level, and positive conservation measures are therefore needed. In Sutton Park several interesting wetland regions have been conserved by periodical dredging while others have been saved by reducing, by various means, the quantities of silt entering the areas concerned (Pritchard and Thompson, 1965[2]) - both of these techniques would seem to be applicable to many wetland sites in Britain but the major problem often facing conservationists is the maintenance of an adequate overall water table and the ways to tackle this problem would vary considerably from location to location.

Management to Minimise the Adverse Effects of Recreation

3.27 In extensive heathland regions wetland areas are often relatively inaccessible and thus provide a good refuge for wild life, a factor of increasing importance as areas of heathland are opened up for public recreation. It has been stated that if the wetland areas of Sutton Park were rendered accessible by drainage their value as a refuge for wild life would be greatly reduced and the Park would no longer be able to accommodate such large numbers of visitors without detriment to its wild life - upwards of 35,000 people visit the 970 hectares (2,400 acres) of this park at Bank Holidays.

3.28 Footpaths should not traverse valuable wet heathland areas unless absolutely essential but if they really are necessary they might be raised above the general level of the ground by means of duck boards fixed on wooden piles so preventing the inevitable erosion and damage to vegetation which always accompanies footpaths across wet ground.

3.29 Wetland areas are really quite unsuitable for any kind of recreational activity and should be maintained solely for their wildlife value.

CALCAREOUS GRASSLAND

3.30 The calcareous grassland of Britain, particularly that developed over chalk, has shown a marked change in the last 20 years. The habitat is essentially artificial being created and maintained under a regime of grazing, typically by sheep and/or rabbits. Most of the problems of management are a consequence of the cessation of grazing; changes in management policy for economic reasons, coupled with the dramatic reduction in rabbit populations through myxamatosis has allowed deleterious successional changes to occur. Grasses such as tor grass *(Brachypodium pinnatum)* and upright brome *(Zerna erecta)* tend to become dominant, suppressing more interesting plant species, and a marked increase in the rate of scrub invasion is apparent - positive management is required to check both problems. With changes in farming practice and the increasing demands of public recreation the scientific value of many of these grassland areas is increased; conservation of the most valuable of these is now of vital importance.

3.31 Recreation, if not too severe, does not seem to seriously conflict with the management required to effect a satisfactory stabilization of the grassland system, though the choice of techniques is reduced. Obviously very heavy use is to be avoided as this must cause some damage to the vegetation and the inevitable soil erosion.

Management to Conserve the Habitat

3.32 The Nature Conservancy has been involved in a series of experiments to try and establish the optimum conditions for the maintenance of rich chalk grassland and these experiments are outlined below (Nature Conservancy, 1968); reference to other work is made where appropriate.

3.33 The continuation or re-establishment of the traditional pattern of grazing by sheep is usually considered to be the best form of management, this producing ideal conditions for both the creation and the continued maintenance of a rich chalk grassland sward.

3.34 Although sheep grazing is traditional, observations at Wylye Down in Wiltshire, which has been grazed by cattle (Ayrshires) for the past 25 years show that, under certain circumstances, cattle grazing can produce a sward at least as rich in plant species.

3.35 It is important to understand the differential effects of the two grazing animals (Wells, 1965). Beast for beast sheep have little effect on the vegetation in comparision with cattle and it is only when sheep are grazed at a fairly high density for long periods that obvious changes in the vegetation become apparent, yet a small number of cattle can rapidly "cut up" a field, particularly in wet weather. A small amount of research has been undertaken on the effects of cattle grazing but most work has been directed to establish the optimum conditions for grazing by sheep.

3.36 In 1964 the Nature Conservancy purchased some sheep for the Aston Rowant National Nature Reserve in order to have full control over grazing intensity and the grazing period in a series of trials designed to measure the effects of sheep grazing on the floristic composition of the turf.

3.37 Pairs of paddocks have been grazed at densities of one and three sheep to the acre from October to May in three areas differing from each other in both aspect and flora. Grass litter which had accumulated over ten years has been eliminated and in the heavily grazed plots the height of the vegetation has been reduced from 45 cm. to 8 cm. or from 10 cm. to 4 cm. It is clear that the selection made by the sheep in their diets is largely governed by the availability of different species and their preference appears to change when the choice is reduced, thus wood false brome *(Brachypodium sylvaticum)* is only eaten when the herbage is scarce as it shares the property of being very unpalatable with the related tor grass *(Brachypodium pinnatum)*, a species which has spread markedly on chalk grassland in many areas possibly for this very reason.

3.38 It is probable that cattle are less selective in their choice of diet and thus might be more effective than sheep in preventing scrub development and the spread of coarse grasses (Chappell, 1969[1]). If cattle grazing is to be employed careful management is essential, through such means as restriction of grazing period or rotation of grazing area, if deleterious effects of over-trampling and over-grazing are to be avoided.

3.39 Clearly, extensive recreational use of grassland will rule out the possibility of any form of grazing and we must look to other methods to maintain the sward.

3.40 Cutting appears to be a successful substitute for grazing. This was clearly demonstrated in a comparative experiment conducted on chalk downland near Marlborough, Wiltshire (Warne, 1934). In this experiment plots were either mown, at three weekly intervals, or grazed by sheep, again at three weekly intervals, the treatment being maintained for three years whence the plots were analysed. The remarkable similarity between the grazed and mown plots was the outstanding result of this work.

3.41 Experiments, begun in 1963, on plots of chalk grassland on the Barton Hills (Bedfordshire) have shown that cutting at any time of the year, by preventing the accumulation of grass litter, increases the diversity of plant species in the turf. The time of cut would appear to be significant in some cases; upright brome *(Zerna erecta)* can be controlled more effectively if the cut is made in April rather than in July or September. Experiments at Knocking Hoe National Nature Reserve suggest that cutting in May can also be of value while cutting three times a year at this site has caused a decrease in upright brome; in contrast in uncut plots this species has increased (about two and a half times). As far as can be seen to date, cutting at this frequency in Spring, Summer and Autumn produces much the same effect as grazing by three sheep per acre, though in the long term the picture may be different - as yet no species have been eliminated by any of these treatments.

3.42 Burning, although widely practised to maintain calcareous grassland, does not appear to adequately conserve the floristic interest of the turf and apparently may encourage scrub advance (Para. 2.113) and allow the spread of coarse grasses.

3.43 Grazing, in addition to maintaining a rich chalk grassland sward by preventing the accumulation of litter and the spread of coarse grasses, effectively prevents the encroachment of scrub. Recreational use of this habitat can have a similar effect and again reduce the rate of scrub advance. Once scrub has become established, the only effective way to remove it is by manual clearance - this was undertaken with 20 hectares (50 acres) of scrub at Newland's Corner (near Guildford) and at Sheepleas, both by Surrey County Council. The freshly cleared areas are now regularly mown but it is too early yet to see whether a rich chalk grassland sward will be re-established (Reynolds & Sankey, 1967).

Management to Minimise the Adverse Effects of Recreation

3.44 It has been shown that heavy recreational use of chalk grassland will eventually cause considerable wear and tear and erosion on steep slopes - clearly seen at Box Hill, Surrey where much of the lower scarp face is now badly worn. The chalk soils are very thin and erosion soon removes the total soil surface so that re-establishment of a complete vegetation cover is necessarily very slow; wear and tear must be prevented before this stage is reached.

3.45 Salad burnet *(Poterium sanguisorba)*, a common species of calcareous grassland, might serve as a useful indicator to determine the degree of wear and tear a particular area has suffered. The species, an easily recognised perennial, present in a vegetative state throughout the year, appears to disappear completely before obvious heavy trampling pressure is apparent (Chappell, 1969[2]).

3.46 Rotation of use over large sites and restriction of car parking at smaller areas would seem the best way to control visitor pressure and numbers ensuring that vegetation is not too heavily worn in any one area.

3.47 In summary, recreational use, if not too heavy and concentrated, is reasonably compatible with the conservation of calcareous grassland. Where grazing is impossible, possibly on any site extensively used for recreation, mowing would appear to be the best form of management, perhaps varying the time of cut to avoid destruction of the same grassland species year after year. It would be ideal if the areas concerned could be divided up and each section be cut at a different time, cutting the same section at the same time each year; there are many advantages in adopting a regular mowing cycle for any one particular spot.

COASTAL HABITATS

SAND-DUNES

3.48 The main interest in coastal habitat management has centred around sand-dune maintenance and rehabilitation, and a considerable amount of research has been undertaken on this topic.

Management to Conserve the Habitat

3.49 Sand-dunes are an integral successional unit and problems of habitat maintenance to limit changes are few, though succession to dune scrub may have to

be checked and areas of scrub cleared from time to time. In many parts of the country scrub growth on dunes appears to have increased in recent years, probably due to a decline in rabbit numbers.

Management to Minimise the Adverse Effects of Recreation

3.50 The first priority must always be to limit wear and tear as far as possible, especially in those parts of the dune system particularly vulnerable to use, i.e. in the mobile dunes.

3.51 Observations on the sand-dunes at Ynyslas, West Wales (Chater pers. comm.), suggest that most people wish to reach the beach as easily and as quickly as possible, either from their cars or from caravans, and are not really interested in the dunes as such, except those parts facing the sea. Thus it is desirable to make easy tracks across the dunes (using old sleepers for example as at Gibraltar Point-Phot. 11), these wide enough to accommodate at least two people abreast. Sea buckthorn *(Hippophae rhamnoides)* might be planted as a border to these paths since this attractive and robust shrub once it is well established can act as a useful barrier to public trespass.

3.52 Car parks should be sited as near to the sea as possible and in the least vulnerable parts of the dunes - serious erosion will inevitably be sustained near these.

3.53 It seems to be most important to block all motorable tracks into the heart of dune systems otherwise new centres of litter, broken glass and surface erosion may be set up. This has been done at Ynyslas by the Nature Conservancy by excavating ditches across entrances to dune-slacks which soon fill with water, and by constructing sand and turf barriers across motorable tracks. Wire fences are also used in some areas, but fences alone tend to be pulled down. The relatively few people at Ynyslas who liked to walk and enjoy the quieter parts of the dunes appeared to do little damage.

3.54 Dune erosion, once started, can rapidly spread and positive steps to restore the system will be required. The main basis of sand-dune stabilisation and reclamation is the protection of the sand surfaces from wind (Steane, 1967). Steane

outlined three methods:-

(a) Bind the sand surface physically to resist wind attack - by water, cement, sump oil, bitumen, latex - a temporary expedient only.

(b) Erect mechanical barriers to the wind, velocity is low at ground level ("boundary layer effect") - palings, reeds, brush fence, bush thatch - a temporary expedient only.

(c) Re-establish and maintain the vegetation cover - normally the best permanent protection and largely self-maintaining.

The main interest now centres on re-establishment of a good vegetation cover.

3.55 If the mobility of the sand is not excessive, successful stabilisation can probably be achieved by direct planting with marram grass (Phot. 12) (Chapman, 1948). The marram should be planted in rows at right angles to the wind incidence to prevent, as far as possible, the creation of wind channels; further, plants in successive rows should not be planted one behind the other but should alternate. The distance at which the plants are set must be determined by the local conditions prevailing; if placed three feet apart, the bunches should touch in 3-4 years but a good distance is about two feet and may need to be even less.

3.56 In areas where the sand is particularly mobile, it will be impossible to plant until any movement has been stopped. If the mobile area is small, the best method to contain it is probably to cover the sand with top soil and plant on top of that but, for larger areas, catching fences may be appropriate and these can be constructed with wattles or branches of trees and shrubs.

3.57 Dune blow-outs are a particular problem in heavily used areas and often bulldozing may be necessary before even small blow-outs can be restored; wind action will have undercut the dune and a smooth aerodynamic profile is the first requisite in dune stabilisation (Wright, 1967).

3.58 At Ainsdale National Nature Reserve, Lancashire, a thatching of pine branches laid along the slope of blow-outs has proved successful in holding the bare sand which can then be underplanted with marram (Greaves, 1966). A similar

Photo. R.B. Wilkinson

11. Sleeper Track

Gibraltar Point (L.N.R.), Lindsey

a sleeper track across the East Dunes has provided easy access to the beach and has concentrated public pressure where it can do relatively little harm

technique is in use along the coastline of Lindsey, the catching material being branches cut from the sea buckthorn scrub which grows prolifically on the Lindsey dunes (Phot. 13).

3.59 Experiments at Scolt Head Island (Steers, 1964), have demonstrated the advantages of latex spraying in the initial stages of stabilisation. Latex spraying prevents the removal of surface sand by wind and can be used to stabilise both fore-dunes and blow-outs. The latex film holds seeds in position during germination, and vegetation, once established, encourages further natural dune building. At Southport, 1.5 hectares (3 acres) of mobile sand were grassed within a year by this method at a material cost of less than £50. Labour costs involved in marram planting, which is of doubtful efficiency in exposed areas, are considerably more than this.

3.60 Hydraulic seeding, a process which delivers an appropriate seed mixture, fertiliser and mulch simultaneously, may be applicable to some situations. The Nature Conservancy recommended such treatment at Camber Sands where East Sussex County Council, in conjunction with Battle Rural District Council and the Kent River Authority, are carrying out an extensive rehabilitation programme (East Sussex County Council, 1968).

3.61 Clearly the success of all stabilisation measures must rely initially on total exclusion of the public and, if the vegetation cover is to be sustained, some form of continued access control.

3.62 Prohibition of access is always unpopular and thus some form of publicity to explain to the public what is being done and why is vital. Strategically placed notice boards bearing attractive explanatory posters could be of the greatest value.

3.63 Prevention of erosion by controlling public use of dune systems from the beginning is clearly the ideal solution to the problem, but rarely is this a feasible proposition. However, it can be seen that rehabilitation of dune systems is now practical; continuous "small scale" maintenance should ensure that widespread erosion does not occur, but erosive damage can be repaired and even extensive sandy wastes restored.

Photo. Nature Conservancy

12. Dune Restoration

Braunton Burrows (N.N.R.), Devon

marram planting on dunes laid bare in the course of operations to remove beach mine fields. Work carried out since 1952 by the War Department under the guidance of the Nature Conservacy

3.64 A considerable amount of dune restoration and rehabilitation work has now taken place at many points around the coastline, most of it on a small scale, but several larger projects have been tackled, including work at Gullane, East Lothian (Para. 2.50), at Camber sands, East Sussex (Para. 3.60) and at Braunton Burrows, Devon (Phot. 12). At Gullane an extensive long-term scheme covering about 35 hectares (90 acres) of eroded dunes and grassland, visited by tens of thousands of people each year, is still in progress, the work commencing in 1962 (East Lothian County Planning Department, 1965[2]).

3.65 Recreational use of other coastal habitats such as shingle, salt-marsh and mud-flat is very restricted. None are of real value for recreation, save for wild life study, and problems of wear and tear have rarely been encountered. Nevertheless, the small amount of use which these areas receive may be detrimental, especially to bird life as many of these zones are important feeding or nesting grounds; both land based and particularly water based recreation must be carefully controlled.

FRESH WATER HABITATS

(i) STILL WATER (Ponds, Dykes & Canals)

Management to Conserve the Habitat

3.66 Succession will cause the gradual filling up of still water habitats through accumulation of silt or the dead and partly decaying remains of the plants (sub aquatic humus) or by both processes together, this particularly at the edge of the water areas. Clearly dredging and manual clearance of excessive growth of "reed" vegetation will be needed from time to time.

Management to Minimise the Adverse Effects of Recreation

3.67 Bank erosion through fishing can be reduced by either rotation of the areas where fishing is permitted, this allowing a recovery period for vegetation, or by constructing raised platforms and limiting fishing to these, but erosion and disturbance to bank vegetation and to nesting birds by water craft is more difficult to control. British Waterways Board Bye-laws concerning the speed of boats in their navigable waters limit the speed of craft to about 6.5 to 9.5 k.p.h. (4 to 6 m.p.h.) (Trent River Authority, 1966), the maximum speed permitted varying from navigation to navigation. Speed control is clearly an effective solution

13. Dune Blow-out Restoration

Saltfleetby/Theddlethorpe (N.N.R.), Lindsey

stabilisation of mobile sand using branches cut from sea buckthorn

to the problem of bank erosion though very difficult to enforce. Serious erosion can, of course, be checked by piling the banks, but this is aesthetically unpleasing and greatly reduces the wild life potential of the areas concerned.

3.68 Above all else, it is essential to prevent all forms of pollution as far as possible (Paras. 2.86 to 2.88).

(ii) RIVERS

3.69 There are few problems of maintenance though again it is essential to safeguard against all forms of pollution. Any damage to the habitat is largely "shore based" - damage to banks by fishing, etc. - though extensive use of rivers by water craft can cause some erosion. Bank maintenance on the same lines as that outlined for still water habitats would seem applicable.

EDUCATION AS A MANAGEMENT TOOL

3.70 Many of the problems resulting from human pressures in the countryside might be greatly reduced through education. In Chapter II the consequences of recreation were outlined and the undesirable side effects of use were frequently shown to be quite unnecessary and mainly the result of ignorance and carelessness.

3.71 The majority of the public who visit the countryside are uninformed about nature, its purpose and its future. They pick flowers and dig up plants because they do not consider it wrong; many visitors even feel that it is their privilege - it is their countryside so why should they not do just as they wish? They drop litter, disturb wild-life and cause fires, mainly through carelessness - they just do not think. The future of our countryside depends to a great extent on public interest and co-operation and education is really the only way to achieve this interest. There is tremendous scope for education in all its forms.

3.72 Nature conservation receives a much wider publicity through the press radio and television than it did even five years ago. The work and aims of the Nature Conservancy, of the County Trusts and of other bodies concerned with conservation is now appreciated by quite a large number of people and the Trusts do a great deal to make their aims and activities well known.

Photo. Norman Beckett Studios, Skegness

14. Interpretive Centre

Gibraltar Point (L.N.R.), Lindsey

3.73 National and regional publicity on nature conservation is essential but much can be done at a purely local level to convey to the public the needs of wild life preservation. In Lindsey there is an excellent example of this.

3.74 At the Gibraltar Point Local Nature Reserve there are splendid opportunities for visitors to see and appreciate what is happening. There is an Interpretive Centre (Phot. 14) where exhibits illustrating the geographical features and the flora and fauna of the reserve may be seen, and there is a permanent nature trail. There have been problems of visitor pressures at Gibraltar Point but these have been tackled by appealing for co-operation from the public. Informative notice boards and leaflets have been produced explaining the need for restrictive measures such as a ban on collecting and limited access to parts of the reserve and the results of this approach have been very encouraging. One of the main problems encountered has been disturbance to the shore nesting birds, the Little Terns, Ringed Plovers and Oystercatchers, but this has now largely been eliminated through public co-operation; deliberate vandalism is of course another matter.

3.75 Clearly such measures are possible only at major nature reserves but gradually, through the extensive use of these areas (180,000 people visited Gibraltar Point in 1968), a well informed corps of people may emerge who appreciate the countryside in a better light.

3.76 The short-term nature trails, organised by the Lincolnshire Trust for Nature Conservation in conjunction with Shell Petrol, again have an excellent educational value and their use should promote a better understanding of the countryside. About 6,000 people visited the two trails in 1968 at Brocklesby and Well Vale and over 13,000 the two trails in Lindsey in 1969 at Willingham Forest (Phot. 15) and Normanby Park (there was a third trail at Grimsthorpe Park, Kesteven); further trails are planned for future years.

3.77 There is an entirely new approach to countryside studies (biology, botany, zoology, geography, geology, and rural sciences etc.) in schools with a far greater emphasis than ever before on the field approach. Even if parents are not well informed perhaps their children may grow up with a better appreciation of the values of our countryside and learn to respect them.

Photo. J.D. Leefe

15. Nature Trail

Willingham Forest, Lindsey

a short term nature trail mounted by the Lincolnshire Trust for Nature Conservation in conjunction with Shell Petrol
June 1969

3.78 It is probably true that education is the most important management tool of all since without public interest and co-operation countryside conservation must be doomed to failure.

CONCLUSIONS

1 In this survey an attempt has been made to evaluate the natural and semi-natural regions of Lindsey from a standpoint of both recreational potential and nature conservation while in Chapters II and III of the Report literature on the ecological effects of recreational use of the countryside and techniques for management of natural areas has been reviewed.

2 It became increasingly apparent that the amount of information on the ecological effects of recreation and on management is still very small and there is little data on which to base sound recommendations for management. Here is ample scope for future research. A fully comprehensive search for literature was made but it is clear from the countless correspondance with many organisations and individuals that many people are chasing the same limited information.

3 Natural and semi-natural vegetation is now very poorly represented in Lindsey and thus any conflict between recreation and nature conservation is of particular consequence.

4 The assessment of the value of the County's natural features for recreation and for conservation should be of considerable aid in deciding which areas, if any, should be opened up for public use.

5 The alternative to recreation in natural and semi-natural areas must be to take land out of agricultural use and make this available for recreation. Is this completely out of the question and perhaps not a desirable solution to the problem of meeting the demands for countryside recreation in a region where natural habitats are so restricted and the need for nature conservation so urgent?

6 Increasingly, farmers and landowners are realising that perhaps there is even money to be made out of recreation, indeed often more money than from conventional farming - witness the growth of "wild life parks". In many parts of the country farmers already actively encourage camping and caravanning on their land during the holiday season and this trend is likely to continue.

7 Parkland, well represented in Lindsey, probably offers the greatest potential for development (in 1968 there were 125 areas of parkland in Lindsey each over

4 hectares (10 acres). Parkland areas are frequently high in amenity value with attractive views, lakes and mature trees, while they are often at present only of a relatively low value for agriculture and also rarely of an outstanding ecological interest.

8 Exploitation of these areas, perhaps on the lines of small scale country parks and picnic areas, could go a long way to satisfying the demand for countryside recreations and if carried out by the owners, perhaps with advice from the local authority, could remove the huge problem of financing countryside recreational development.

9 Use of the County's "natural" areas for recreation might then be lessened and recreation would probably need to be confined only to small scale informal use for picnicking, walking, riding and nature study, at levels which should ensure that this valuable natural asset is not destroyed and that it will be conserved for future generations to enjoy.

APPENDIX I

NATURE CONSERVATION

1 The need for wild life conservation in Britain has long been recognised and this need becomes more urgent every year yet comparatively little in the way of constructive work had been carried out until quite recently. It is only during the last 20 years and particularly during the last 10 years that positive action to conserve our natural heritage of wild life has got underway.

2 Today many organisations are involved in the field but the two most significant by far are the Nature Conservancy (sponsored by Central Government) and the County Trust Movement (voluntary bodies), though many other institutions, which include the Forestry Commission and the National Trust, do admirable work. The total list is impressive, reference to the proceedings of the Countryside in 1970 Study Conference of 1963 will show some 90 delegations all interested in one aspect or another of conservation.

The Nature Conservancy

3 The Nature Conservancy was set up by Royal Charter in 1949 "to provide scientific advice on the conservation and control of the natural flora and fauna of Great Britain; to establish, maintain and manage nature reserves in Great Britain, including the maintenance of physical features of scientific interest and to organise and develop the research and scientific services related thereto".

4 The Nature Conservancy became a component body of the Natural Environmental Research Council in 1965, under the Ministry of Education and Science but was originally established under the Privy Council.

5 The Conservancy has statutory powers under Part III of the National Parks and Access to the Countryside Act, 1949. (See also Appendix II, section A4).

6 3 main types of conservation area are now recognised:-

(a) The National Nature Reserve (to be held and managed by the Conservancy), established under Sections 16-19 of the Act.

(b) The Local Nature Reserve (to be administered by Local Authorities or other bodies with advice from the Conservancy), established under Section 21 of the Act.

(c) The Site of Special Scientific Interest, (scheduled areas of great scientific value, notified to the Local Authority who must consult with the Conservancy over any proposed change of land use involving permission for development as defined in the Planning Act of 1947). These sites, many of which are now owned or leased by the County Trusts, are under private ownership and are notified under Section 23 of the Act. Although occassionally under agreed management plans the owners are not legally bound.

The County Trust Movement

7 The County Naturalists' Trusts, backed by their parent society, the Society for the Promotion of Nature Reserves (formed as long ago as 1912), have acquired and manage many areas of natural interest.

8 The first County Trust, Norfolk, was set up in 1926 and from this small beginning a nation wide organisation has grown - there is now a County Trust for every County in England and Wales. A Scottish Wild Life Trust (a single organisation) having aims similar to those of the County Trusts of England and Wales was set up in 1964.

9 The County Trusts have stimulated a great public interest and awareness to the need and problems of wild life conservation and this must rank among their greatest achievements.

10 Areas managed by the Nature Conservancy and by the County Trusts account for only a small fraction of our "natural countryside" albeit probably scientifically the most valuable part, but conservation measures must not be limited just to "protected sites". Conservation is not only the protection of species it is the management of a healthy and biologically productive environment.

11 This expanded view of conservation is now very much in vogue and a considerable proportion of the work of the Nature Conservancy is at present devoted to these wider issues. The Toxic Chemicals and Wild Life Division, based at Monk's

Wood Experimental Station near Huntingdon is primarily concerned with conservation outside reserves. It is carrying out research on the effects of the changes in agricultural practice so detrimental to wild life - hedgerow removal, use of insecticides, herbicides etc. and the result of its work should provide information on how best to retain a wide and diverse natural flora and fauna in company with modern mechanised and intensive farming techniques.

12 Equally important is the role the Conservancy is playing in an advisory capacity on planning for countryside recreation. It has been involved in a number of projects including an extensive appraisal of the implications of recreation on the Broadland of East Anglia (Nature Conservancy, 1965) and has given advice to several County Councils on management of public open spaces, including the West Riding of Yorkshire County Council (Malhamdale) and Hampshire County Council (Ashford Chase Beechwoods, Yateley Common Heath and chalk downland at Butser Hill).

Nature Conservation in Lindsey

13 Much of the Nature Conservancy's conservation and advisory work is carried out through its regional structure. Lindsey is part of the East Anglia Region of the Conservancy and a Regional Officer, supported by an Assistant Regional Officer for Lincolnshire (Lindsey, Kesteven and Holland), is responsible for advising on nature conservation in Lindsey, for the management of the County's Statutory Nature Reserves, and for liason with the Local Authorities, with the County Naturalist Trust and with other bodies. The Assistant Regional Officer is based at the Saltfleetby/Theddlethorpe National Nature Reserve.

14 Lindsey is fortunate in possessing an extremely active County Naturalists Trust. This Trust, the Lincolnshire Trust for Nature Conservation, was set up in 1948, then only the third County Trust to be formed, but already manages 26 reserves *and more than 1,200 hectares (3,000 acres)* of land in Lindsey, Kesteven and Holland. With a total membership of 1800* the Trust has one of the highest membership figures/head of population of any County Trust and this may reflect the great need for positive action in the field of nature conservation in Lincolnshire. The Trust is closely involved with Lindsey County Council over matters of countryside policy and is represented on the Countryside Committee.

* Figures at the end of 1969.

APPENDIX II

ABSTRACT OF LEGISLATION

There are a great many threats to the rural environment, some clearly avoidable. Particularly serious are the problems of environmental pollution and problems caused by visitor pressure - vandalism, litter and damage to wild life etc. Some legislation has been passed in an attempt to deal with both, and this and other legislation is summarised below.

(A) Acts concerned with the Protection of Wild Life

1* Game Acts, 1828 to 1960.

These acts provide the Police with power to prevent poaching and for the arrest of persons found trespassing in the pursuit of game. (Game includes hares, pheasants, partridges, grouse, heath or moor game, black game, bustards, woodcock and snipe). Wild fowl are not covered by these Acts.

2* Grey Seals Protection Act, 1932.

This Act prescribes an annual close season for grey seals, both in England and Scotland, extending from the 1st September to 31st December. The appropriate Minister may be Order suspend a protection under the Act for the ensuing 12 months or vary the length of the close season.

3* Local Government Act, 1933.

Under this Act County and Borough Councils are empowered to make by-laws, e.g. for the protection of wild plants.

4 National Parks and Access to the Countryside Act, 1949.

The Nature Conservancy, set up under this Act, has powers to make by-laws in respect of land which is managed as a nature reserve; these laws include prohibition of entry to a reserve, restriction of movement within a reserve, prohibition of the taking and disturbing of animal life, removal of bird's eggs and the disturbance and removal of vegetation.

5* Rivers (Prevention of Pollution) Act, 1951.

Rivers (Prevention of Pollution) (Scotland) Act, 1951.

Under these two Acts all new discharges into rivers are, or can be, controlled by River Boards, River Purification Boards or River Authorities.

6* Protection of Birds Act, 1954.

This Act provides that, subject to specified exceptions (of which some details are given below), it is an offence to kill, injure or take, or attempt to kill or injure or take any wild bird, to take, damage or destroy the nest of any wild bird whilst the nest is in use, or to take or destroy an egg of any wild bird. Provision is made for the establishment of bird sanctuaries from which the public may be excluded and for the imposition of special penalties for certain offences. Close seasons are defined and varying protection is afforded to specified birds and their eggs according to whether they are rare in the United Kingdom, or are destructive or are a nuisance, or are customarily killed for sport, or for human consumption. Restrictions are imposed on the sale of live and dead birds and their eggs, on their skin and plumage, on the importation of birds and eggs and on the method of taking birds when taking is not absolutely prohibited. Exceptions are made for pheasant, partridge, grouse, black game, and ptarmigan which are regarded as Game Birds. Provision is made for the granting of licences by the Nature Conservancy to do things otherwise prohibited by the Act for the purposes of research, and for the setting up of advisory committees to advise on the administration of ornithological questions arising out of the operation of the Act. The Home Secretary and the Secretary of State for Scotland may also grant licences.

7* Oil in Navigable Waters Act, 1955.

This Act makes it an offence for any ship, regardless of nationality, to discharge any type of oil within U.K. Territorial Waters, including Inland Waterways and rivers navigable by sea-going ships. The Act also gives effect to the provisions of the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, by prohibiting the

discharge of persistent oils by U.K. registered ships in the prohibited zones laid down in the Convention.

8* Deer (Scotland) Act, 1959.

This Act enables the Secretary of State for Scotland to further the conservation and control of red deer in Scotland; to prevent the illegal taking and killing of all species of deer in Scotland; and makes full provision for the protection of the interests of agriculture and forestry. Statutory close seasons for both hinds and stags are also provided.

9* Clean Rivers (Estuary and Tidal Waters) Act, 1960.

This Act amends the Rivers (Prevention of Pollution) Act, 1951, so as to give River Boards powers to deal with new outlets and new discharges of trade and sewage effluent into tidal waters or parts of the sea.

10* Rivers (Prevention of Pollution) Act, 1961.

This Act extends the control in non-tidal parts to all existing discharges, except in Scotland.

11* Oil in Navigable Waters Act, 1963.

This Act enables effect to be given to certain amendments of the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, and otherwise to extend the Oil in Navigable Waters Act, 1955.

12* Deer Act, 1963.

This Act provides close seasons for deer; prohibits the killing and taking of deer by certain devices and at certain times and restricts the use of vehicles in connection with the killing and taking of deer. It applies to England and Wales only.

13 Protection of Birds Act, 1967.

This Act grants additional powers to the 1954 Act extending protection to lapwing eggs and for eggs of common wild birds and places a restriction on ringing and marking. Special protection for birds may be authorised in severe weather.

14 Seafish Conservation Act, 1967.

This places lower limits on the size of fish to be landed and includes regulations on net mesh.

15 Theft Act, 1968.

Taking or killing of deer:-

This Act makes it an offence to take or kill, or attempt to take or kill any deer on enclosed land where deer are normally kept.

Taking or destroying of fish:-

This Act makes it an offence to take or destroy, or attempt to take or destroy any fish in water which is private property or in which there is any private right of fishing.

The Wild Plants Protection Bill, 1968.

This Private Members Bill proposed that there should be a short list of very rare plants which it would be an offence to pick or up-root, and a longer list of plants which it would be lawful to pick but unlawful to sell. In addition it was proposed that local orders could be made against up-rooting plants in defined areas where species are locally scarce. The Bill failed to obtain a Second Reading in the House of Commons, but it is anticipated that this, or a similar Bill, will be reintroduced in a subsequent Session.

Toxic Chemicals

Further legislation on the use of toxic chemicals (particularly insecticides) is still required but a voluntary ban on the use of aldrin, dieldrin, and heptachlor as spring seed dressings and in sheep dips has considerably reduced the threat to wild life and particularly to bird life. The recent additional restrictions on the use of D.D.T. and of aldrin should further reduce the levels of pesticides in the environment. Pesticide use is now controlled to some extent by the Pesticide Safety Precaution Scheme (a purely voluntary service run by the Ministry of Agriculture, Fisheries and Food in conjunction with the Natural Environmental Research Council, the Agricultural Research Council and the Medical Research Council) and the scheme works quite well but some mandatory control would still seem desirable. At present new pesticides are vetted for possible hazards but products marketed before the control still cause problems. (Paras. 2.137 to 2.139).

Tree Preservation.

Local authorities may (if it appears that it is expedient in the interests of amenity) under Section 29 of the Town and Country Planning Act 1962, make orders known as Tree Preservation Orders prohibiting, except with the consent of the authority, the cutting down, topping, lopping or wilful destruction of any tree, group of trees or woodland in their area. Such an act, in addition to the maintenance of amenity thereby affords some protection for wild life. Provision is made for replanting where trees so "protected" are removed and for payment of compensation in certain circumstances where commercial timber is involved. Any person contravening the provisions of a Tree Preservation Order is guilty of an offence and is liable on summary conviction to a fine not exceeding £50.

* Material taken from the Abstract of Legislation, Proceedings of The Study Conference, 1963 on The Countryside in 1970. Paper No. 6, pp. 193-201.

(B) Other Legislation

1 Legislation to control the dropping of litter and unauthorised dumping.

Many local by-laws include provisions for dealing with problems of litter but the first attempt nationally to tackle the problem came with the passing of the Litter Act, 1958, which made it an offence under criminal law to drop litter or deposit rubbish in any open space where the public have free access.

Conviction under the law carries a maximum fine of £10 for each offence.

The Civic Amenities Act, 1967, granted considerably enhanced powers. Abandonment of vehicles or deliberate dumping of any object, specifically brought to the land for the purpose of abandonment, now carries a fine not exceeding £100 for a first conviction or in the case of a second or subsequent conviction a fine not exceeding £200 or imprisonment for a term not exceeding three months, or both.

2 Legislation to control public order and vandalism.

There were provisions in the 1949 National Parks & Access to the Countryside Act for the Nature Conservancy to make by-laws for its

reserves, and for the National Park Planning Boards to make by-laws for the National Parks. Further provisions were made in the Countryside (Scotland) Act, 1967, the Forestry Act, 1967, and the Countryside Act, 1968. Under the 1968 Countryside Act local authorities are empowered to make by-laws (subject to confirmation by the Home Secretary) and provide wardens for Country Parks and Picnic Areas established by them and for other land over which the local authority have exercised powers conferred by Section 9 of the Act. Wardens are to be appointed to secure compliance with any by-laws made and with the provisions of the 1958 Litter Act.

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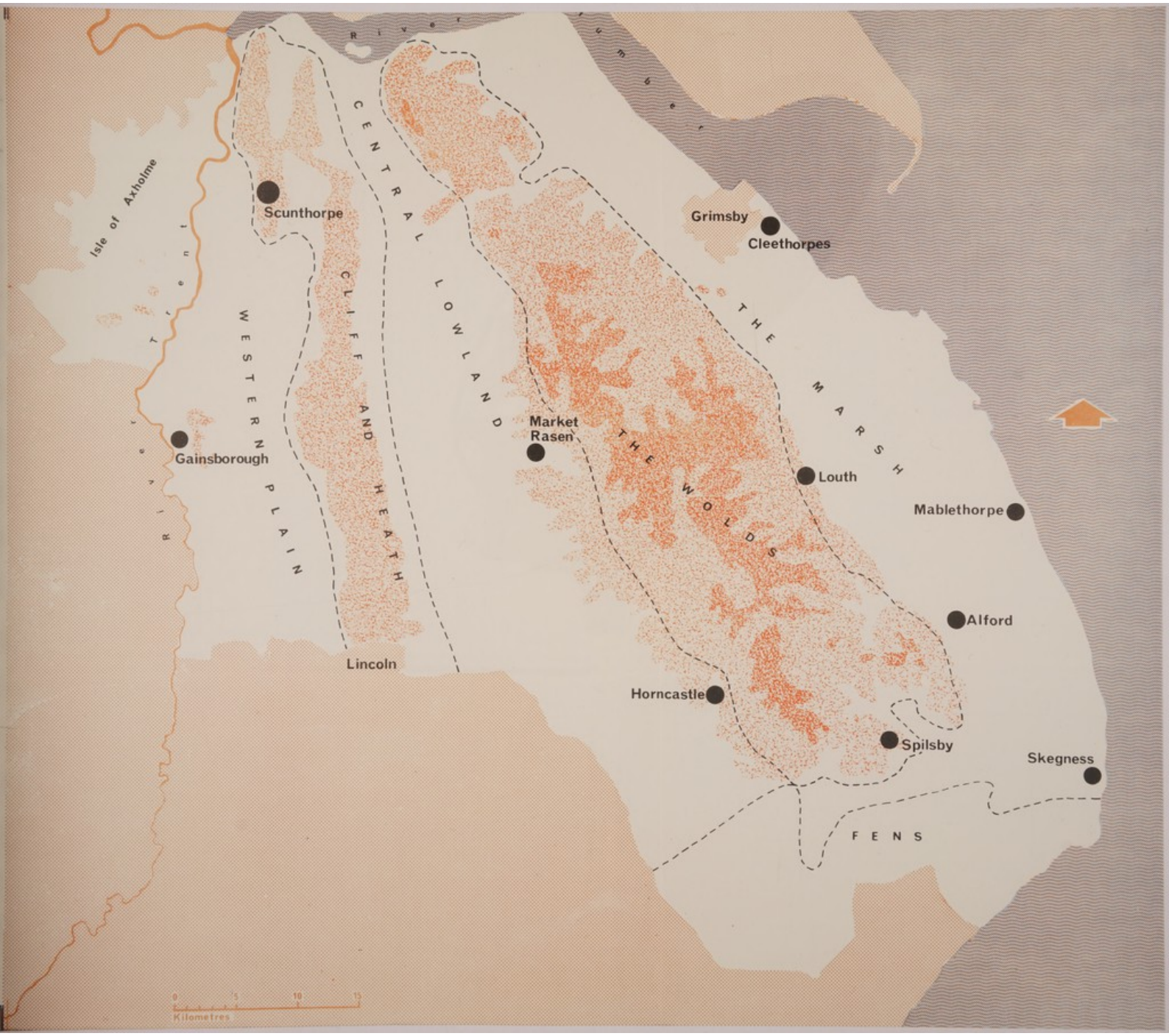
Maps

1. NATURAL REGIONS

Land over 300 Feet 

Land over 100 Feet 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River Trent
Scunthorpe
Gainsborough
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CLIFF AND HEATH
CENTRAL LOWLAND
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THE WOLDS
Grimsby
Cleethorpes
THE MARSH
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Mablethorpe
Alford
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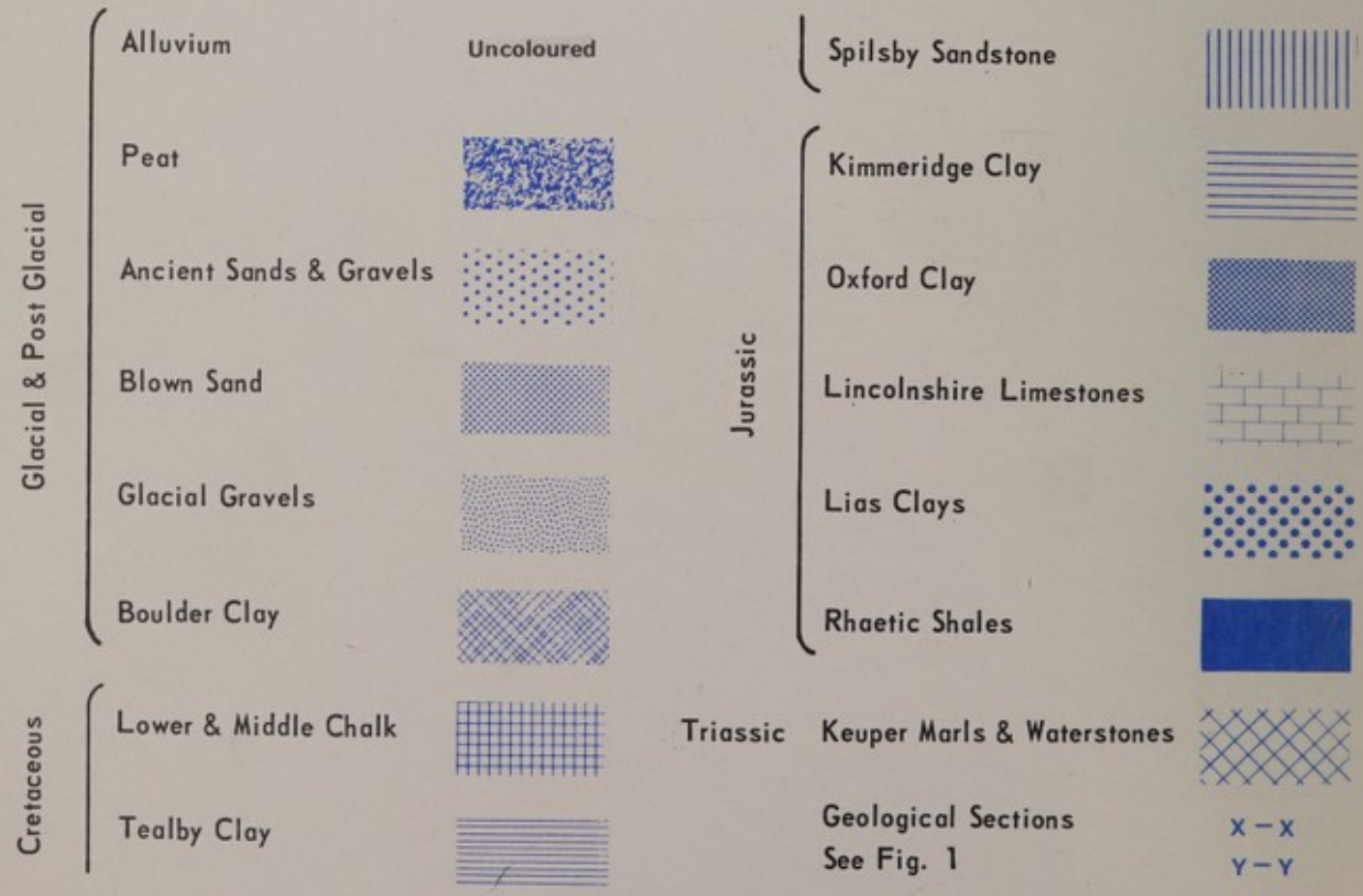
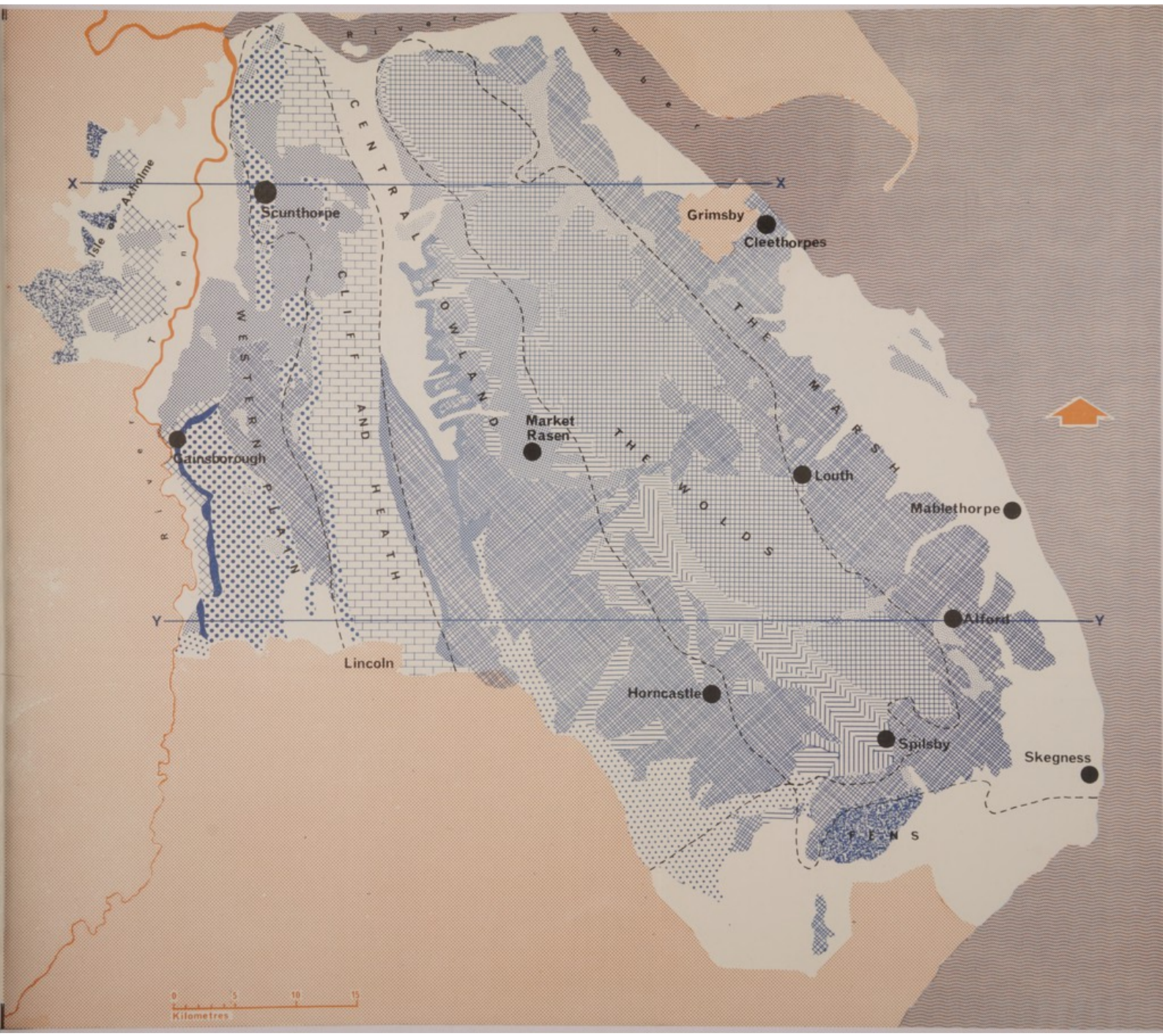
2. GEOLOGY Including Superficial Deposits

2. GEOLOGY Including Superficial Deposits

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CLIFF AND HEATH
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Horncastle
Spilsby
Skegness
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River Trent
River Ouse
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Kilometres

3. SOILS

Predominant Soil Type

Brown Calcareous Soils (including Rendzinas)

Calcareous Gleys

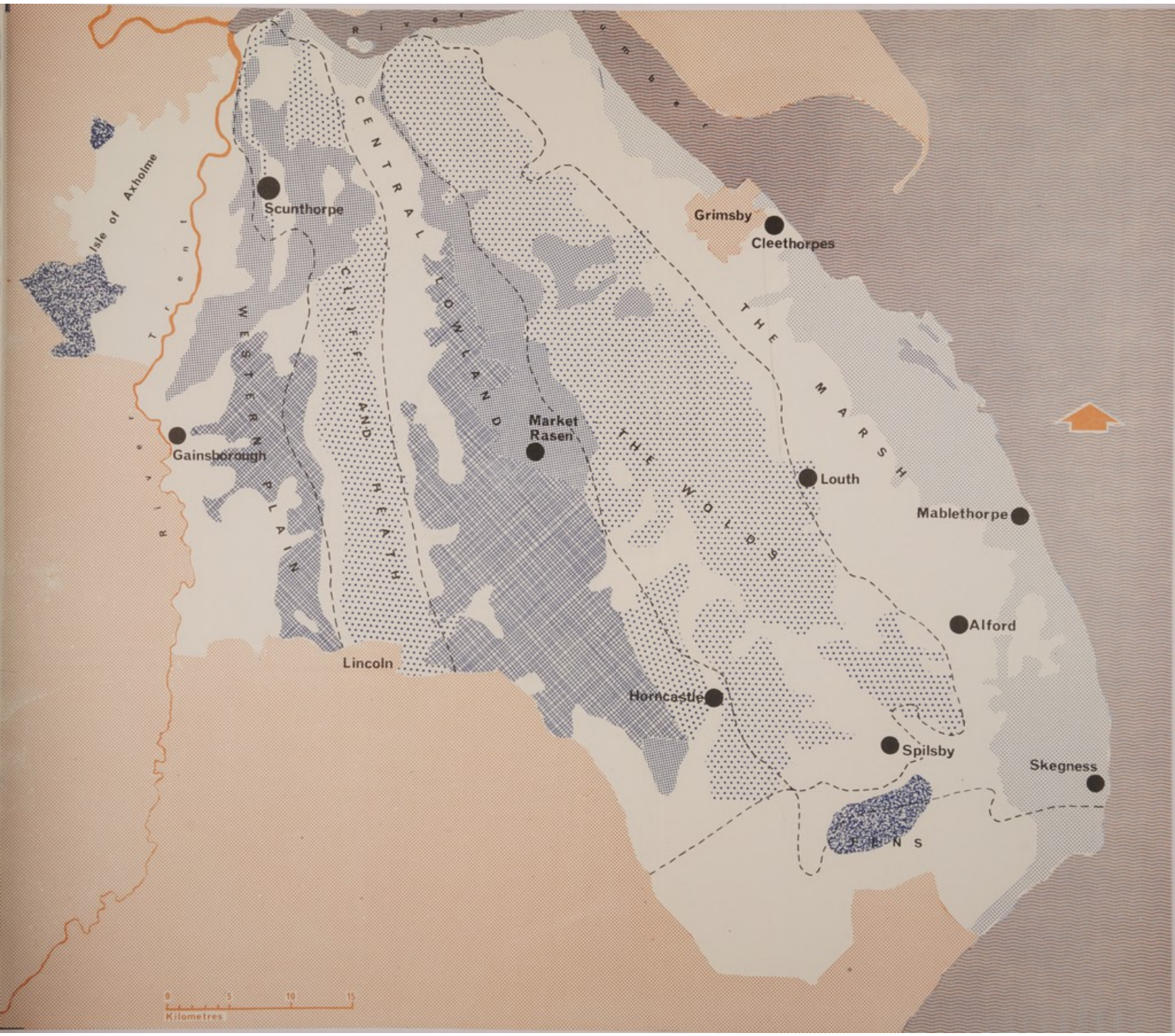
Brown Earths

Uncoloured

Non Calcareous Gleys

Podzols

Peaty Soils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THE MARSH
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Alford
Horncastle
Spilsby
Skegness
FENS
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Kilometres

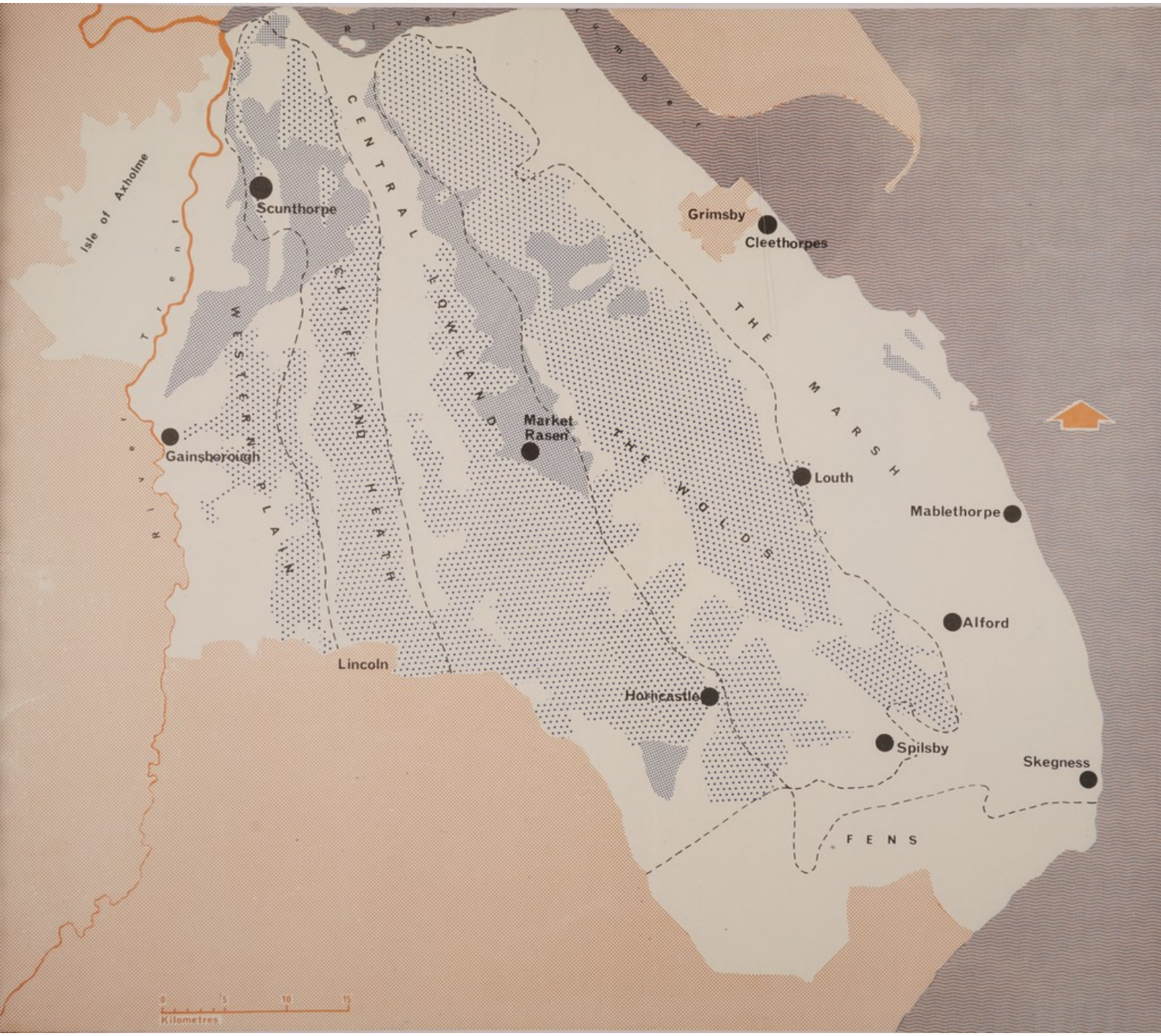
4. SOIL REACTION

Predominant Soil Reaction

Strongly Acid 

Neutral to Moderately Acid **Uncoloured**

Neutral to Alkaline (Calcareous) 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THE MARSH
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Market Rasen
THE WOLDS
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Horncastle
Spilsby
Skegness
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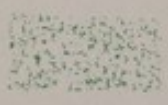
Kilometres

5. PERMANENT PASTURE AND ROUGH GRAZING—1956

5. PERMANENT PASTURE AND ROUGH GRAZING—1966

Land under Grass (by Parish)

%	
Over 60	
40 to 60	
20 to 40	
0 to 20	Uncoloured


River Trent
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Lincoln
Market Rasen
THE WOLDS
Grimsby
Cleethorpes
THE MARSH
Louth
Mablethorpe
Alford
Horncastle
Spilsby
Skegness
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0 5 10 15
Kilometres

6. NATURAL AND SEMI-NATURAL VEGETATION
Principal Areas

6. NATURAL AND SEMI–NATURAL VEGETATION Principal Areas

Woodland
(including commercial plantations)

Grassland  g

Heathland h

Wetland w

Sand-dune d

Salt-marsh s

Still water ▲

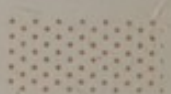
Rivers & Streams »»

"Protected" Road Verges — —

Predominant Soil Reaction

Strongly Acid 

Neutral to Moderately Acid Uncoloured

Neutral to Alkaline
(Calcareous) 

Numbers Refer to Text


Isle of Axholme
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Gainsborough
Market Rasen
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Grimsby
Cleethorpes
Louth
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Alford
Horncastle
Spilsby
Skegness
CENTRAL LOWLAND
WESTERN PLAIN
GLEY AND HEATH
THE WOLDS
THE MARSH
FENS
River Trent
River Ancholme
Kilometres

7. SCHEDULED SITES OF SCIENTIFIC IMPORTANCE

7. SCHEDULED SITES OF SCIENTIFIC IMPORTANCE

Site of Special Scientific Interest – Biological

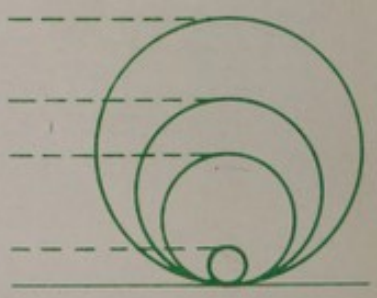
Site of Special Scientific Interest – Geological

Local Nature Reserve LNR

National Nature Reserve NNR

Lincolnshire Trust Reserve TR

Hectares



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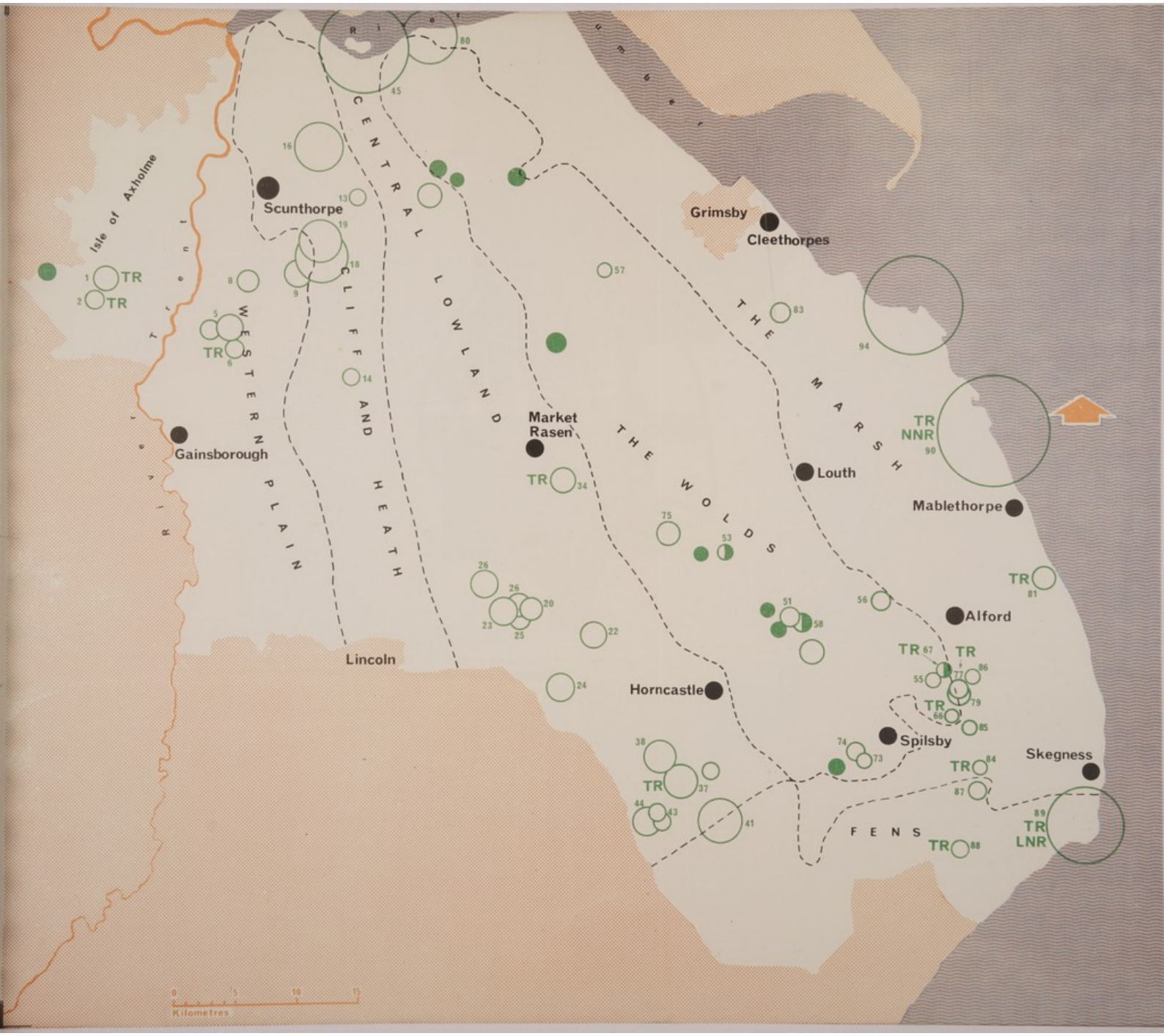
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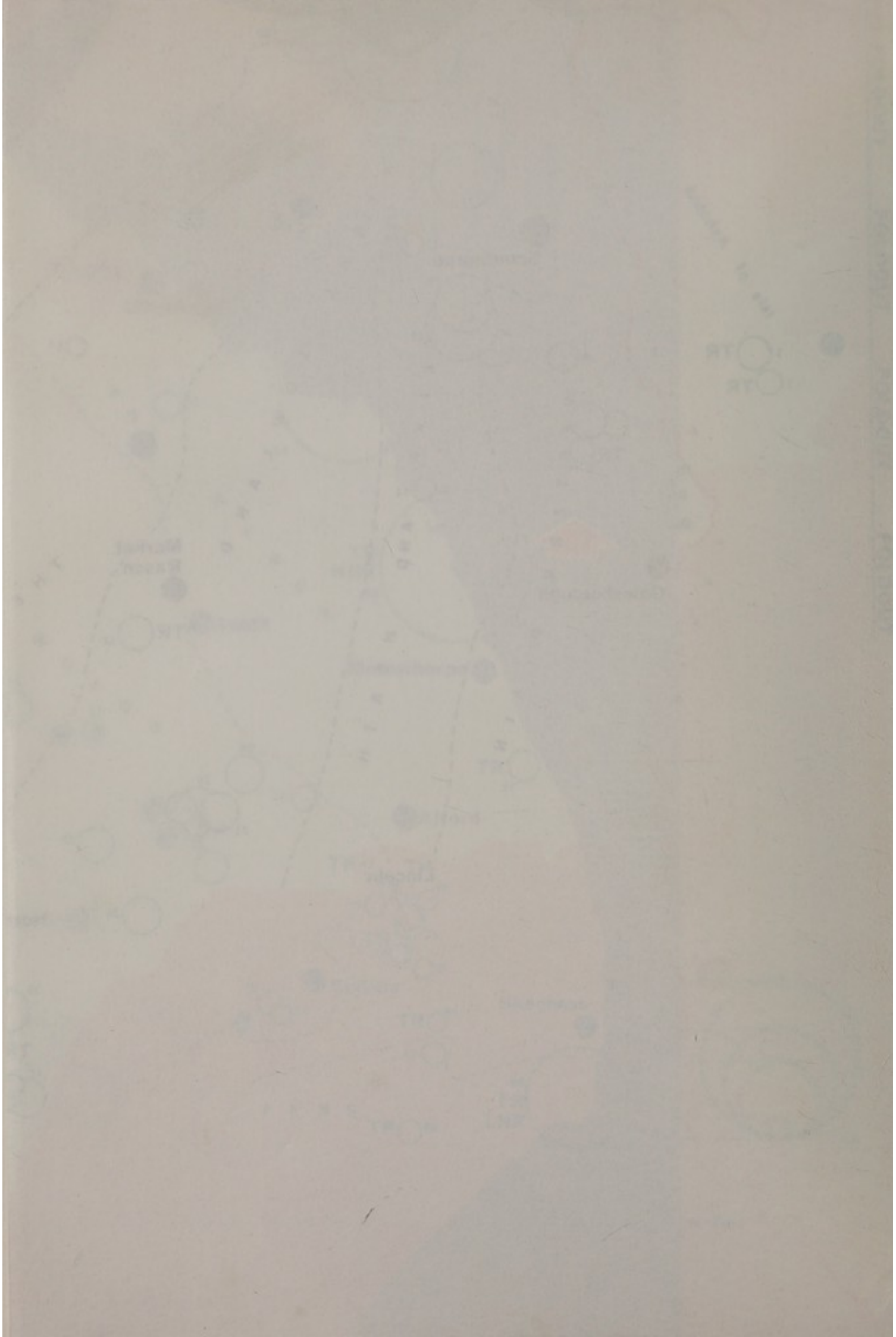

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