A NOTE ON THE SERIES

These maps of Great Britain are produced in two sheets, are on the Transverse Mercator Projection, and carry the new National Grid lines at ten kilometre intervals.

The series was initiated at the suggestion of the Advisory Maps Committee of the Ministry of Works and Planning (now the Ministry of Housing and Local Government) whose members included representatives of the British Association National Atlas Committee.

The planning maps already published or in preparation on this scale have been sponsored by the Ministry of Housing and Local Government and the Department of Health for Scotland and form a related series depicting the primary physical, economic, human and social facts concerning the country as a whole. They are listed within. For convenience of reference, maps prepared independently by the Ministry of Agriculture, the Geological Survey and by research organisations such as the Land Utilisation Survey are included in the list overleaf.

The series will be found valuable not only by those concerned with planning, but by all who wish to see in convenient form essential facts about Britain as a whole. They should be invaluable to schools, business men, and administrators, and constitute the nucleus of a National Atlas.

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Published by the Ordnance Survey on a Scale of 1:625,000 or about 10 miles to one inch

Explanatory Texts

This series of Texts is issued by the Ministry of Housing and Local Government and the Department of Health for Scotland to assist in the interpretation of certain of the maps in this series

No. 8

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VEGETATION: RECONNAISSANCE SURVEY OF SCOTLAND

SCALE 1: 625,000
(about Ten Miles to One Inch)

WITH THE NATIONAL GRID

SHEET 1

Scotland and England—north of Kendal

Published in colour

by The Director-General, Ordnance Survey

Introduction

THIS Explanatory Text deals with the main, Scottish, portion of the Map in the following six aspects: (I) the purpose, origins and "relative reliability" of the Map; (II) the fundamental boundaries and regional divisions of Scotland according to their prevailing vegetation types or plant communities, with (III) brief lists of plant names; (IV) the interpretation of the Map, by location of given physical factors (as in Figure 1), i.e., by the correlation with relief, rainfall and other significant distributions shown on the Planning Maps, by the detailed study of Topographic Maps, and by field observation; (V) modification of vegetation by prolonged uses (Figure 2); and (VI) the need for vegetation surveys. This text is by Arthur Geddes, D. es L., Ph.D., University of Edinburgh. It concludes with a list of References.

The portion of the Map covering England north of Kendal was compiled by T. E. Williams, B.Sc., from Rough Grazing Types in Sheet 1 of "Vegetation: The Grasslands of England and Wales", a survey directed by Sir R. G. Stapledon, which is dealt with in Explanatory Text No. 5.

(I) THE MAP

As indicated on the Map by the title, by the explanatory note and by the inset map of relative reliability, this Map was compiled "to show the present state of knowledge" and also to assist the renewal of systematic vegetation surveys. The first Botanical Surveys were made by the brothers Smith from Edinburgh's Outlook Tower and the University College, Dundee, by methods taught by Patrick Geddes and by Charles Flahault, Montpellier (Smith, R., 1900, Smith, W. G., 1904 and

1905)*. Their maps were incorporated in a reconnaissance map by M. E. Hardy (1905; and 1906*). In this tradition later mapping was done by C. B. Crampton (1911), by Hardy and A. Geddes (1936*, and revised 1955) and J. W. Watson (1939)*, and on intensive and extensive lines by E. Wyllie Fenton (to 1951-52). As a geographer concerned with the best use of the nation's land, Professor L. Dudley Stamp asked the present writer, who had habitually used the published maps in the hills, to co-operate in the revision, recompilation and extension of these and of manuscript maps to cover Scotland. Professor Stamp supervised the redrawing of the Map by Miss K. M. Clark. Preliminary explanatory notes accompanying line versions of the Map were published by L. D. Stamp, *The Land of Britain, its Use and Misuse* (1948) and A. Geddes, *The Isle of Lewis* (1955), with references.

Nearly three-quarters of Scotland's land surface consists of Rough Pastures, that is of mountains and moors used for rough grazing and deer forest with a margin of poorest permanent grass, as against the arable and better permanent grass. This Map and Text are offered as a geographical contribution to their systematic survey. In course of our search for surveys, we found that useful maps had been destroyed for lack of co-ordinated use and publication. Fortunately further surveys are proceeding. This Text defines the facts shown on the Map and endeavours to assist its interpretation for present use and further progress.

(II) SCOTTISH ROUGH PASTURES AND THEIR MAIN DIVISIONS

A. RELIEF, CLIMATE AND THE BOUNDARY

From the narrow, well-cultivated Mid-Lowland of Scotland—less than fifty miles across—there rise to south the hill-country of the Southern Uplands, to north and west the Highlands and Isles, extending 400 miles from Zetland to Kintyre. The Southern Uplands are fringed by fertile coastal lowlands, as are the Highlands on the east. But to west the serrated Highland peaks and ridges finger out to rocky capes, fringed by isles, and are divided by deep glens and straths, by sea-lochs, sounds or straits. To NNE. lie the lowland isles of Orkney and the cliffed isles of the Northmen's " Heightland ", Shetland or Zetland today. Upon the many-peaked " Ridge of Scotland "—Drum-Alban, stretching from Ben Lomond through Ben Nevis to Ben More of Assynt in the far north—the moist Atlantic winds have poured down rain and snow, Ben Nevis (4,406 ft.) receiving 160 ins., Fort William at its feet, nearly 80 ins. To lee of Drum-Alban the rainfall lessens toward the Lowlands where it is but little augmented from the North Sea (Edinburgh, 25 ins.).

On the smoother, sunnier east, the length of the growing season for crops and grass has led the plough up the marginal slopes bounded by the head-dyke at 800 to 1,100 or 1,200 ft., typically about 900 ft. This head-dyke marks the balance between factors favouring or resisting the plough. Beyond the head-dyke fringing Central Scotland, and the coastal lowlands of the south and east, extend continuously the almost unimproved pastures with their varied moors, woodlands, peat-mosses and rocky ridges distinguished on the Map.

B. THE HIGHLANDS

Highland vegetation is of two main regional types, the eastern and western, together with five main tracts of peaty moor and moss. East of a line from Stirling to Inverness, true heaths or Heather Moors of heather (ling) predominate, as they do from north of the Cromarty Firth and Ben Wyvis and the heights around the Dornoch Firth to the border of Caithness. Intermingled with the Heather Moors tracts of relatively " Dry " Grass Moors with bent (*Agrostis*) and mat grass (*Nardus*) lie inland from the Beauly Firth and Dingwall and from Stonehaven. [NOTE.—The English name for a plant is used with the Latin name (in brackets) the first time; and a Latin name recently superseded is followed by the new name, thus: (*Scirpus/Trichophorum*), in full (*Scirpus caespitosus/Trichophorum caespitosum*).]

To the west of the true heather moors, throughout most of the moister Western Highlands, from Gairloch and Loch Torridon southward to Kintyre, Wet " Grass " (or Sedge) Moors predominate on the lower slopes. They show a wide range of variation in which, intermixed with much heather and with other heaths, are found sedges, such as deer's hair sedge, the so-called deer " grass " (*Scirpus/Trichophorum*); purple moor grass (*Molinia*), with bent (*Agrostis*) and fescue (*Festuca*) in favoured spots, often invaded by bracken fern (*Pteris/Pteridium*). Intermixed or above these are found "Acid or Mountain Grasslands " in which, together with the above genera of heath, grass and sedge, mat grass (*Nardus*) is important, while bracken is rather less widespread and fades out about 1,000 to 1,200 ft. In the absence of adequate surveys in the west, following Hardy (1905), the 1,000 ft. contour was followed as a boundary. The three types, the " Dry " Grass Moors, Wet " Grass " Moors and Acid or Mountain Grasslands are discussed later. At about 2,500 ft. Sub-Alpine Moors with berry plants and " grasses " may be reached; and these lead to the Arctic-Alpine vegetation of the summits.

Inset into the Highlands are three desolate tracts of " Peat Moors, Mosses and Bogs ", in which sedges such as deer grass are dominant, with heather on Peat Moors. Both are mixed with bog moss (*Sphagnum*) on true Peat Moss and absent in bogs which produce bog moss and cotton " grass " or bog cotton (*Eriophorum*):

(1) Probably the greatest of these peat-covered tracts occupies much of the interior of Sutherland, in a great equilateral triangle broken especially around Loch Eriboll. Its base lies along the north coast between Cape Wrath and the Caithness border, about the upper Thurso Water, while its most southerly point approaches Strath Brora.

(2) The best known is Rannoch Moor, far to the south.

(3) Only twenty miles further to the south-west, at the foot of high Ben Cruachan, the levels and hollows of the 1,000 ft. plateaus of Lorne and Mid-Argyll carry a third expanse, patchier and intermixed with Wet " Grass " Moors.

Marginal to the Highlands are (*a*) the high-lying, drier and more dissected plateau peat moors between Lochnagar and Stonehaven, and (*b*) the intermittent stretches of low-lying, drier peat moor, pressed upon by the reclaiming farmer or the forester, which recur from Orkney, Caithness and the Black Isle to Buchan and the coast round Peterhead. Thus to north of the " Highland boundary line ", there lie five chief tracts with much peat moor or moss, in addition to which are the peat moors and mosses of Lewis in the Outer Hebrides.

Finally, intermixed with all these pastoral plant communities, strips of woodland have survived below 1,200 feet and plantations are extending.

Summing up, true heaths or heather moors dominate the eastern Highlands; while moors of sedge and grasses with heather, usually boggy, leading up to mountain pastures of mixed flora, dominate in the west. Intermixed with these lie some five tracts of peat moor and moss.

C. LOWLAND HILLS AND SOUTHERN UPLANDS

The Field Surveys from the eastern Grampians south to Tweeddale and Strathclyde (by the brothers Smith 1900 and MS. c. 1918) have been simplified as " Dry " Grass Moors rising to Acid Grasslands, and are topped, where plateau-surfaces are widespread, by high Peat Moors, typically with haggs in course of erosion from which downwashing impoverishes the slopes below, favouring mat grass (*Nardus*). Where the crest ridges

*Years of publication of maps, with coloured maps to 1936 printed by John Bartholomew, in Scottish Geographical Magazine. For E. Wyllie Fenton see S.G.M., *passim*, and, for 1951-52-53, Bulletins 4, 5 and 7 of Edinburgh School of Agriculture.

are steep and the rocks acid, Heather Moor may prevail; and it recurs locally on freely drained spurs and slopes where burning has been slight—bilberry or " blaeberry " (*Vaccinium myrtillus*) forming a vanguard in its re-advance upon " Dry " Grass Moors. Patches of almost level upland between 400 and 1,100 ft. are shown as " Dry " Grass Moor, or as Peat Moss where both natural and artificial drainage have been lacking. The patches of Woodland shown at lower altitudes are mainly plantations of deciduous species in course of replacement by spruces and other conifers.

Between the cliffed capes, fringed with turf and maritime herbage, and the cultivated raised beaches, lie Sand Dunes and Links, smoothing the bays, joining adjacent islets or narrowing estuaries by sand-spurs, as Budden Ness at the Tay's mouth or those around the Moray Firth. The contrasted sites of cliffed cape and sandy bay are almost unmistakable on the Map, but in the first edition the maritime Dunes and Links (D) were not distinguished from the maritime Cliffs, which are now shown as (C): e.g., for the cliffs west of St. Abb's Head; for Buchan Ness, Troup Head, much of the coast of Lewis and parts of the Solway Firth.

Further south lies the main mass of the Southern Uplands. From fertile coastland with raised beaches the Dales reach in through gently rolling lowland to hill waters and occasional lochs, overlooked by slopes less steep and concave than those of the more markedly glaciated, U-shaped straths and glens of the Highlands. The valley sides rise to rolling hills or rounded plateau tops; sharp " edges " and crags with corries are comparatively few. All that could be attempted are a few broad distinctions notably that found on either side of a line from the Solway following up the River Annan and over from Moffat to Carstairs and the Clyde: eastward to the Cheviots " Dry " Grass Moors prevail, while westward, Acid Grasslands merge into Wet " Grass " Moors, with a tendency to Peat Moors and Mosses at ill-drained low levels, as in Wigtownshire.

(III) THE PLANT COMMUNITIES

(See Key to Map)

The following is an attempt to summarise the chief components of the plant communities mapped. The dominant species or genera are placed first. A species dominant in one community may be fairly common (and therefore listed) in another, but be rare (and not listed) in a third. Sub-types due to site are more fully discussed later.

Types 1 and 2. ARCTIC-ALPINE VEGEGATION OF SUMMITS AND SUB-ALPINE MOORS (BILBERRY)

The broad mountain summits of the Eastern Highlands, with their high shoulders, are plateau-topped and table-like, e.g., *Ben-a-Bhuird* in the Cairngorms, " Mountain of the Table or Board "; they contrast with the narrow ridge summits and the steeps of the more dissected Western Highlands. Hence the first two types cover a wide surface only in the east. The first type passes rapidly into the second with descent to slopes which may remain covered with drifted snow until late spring when the windswept summits above are bare and exposed. The Arctic-Alpine plants are often thinly spaced amid rock and gravel, with fine turf of viviparous sheep's fescue on saddles, while the plants of the Sub-Alpine Moors frequently grow in cushions, aflower in summer. Beside the dominants, " alpine " flowering plants may grow in sheltered nooks and crannies. Owing to altitude and poleward latitude, these two types characterise the Highlands rather than the Southern Uplands.

1. ARCTIC-ALPINE VEGETATION OF SUMMITS

Lichens (*Cladonia spp.*)
Woolly fringe moss (*Rhacomitrium lanuginosum*)
Sedge (*Carex rigida/C. bigelowii*)
Club mosses (*Lycopodium selago, L. alpinum*)

Rush (*Juncus trifidus*)
Sheep's fescue grass (*Festuca ovina, var. vivipara/F. vivipara*)
Dwarf willow (*Salix herbacea*)
Crowberry (*Empetrum nigrum/E. hermaphroditum*)
Sea-pink (*Armeria maritima*)
Alpine lady's mantle (*Alchemilla alpina*)

2. SUB-ALPINE MOORS

Lady's mantle
Saxifrage (*Saxifraga oppositifolia*)
Bedstraw (*Galium saxatile*)
Crowberry
Bilberry or blaeberry (*Vaccinium myrtillus*)
Bearberry (*Arctostaphylos uva-ursi*)
Cowberry (*Vaccinium vitis-idaea*)
Mat grass (*Nardus stricta*)
Mosses (*Hypnum spp.*)

3. PEAT MOORS, PEAT MOSSES AND BOGS, WITH PEAT 3 FEET THICK OR MORE, OR HAGGS

Tracts of Peat Moss and Peat Moor dominate lower summit plateaus in the Eastern Highlands and the Southern Uplands at 3,000 to 2,000 ft., although they are still more widespread at lower levels down to raised beaches 50 ft. above sea level. Throughout Scotland, the terms " peat moor, moss and bog " denote an increase in wetness underfoot, although locally a Moss is where the peat is deep enough to be cut, yet not too boggy. Peat has accumulated where poor drainage, low temperatures and acidity have inhibited the soil activity by which dead vegetation can be rotted and absorbed. As a thin covering, peat is far more extensive than mapped here. It may be smooth and still accumulating, or broken up by dissection into heathery-topped peat-haggs divided by squelching channels of bare peat on slopes or near the edges of uplands and plateaus. Broadly, drier peats of the east are fibrous and brown ; those of the west darker and more colloidal.

In parts of the Mid-Lowland between 400 and 1,100 ft., an excessively gentle slope and the slightly hummocky surface of the boulder clay so impede drainage as to induce an acid soil underlain by a hard pan and overgrown with peat moss (Figure 1).

Deer sedge, deer's hair " grass ", or " deer grass " (*Scirpus caespitosus/Trichophorum caespitosum*)
Cotton " grass " or bog cotton (*Eriophorum sp.*)
Heather or ling (*Calluna vulgaris*)
Bog asphodel (*Narthecium ossifragum*)
Bog myrtle or sweet gale (*Myrica gale*)
Bog moss (*Sphagnum spp.*)

4. WET " GRASS " MOORS

Bordering upon the damp Peat Moors of the west are the sloping Wet " Grass " Moors with purple-flowered moor grass (*Molinia*), deer grass and heather, often inextricably mixed. Very locally, on a damp alluvial fan, one may find a pure stand of moor grass. On hillsides in the closely grazed flushes or " well-eyes ", green " bent " may be found invaded by bracken. In the wide open hillfoot hollows, the pale pink cross-leaved heath and bog myrtle appear with the moor grass rather than the heather, which thickens where the slopes are steep and approach an edge with rock outcrops, fringed by crimson bell heath. The characteristic hillside patchwork of younger, greener vegetation is due to more recent burning of old " heather " (etc.) for sheep grazing. Severe burning of the heather may induce the dominance of bracken, smothering the hillsides and ruining the better hill pastures. As far north as Loch Torridon open oak woodlands still mantle the foot of the steeper hillsides of the west, but native woodland of pine is rare. In the stream gorges opening on the glens grow oak, ash and holly, with hazel underwood ; further up, rowan (mountain ash) clings to steep stream banks up to 1,000 ft. or more.

Although they are not differently coloured on the Map, a distinction must be drawn between the drier

form of this Community on the lower coastal tracts of the northwest and southwest Highlands and Isles, and the damper form inland on the rain-soaked mountain slopes. The difference in vegetation between the coastal tract of Common Grazings of the Crofters, or hereditary Small-holders, and the wild, almost treeless Deer Forests of the mountains is important ; it is examined in Section V with map (Figure 2).

The western half of the Southern Uplands is shown as composed of Wet " Grass " Moors and Acid Grasslands in presumed similar proportion while three moorland masses northwest, west and southwest of Glasgow are classed as Wet " Grass " Moor with Peat Moors on plateau surfaces and Peat Moors, Mosses or Bogs beyond the hillfoot.

Purple moor grass (*Molinia coerulea*)
Heather
Deer grass and other sedges (*Scirpus/Trichophorum and Carex spp.*)
Heath rush (*Juncus squarrosus*)
Wood rush (*Luzula sylvatica*)
Locally, bent (*Agrostis*) and fescue (*Festuca*) with bracken (*Pteris aquilina/Pteridium aquilinum*) below 800 ft.
Mat grass (*Nardus*)
Cross-leaved heath (*Erica tetralix*)
Crimson bell heather (*Erica cinerea*)

Open woodland of oak (*Quercus spp.*) with underwood of grasses and flowering plants, or of birch (*Betula*) with underwood or bracken. Also ash (*Fraxinus*), holly (*Ilex*), hazel (*Corylus*) and rowan (*Sorbus*).

5. " DRY " GRASS MOORS

Merging with the Wet " Grass " Moors of the west come the true grass moors of the east, dominated by the coarse and tufty mat grass ; its grey-buff changes to pale green in summer, as the young blades struggle through. Where the heather has been heavily burned, mat grass has gained. Thus, typically, heather is absent, but, often preceded by bilberry, it may re-advance on the mat grass if left long unburned. Locally, bracken may invade well-drained but moistened slopes, ousting bent, etc. " Dry " grass moors dominate the eastern Southern Uplands.

Mat grass, with bent and fescue, locally with purple moor grass
Common rush (*Juncus*)
Bilberry
Heather
Bracken below 1,000 ft.
Woodland of birch or scattered Scots pine (*Pinus sylvestris*) with juniper (*Juniperus*)

6. HEATHER MOORS (Heather dominant)

In the true heather moors of the Eastern Highlands, the growth of heather is continuous and almost unbroken over hill slopes and wide rolling moors, often with an undercover of woolly fringe moss, a few flowering plants peeping through in summer. It is found on the gravelly river terraces of the great eastern rivers, such as the Dee, Spey and Garry, and on the slopes above up to the Sub-Alpine Moors. Patches of berry bushes and of the other heaths, and even grass patches, occur. Heather flourishes under open pinewoods and allows of natural regeneration, nursing, rather than smothering, the seedlings. Mixed open woodlands of pine and juniper are characteristic, and, secondarily, of birch.

Heather
Woolly fringe moss or tormentil (*Potentilla erecta*)
Bilberry
Mat grass, wavy hair grass (*Deschampsia flexuosa*), etc., bracken
Cowberry
Heaths
Woodland of pine or birch and juniper

7. ACID GRASSLANDS

A great variety of grassland types with tracts of grass heather sedge are covered by this type. The eastern areas, mapped by R. and W. G. Smith, show the boundary of transition between these and the heather moors to the east (see Reliability Index Map). The Smith maps also differentiate sub-types in an accurate and significant way, inevitably generalised here, and reference should be made to the published originals. There is a great contrast in appearance and in value as grazing between well-drained slopes in which bent and fescue dominate, as they do in parts of the good hill grazings bordering the heather moors, and the poorer " Dry " Grass Moors of the east or the high-lying mountain pastures or Acid Grasslands of the west (as generalised by Hardy) much intermixed with mat grass, deer grass sedge and heather.

Bent, fescue and wavy hair grass, or mat grass with " sedges "
Herbs
Heather
Bracken below 1,000 ft.

8. SAND DUNES, LINKS AND OTHER COASTAL PLANT COMMUNITIES

Coastal plant communities range from the flowery, dry heaths and short turf of cliff capes to the sandy bays with dunes, imperfectly held from blowing by the wiry grass root stems, grassy " links " of short turf as at St. Andrews, or valuable turf (of fescue) on mud flats covered at high tides and fringed by salt marshes, as on the Solway, but mainly on its southern shore, note (S). The storm beach links or *machairs* of shell sand on the western bays of the Outer Hebrides are self-sown with a variety of clovers and flowering plants or turf between periodical, communal cultivation for potatoes, oats or even rye.

On Sand Dunes (D): Marram grass (*Ammophila arenaria*)
Sand couch grass (*Agropyron junceiforme*)
On Tidal Turf (S): Fescue (*Festuca rubra, var. arenaria*)
On Cliff Tops (C): Short turf and sea pink; or crimson bell heath and heather.

9. IMPROVED LAND

This, the predominant Lowland land use, covers a series of types descending as follows:—

Enclosed land which has reverted to rough pasture (classed as Rough Pastures on the Map).
Long-brake grassland, of short growing period; shelter belts of trees.
Mixed farmland, with a general increase of arable eastward, and locally downhill, unless prohibited by undrainable land.
Permanent grass of mansion parks with wooded shelter.
Best arable and market garden zone on raised beaches stepped from 150 or 100 ft. to the sea shore, and around Urban Areas.

10. CHIEF WOODLAND AREAS

Such is the rapidity of replacement of natural woodland of oak, Scots pine and even birch by the plantation of spruces and other conifers that the valuable distinction between these three, made by the brothers Smith and by Hardy, has had to be dropped, to our regret. New plantations have been added since this Map was drawn. The greatest arboreal forests of Scotland extend up the Dee and Spey, reaching 1,750 ft., formerly more, and these are still to some extent descendants of the native Scots pine, often by natural regeneration, and they still cling to predominantly northern exposures. On the fluvio-glacial gravels poured from the Braes or hill country around the Laich or plain of Moray, the former pinewoods or heather moors have been re-afforested both with pine and spruces as have the Culbin Sands of eastern Nairn. The glens fingering back from the Moray Firth still bear old woods of pine on the shadowed northern exposure, replaced by open birch on " Grass " Moors

on the sunnier, where the hill sheep farmers' fires have driven out the pine. In the steeper valley and loch-sides of the West Highlands, as along upper Loch Lomond and many western sea lochs, oakwoods still predominate. There too, however, the birch marks a stage towards open grazing. Alders occupy the dampest sites, ashes well-flushed slopes, while in gorges holly may flourish at low levels and rowans to 2,000 ft.

Scots pine
Oaks: durmast oak (*Quercus sessiliflora*/*Q. petraea*) or lowland oak (*Q. pedunculata*/*Q. robur*)
Birch; red (*Betula pubescens*) and silver (*B. pendula*/*B. verrucosa*)
Alder (*Alnus glutinosa*)
Ash (*Fraxinus excelsior*); underwood of hazel. Rowan or mountain ash (*Sorbus aucuparia*)

In the lowland woods gracing the " policies " or grounds of mansion houses, mixed deciduous woods still predominate, with beech (*Fagus sylvatica*) on lighter soils, frequently unmixed.

From the plants at his feet one looks further afield to recognise their sub-communities, each in its habitat. An artificial patchwork is typical of heathery moors regularly burned over with a short rotation, from the black, then the light green, of recent burning to the darker tints of mature growth. Yet from high to low, the landforms of crest and steep, slope and flat, hump, cleft or hollow, have each their sub-community, recognisable by its seasonal colour. Change is anxiously watched for by the grazier at the winter's end. Change in leaf colour occurs even among the evergreens, though the greatest changes occur among deciduous plants and certain grasses. Thus, the evergreen berry plants contrast with the bilberry, whose bare twigs reveal mossy grass in winter but in spring turn to translucent green, sobering in summer and changing to vivid tints in autumn. Of the grasses, mat grass is most apt to turn grey-white in early autumn; it is sometimes known as " white bent ". The " bloom " of flowering helps the recognition not only of the heaths but in varying degree of every tree, herb and grass. Colour reveals the sub-community fitted to each landform.

(IV) INTERPRETATION OF THE MAP BY LOCATION OF THE PHYSICAL FACTORS

For the first time a series of national maps of Britain is appearing to the same " ten mile " scale, thereby permitting broad comparisons of the location of inter-related factors as never before. The interlocking nature of these ten plant communities is evident and is due to a number of common factors of climate, relief, rock and soils.

For comparisons of any two maps the uniform grid is an immediate aid, and by the use of a glass-topped tracing table or even a picture frame, lit from below, light can penetrate two maps, with precise location of any two related geographical distributions, e.g., of rainfall compared with altitude. When the Vegetation Map is thus superimposed on another map of the series, the comparison is illuminating. Yet the differences in plant communities and in their variants call for recognition on the ground and for interpretation first through the physical factors, and then through those of Land Utilisation (Section V).

ALTITUDE AND LANDFORMS

The Highlands were sculptured by the erosive power of narrow running streams and in the Ice Age by slow-flowing, wide and weighty ice streams from great stepped plateaus. Thus, like tread and rise in a worn staircase, a few relatively smooth and gently sloping surfaces recur at different elevations, separated by crags, steeps or steep slopes, and each bears its own plant community. For the Grampian Highlands the following " erosion surfaces " have been recognised:

Grampian summits—high peaks or " Bens ", from 4,400 to 3,500 ft. or less. These dominate the *Grampian main surface*, with rounded " mell " (*meall*), typically at 2,900 to 2,200 ft.; *Grampian lower surface*, 1,600 to 1,300 ft.; and *Grampian valley benches*, at lower elevations. (Fleet, 1936). Higher or separate hills stand out, their summits comparable and no doubt once linked to these surfaces, an isolated Ben and lower *tulach* or " knock " (*cnoc*). In the west heavy precipitation has led to greater dissection by running water and by ice in alternation.

The summit peaks and Bens bear an Arctic-Alpine Community; their shoulders and the " mells " of the Grampian main surface bear Sub-Alpine Moors, passing down to high Heather Moors (with peat on plateaus) or to Acid Grasslands, extending over the Grampian lower surface. Rocky steeps are fringed with bell heath and berries or herbs and the benches are greener. The lowest, gentle slope of strath and glen is mantled with boulder clay, grooved from the green grassy " well spring or flush " down to the rushy hollow or streamlet below; groove and intervening camber bearing the best pasture where moisture is balanced with drainage and forming a zone too frequently invaded by bracken. River terraces may flank the flood plain; they are gravelly to lightsoiled, the latter siting croft or farm. On a flood plain, banks of shifting meanders are aligned with alders and slope back to lush grass and rushes while a gravelly braided reach carries thin grass and ragwort (*Senecio jacobea*) and may be overhung by birch and rowan.

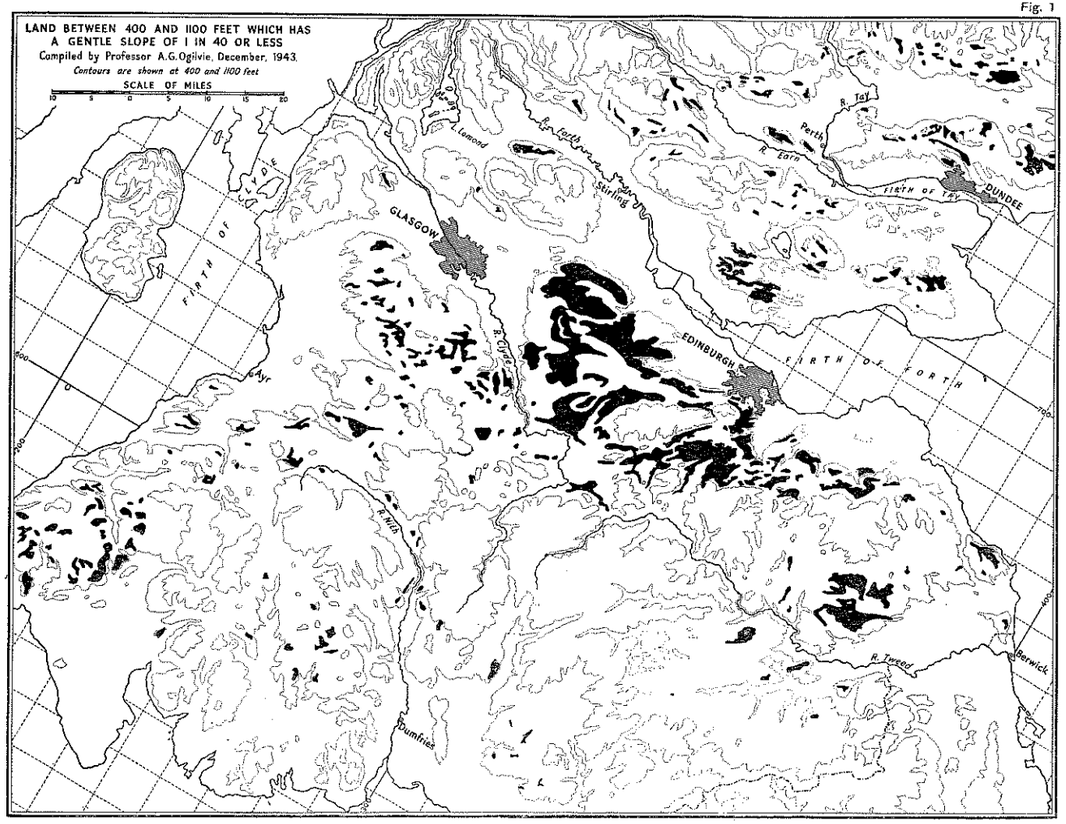
Whether in narrow glen or wider strath, the river's long profile is not a smooth parabola but irregular: reaches with rapids or falls alternate with level reaches and long hollows, often with a loch in process of infilling from upstream by alluvium thrusting out a rushy, alder-lined delta with reeds. Rapid reaches are cut in narrow defiles often thickly wooded as at Killicrankie; while the more level reaches are the wider, as upstream at Blair Atholl. The massive gouging of a valley-glacier's ground moraine widened its valley at the expense of its interlocking spurs, leaving their truncations as blunt or craggy steeps. Thus along a main U-valley craggy " truncated spurs " with trees alternate with gentle, concave slopes, clad with thicker woodland beside the streams, and smoother pasture round a farm or ruined hamlet.

From a main glen, a tree-clad gorge, whose torrent has built out a grassy alluvial cone, may lead back through a hanging valley, marked by green spots round old summer shieldings, to a rocky bowl, the corrie, ice-gouged in the fold of a peak. The shallower, southward corries are more flowered; the northward shady, with abundant ferns among the rocks, often cup a grass-fringed tarn, a corrie lochan. The great eastern straths open upon hillocky terminal moraines, heathery or grassy, with birches. In the western straths, the gravelly river terraces, heathery or planted with spruce, merge with the raised beaches cultivated above the loch-head, " kin-loch ", village.

In the Southern Uplands the dales recall the straths, rather than the glens of the Highlands: their long profiles are smoother, and their formerly interlocking spurs less sharply truncated. They rise to hills with summits at 2,000 to 2,750 ft. Characteristically, their rounded summit plateaus terminate at a gentle edge, the " hilch " (*ch* as in loch), trodden by a contour path from which the shepherd can see up to the crest and down the smooth slopes to head dyke or tributary stream, and which marks a change of soil type and vegetation.

However gentle, relief forms an important distinction of Lowland plant habitat and demands an analysis of elevation and of slope combined. Peat is still widespread on low flats in the Mid-Lowland. While " Carse " land (level tracts of loamy clay at 20 to 30 ft. above sea level) is now almost synonymous with fertility, its derivative meaning, still retained in Welsh, is " bog ". Level peat moors and mosses survive south of the estuary mouth of the Tay (Tents Muir, now afforested), and

Fig. 1



locally at the level of the remnant raised beaches 50 ft. above sea level seawards from Stirling and inland, in Flanders Moss round the Lake of Menteith.

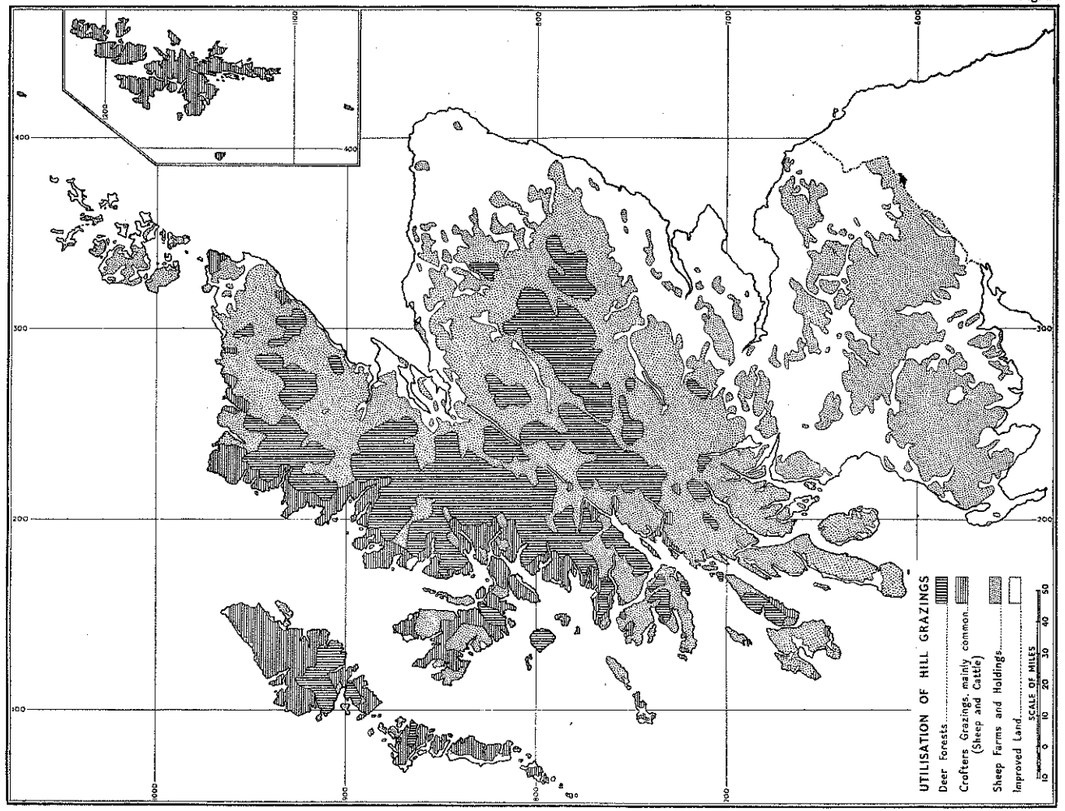
Upwards from the present beach and terraced series of raised beaches, there rises (1) a well-farmed, gentle, lower surface overlooked by a marked slope transitional to (2) a higher surface, which is poorly drained with much Rough Pasture and Peat Moss. The greatest continuous expanses of the higher surface lie between Edinburgh and Glasgow and towards the water parting between Clyde and Tweed, where they rise to 1,000 or 1,100 feet; smaller tracts lie further to southwest, southeast and north (Figure 1). To Professor Alan G. Ogilvie is owed the recognition of these two main, almost planed surfaces, the Lower and the Upper Lowland Peneplanes. Ogilvie had been struck by the rather desolate, ill-drained expanses of upland lying above the cultivated Lowlands and better drained stream-sides, yet still below the cultivated slopes of the hillfoot stock farms. By combining field observations with topographic map measurements of tracts with "a gentle slope of 1 in 40 or less" (2.25 per cent), Ogilvie revised his survey for the planned improvement of these "Debatable Lands" (1943). From this has been drawn Figure 1 which, by help of the Grid, can be sketched upon the Vegetation Map. It can also be compared with the Land Utilisation Map of this series where it corresponds to a patchwork of Rough Pasture transitional to the poorest permanent grass. The mean annual rainfall in the eastern tract is 30 to 40 ins.; in the western it reaches 40 to 60 ins. Where not reclaimed along its "debatable" margin, the eastern tracts of this Upper Peneplane are "Dry" Grass Moor with some peat moor and moss, shading beyond the low Forth-Clyde watershed to Wet "Grass" Moor and Peat Moss.

(V) THE MODIFICATION OF VEGETATION ACCORDING TO PROLONGED USES: HILL SHEEP FARMS, DEER FORESTS AND CROFTERS' GRAZINGS

In Figure 2 are mapped the three main uses of hill grazings. (1) the Hill Sheep Farms cover the rough pastures of the Southern Uplands and most of the South-Western and Eastern Highlands, extending northward to Caithness and to Orkney beyond. They were created toward 1800 and after. While the Cheviot breed need grassy, "white" hill grazing, the Blackface like heathery "black" hills also. (2) In the wilder and more inaccessible mountains of the Highlands are the Deer Forests, intermingled with outlying sheep farms but with a very low density of sheep. They extend over the Cairngorms and central Grampians and across the Great Glen from Ben Nevis northward through wild Drum-Alban almost unbrokenly to Cape Wrath. From the Sound of Mull they are almost continuously fringed along the north-west coast and its lochs by (3) Crofters' Grazings, mostly held as the Commons of Crofting Townships, as they are in Skye and the Outer Hebrides and Zetland. Security of tenure recognised by law from 1886, an all-round way of life on land and sea and a strong community tradition, kept people of the townships together. The Crofters' Grazings are bordered along the southwest coast by smaller sheep farms and by mixed sheep holdings, both having a few cattle.

The Common Grazings are fairly heavily stocked with both cattle and sheep according to a sum or "souming" of stock per crofter, sometimes, however, exceeded. The intensity of grazing diminishes with increasing distance from the homesteads of the township except where shielings survive, as they do in Lewis for summering cattle on distant moors. On the whole, this mixed grazing maintains the pastures. Whereas sheep in grazing tend to select and thereby to eliminate the fine grasses, cattle eat down the coarse, as well as

Fig. 2



the finer herbage. By their heavy hooves, cattle also cut up the coarser herbage and keep down bracken: and their dunging is effective. As against all this, there may be ill-regulated heather burning and inadequate hill drainage by crofters, while if peat is cut carelessly, the top sods over it are thrown down anyhow and pools are left. Turf for thatching, etc., may still be stripped annually from the hard-panned stony soil and rock, leaving it bare or "skinned" round townships, as in western, rural Lewis.

On Hill Sheep Farms there is no removal of turf and little peat cutting. Yet until the recent subsidy encouraged the return of hill cattle, their absence allowed the growth of bracken and this dreaded weed has become the sheep farmers' worst enemy, both on upper and on lower slopes. On the hills over-burning of old heather at the end of the winter also encourages coarse grasses and bracken. Its root stems (rhizomes) containing the previous summer's reserve of starchy plant nutriment lie safe from fire; enriched by the salts from the ashes, the new fronds can shoot up rapidly. Spores may have a better chance of development on the ashes. On lower, flushed and grassy slopes, bracken prevents the effective growth of grass; and covers it up completely through the winter. In summer too, sheep attacked by maggots, lie hidden and may die in a few hours if not found and rescued. The spread of bracken and its menace have not yet been overcome in spite of research and subsidised bracken cutting.

By contrast, deer forests were allowed to run wild. Many were never much more than wilderness, from the "growthy" tracts (*fasach*), surviving on steeps and northern exposures, up to the bare moors and peaks of the "rough-bounds", the March country bounding ancient clan territory or modern county. Forest fires, the cutting of timber and charcoal, and the stripping of oak bark for tanning, reduced the forests of pine and oak in recent history. But except for the occasional blaze on dry heather, little was done to check the growth of open Deer Forest. Particularly as the result of the clearances of crofters from inland glens and straths to the sea board (c. 1780-1820), first cattle grazing declined or ceased inland, then sheep grazing after 1860. Apart from the stark rock faces of the pyramidal mountains carved in Torridonian Sandstone or pre-Cambrian quartzites, coarse unchecked growth characterises the vegetation types of Deer Forests.

The utility of the different Plant Communities may be assessed according to the nutrition value for stock of their dominant species, except that the Heather Moors stand somewhat apart from other Communities in which a mixture of the better species contributes to year-round nutrition. In order of descending value one may list the two better grasses, bent and fescue, interjecting cotton "grass" (in spring), then purple moor grass, heath rush (because winter green), deer "grass" and lastly mat grass. Over-burning of Heather Moors may cause the heather to yield not only to bracken but to mat grass. This in fact is what has happened over this century in the eastern Southern Uplands and in the Eastern Highlands since mapping by the brothers Smith (1900-05) as noted by Fenton (1951-52-53). On Heather Moors, Blackface sheep farming and grouse preserving can be harmonised by judicious burning on a short, ten to fifteen year cycle. The consumption by rabbits of better drained pastures has been enormous. The effects of the epidemic of Myxomatosis have been to permit a far greater growth of turf and of palatable legumes and herbs and the regeneration of natural woodland, and to protect crops, permanent grass and young plantations (F.A.O. 1956).

(VI) VEGETATION SURVEYS AND PLANNING

Surveys of vegetation, by region, district and site are vital to guide national policy and local applications for the best, harmonious uses of our rough grazings,

moors and woodlands, in connection with coastal and lowland life. A simple list of activities suggests the many problems of policy and management which call for co-ordinated planning and practice based on knowledge, on survey. They include grazing and stock-rearing; afforestation; mechanised peat-cutting; catchment control for power and water; sport and fishing with nature conservation; inshore fish farming and seaweed gathering; military training; and recreation. Some of these are conflicting, some complementary, but all are inter-connected. To see how best to tackle each we must foresee how to tackle all together. Here ecology is a clue to an optimum in the interdependence of communities in plants, animals and mankind.

Ecological relationships linking vegetation to grazing and sport have been indicated. Another example of linkage is afforestation, for which the choice of species is increasingly guided by study of the existing plant cover, site by site on a hillside and district. Broadly, the suitability of the Plant Communities for afforestation ranges from nil on (1), the Arctic-Alpine, to greatest in (10) Woodlands. Thus, always below 1,500 ft., moist Peat Moors (3) have been planted with Sitka spruce or the drier moors with pine but wet Peat Mosses are recalcitrant. On (4) Wet " Grass " Moors, Sitka (or even Norway) spruce may take hold if purple moor grass is dominant rather than deer grass (sedge). Damper types of (5) " Dry " Grass Moors permit of spruces, the drier of European larches with Scots and other pines, and (6) Heather Moors encourage Scots pine, larch, or Norway spruce. Acid Grasslands (7) allow a variety of species. Sand Dunes (8) may be protected by pines or Norway spruce. On marginal Improved Lands (9) shelter belts call for maintenance. Our Woodlands are being replanted increasingly by conifers; a long-term policy would call for a mixture of these with broad-leaved trees for the sake of a healthy forest a century ahead. The actual species selected should be planted on each hillside, not in rectangular blocks, non-ecological, unprofitable and unsightly, but on ecological sites carefully picked out according to the existing community of plants. (Anderson, M. L., *Selection of Tree Species*, 1950; Boyd, J., 1945.)

Taking another example, the run-off of water for power and for river control responds to control of the vegetation type in the catchments. Again vegetation surveys should not cease at high water line but include the seaweed and the inshore plankton for their control, both being vital to the development of the fisher-crofters' townships, between moorland and sea (cf. Figure 2). Lastly, for recreation, the mountains, moors and forests, riversides and coasts make a growing appeal. This brings danger to forests and stock. Yet this appeal is reviving a traditional Highland reverence for life recorded by A. Carmichael (1954) with a sheer joy in plant and flower, sung by lettered poets or by illiterate bards such as Duncan Ban MacIntyre, 1725-1806 (1952). For many reasons, economic, scientific and social, the national resources of vegetation call for continued ecological survey, revolutionised by modern methods of field observation and mapping, aerial photography (with colour guidance) and correlation of factors and potentialities, for their conservation and development.

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