

BRITISH NATIONAL AIR PHOTO SURVEYS 1969-88
AND LANDSCAPE MONITORING

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Introduction: aerial photography and landscape change

Aerial photographs in Great Britain are taken by a variety of agencies, including military, civil, commercial and private organisations. With rare exceptions, the photography has been for coverage of much less than national size, for example, for administrative divisions such as regions, counties or urban districts; or blocks and strips for cartographic, civil engineering, agricultural, forestry or archaeological purposes. The exceptions are where the RAF have photographed the whole of Great Britain on two occasions for the Ministry of Defence.

Continuing changes in the countryside of Great Britain have led to a demand for more widespread systematic information on the rural landscape. The monitoring of landscape change at national level has occurred only since the 1970s. Ground fieldwork, aerial photographs and satellite imagery have all been employed, but attempts to derive the required information solely from fieldwork or solely from satellite imagery have been unsuccessful, and aerial photographs are seen as the necessary common denominator to any national landscape investigation.

Until 1985, the major schemes have been limited to using only pre-existing photographic imagery. But for any further progress, it has been recognized that new national photographic coverages to customers' specifications are required, and these are now beginning to be acquired.

Landscape change in Great Britain

A practical distinction is made in Great Britain between the terms landscape and land use. Land use is the functional characteristic of land and is recorded in units of fields or other areal parcels. There is a long history of land use mapping in Great Britain, associated at national level with L.D. Stamp and A. Coleman. In this mapping, complete censuses of land use classes were derived directly from ground observations and presented in map series. More recently, an interest has also developed into the wider landscape, that is, the physical appearance of rural areas. This interest has been sparked by changes in the agricultural and forested countryside related to British and European Community economic policies, and to the concern within Great Britain with rural recreation and conservation issues. Such concern is particularly true of England, which has a higher population density than Wales or Scotland, as well as greater competition for use of land. As examples may be cited the spread of urban areas into agricultural land and lowland heath, the amalgamation of farms, and the spread of forestry into lowland heath and upland moor. These changes in land use have brought about changes in the appearance of the countryside, for

example, by introducing suburban infra-structures, loss of hedgerows and ploughing of moorland.

Whereas land use can be mapped objectively, landscape is a more subjective concept and is difficult to quantify. The major requirement is to be able to analyse change in the landscape nationally, ideally at 5-10 year intervals, and to do this, it is necessary to reduce the landscape to its elemental components, which include linear and point features as well as areas, and consider the changes in these components separately. The many different elements in the rural landscape are of interest to different groups of persons in different combinations but, for conservation, ecology and planning, a common list of elements has emerged (Table 1) and is beginning to be employed by government-funded organisations such as the Department of the Environment (DOE), the Countryside Commission (CC) and the Scottish Development Department (SDD).

The classification of rural landscape features in Table 1 includes the 7 classes at level 1 and the 42 classes at level 2. The full classification is hierarchical and a third level of classes is used in some work. To register landscape change commonly requires the collection of very detailed information about the land, for example, information about the removal of individual hedges and hedgerow timber, or the draining of ponds, as well as area measurements of parcels of land of less than 1 ha. For a national survey, ground fieldwork at this level is too slow and requires unavailably large numbers of skilled surveyors. Satellite imagery can at present be used to classify areal features only, because the resolution even of SPOT scenes is not sufficient to allow inspection and classification of narrow linear features such as hedges. Even for the areal land cover features listed in Table 1, several sub-categories of each of semi-natural vegetation, grassland and developed land cannot be recognized or at best can be identified only at low levels of accuracy. Therefore, because landscape evaluation requires high qualities of identification and measurement, which have to be consistently applied nationwide, aerial photographs have been found to be the most suitable data source. The aerial photographs are supplemented by satellite imagery to indicate broad-brush sampling strategies, and by field survey to confirm photo interpretations.

National air photo surveys available

Vertical panchromatic aerial photographs are available from two national surveys. Firstly, complete coverage of England and Wales at 1:60,000 scale was achieved by the RAF in 1969. Secondly, the RAF photographed about 95 per cent of England and Wales together with large blocks of Scotland, totalling about 45 per cent of the country, at 1:50,000 scale in 1980 and 1981.

These two national air photo surveys provide base-line sets of information on land cover nationally. There are no other national coverages at scales larger than 1:50,000, but there are very many smaller blocks of photographs at larger scales (> 1:30,000), available in panchromatic, natural colour and colour infra-red film. Sequential photography is also frequently available for these smaller areas at different dates, which is of great use

for local and regional studies if not for national projects. Besides lacking consistency of scale or date, the blocks of photographs are archived at several different locations in Great Britain according to the commissioning agent, and this makes the photography difficult to assemble for a national project.

TABLE 1. Classification of features used for monitoring landscape change in Great Britain (simplified)

A. Linear features:	
hedgerows	open ditches
fences	woodland fringe
walls	urban boundary
banks	
B. Small features:	
isolated trees	wooded strips
groups of trees	farmland ponds
C. Woodland:	
broadleaved high forest	mixed high forest
coniferous high forest	scrub
D. Semi-natural vegetation:	
upland heath (2 types)	gorse
lowland heath (2 types)	bracken
upland grass moor (3 types)	
E. Farmed land:	
cultivated land (3 types)	
grassland (3 types)	
F. Water and wet lands:	
coastal open water	inland open water
wetland vegetation (3 types)	
G. Other land	
bare rock	sand
developed land (5 types)	

Completed national projects

Using the existing national air photo coverages, a number of projects have been successfully completed. From the 1969 national coverage at 1:60,000 scale, the DOE commissioned Fairey Surveys (now Clyde Surveys) to classify the 'developed land' of England and Wales. Developed land was defined as all areas of continuous development, including buildings, transportation features and open spaces existing primarily for urban uses. By photo interpretation, 5 broad land use categories of developed land were identified and mapped onto Ordnance Survey 1:50,000 scale base-maps (Smith, van Genderen and Holland, 1977; DOE, 1978).

More recently, using sample photographs from the 1969 and 1980-81 national coverages, as well as much other archived and

specially-flown photography, Hunting Surveys and Consultants completed a project for monitoring landscape change throughout England and Wales (Hunting Surveys and Consultants, 1986), the sponsors being DOE and CC. This two-year project involved a hybrid scheme of data collection from 707 sites of mean size 5.05 sq. km, chosen by a stratified sampling scheme. The principal objective was to provide quantitative data on changes in the distribution and extent of landscape features from the mid-1940s to the present. From aerial photographs, the linear and areal features listed in Table 1 were codified and digitised, the results being supplied as statistical estimates with associated sampling errors.

Additionally in this project, Landsat TM imagery, mainly from satellite orbits in 1984, was analysed in an attempt to estimate the areas of the most extensive landscape features. The conclusion from this part of the study was that only about 12 of the 30 area features could be consistently identified from satellite data at a level comparable with identification from aerial photographs. This conclusion is consistent with the results from other recent attempts to classify British land cover from satellite imagery. Because the parcels of land are so small and fragmented, and because the working classification requires to be so detailed, satellite imagery has been unable to produce all of the data needed to satisfy planning requirements with a sufficiently high level of accuracy.

Current and proposed national projects

The current situation in Great Britain involving national air photo surveys for monitoring landscape is surprisingly complicated. Instead of a single national scheme operated by one government agency, there are several overlapping schemes, either already in existence or proposed (Table 2).

TABLE 2. Current and proposed national projects

<u>country</u>	<u>sponsor</u>	<u>status of project</u>	<u>agent report</u>	<u>a.p. scale</u>	<u>s film</u>
England and Wales	Dept. of Environment	feasibility	Tym & P. 1985	(24,000)	(pan)
England and Wales	Dept. of Environment	feasibility	Bristol Univ. (continuing)	--	--
England and Wales (Nat.Parks)	Countryside Commission	implemented	Silsoe	Coll.15/20,000 NC/CIR	
Scotland	Scottish Devel. Dept.	feasibility	Edinburgh Univ.	24,000 96,000	pan NC
Great Britain (parts of)	Nature Cons. Council	implemented	NCC 1986	10/20,000	pan

Concurrent with Huntings' project to monitor landscape change in England and Wales for DOE, a further study was commissioned by DOE into the feasibility of establishing a new land use stock survey (Roger Tym and Partners, 1985). The consultants recommended that there should be new national aerial photography at 1:24,000 scale, to form the basis of a hybrid scheme that would include field survey in urban areas. While accepting the 1985 commissioned report, the DOE have not acted upon the recommendation that a national photographic survey should be undertaken. In another separate scheme originating from DOE, the Ordnance Survey are undertaking a pilot registration of changes in land use as they occur, but this field approach is slow and time-transgressive, and so cannot create a base-dated national stock survey. A survey based on photographs therefore remains the only workable option.

Instead of photography for a land use stock survey, the DOE are proposing to follow up the project for monitoring landscape change (Hunting Surveys and Consultants, 1986) with a repeat national survey on landscape in 1990-91. To this end, a further feasibility study is currently being funded to consider the methods and results of the original project, particularly the best modes of analysis and presentation of the many volumes of statistical data generated by Huntings. Although it is evident that fresh photographic coverage will be necessary for a repeat survey, any recommendation to this effect has to await the report's findings.

Concurrent with this activity from DOE, the Countryside Commission for England and Wales (CC) proceeded independently in 1987 to sponsor its own project for monitoring landscape change in those parts of England and Wales for which CC have specific responsibility, that is, the ten National Parks and The Broads (Fig. 1). The National Parks are among the most beautiful, spectacular and popular stretches of countryside in Great Britain, every year attracting tens of millions of visitors. The total area is 13,600 sq. km or 9.0 per cent of the land area of England and Wales. The CC are sponsoring a full census of landscape change for all the National Parks by comparing aerial photographic data for the 1970s and the late 1980s. To this end, natural colour photography at 1:15,000 or 1:20,000 scale has already been acquired for three of the Parks and for The Broads (Fig. 1), with the expectation that the remaining Parks will be flown in 1988 at similar scales.

Within Great Britain, Scotland proceeds independently of England and Wales in respect of land planning, and until 1985 the SDD had not initiated any national landscape projects. But following the monitoring landscape change project for England and Wales, the SDD commissioned a review of the sources and approaches that could be used for monitoring change in the landscape of Scotland (Coppock and Kirby, 1987), which concluded that various hybrid systems involving field survey, aerial photography and satellite imagery were possible, but that all systems required aerial photography as an essential element. Following acceptance of the recommendation by SDD, a new aerial

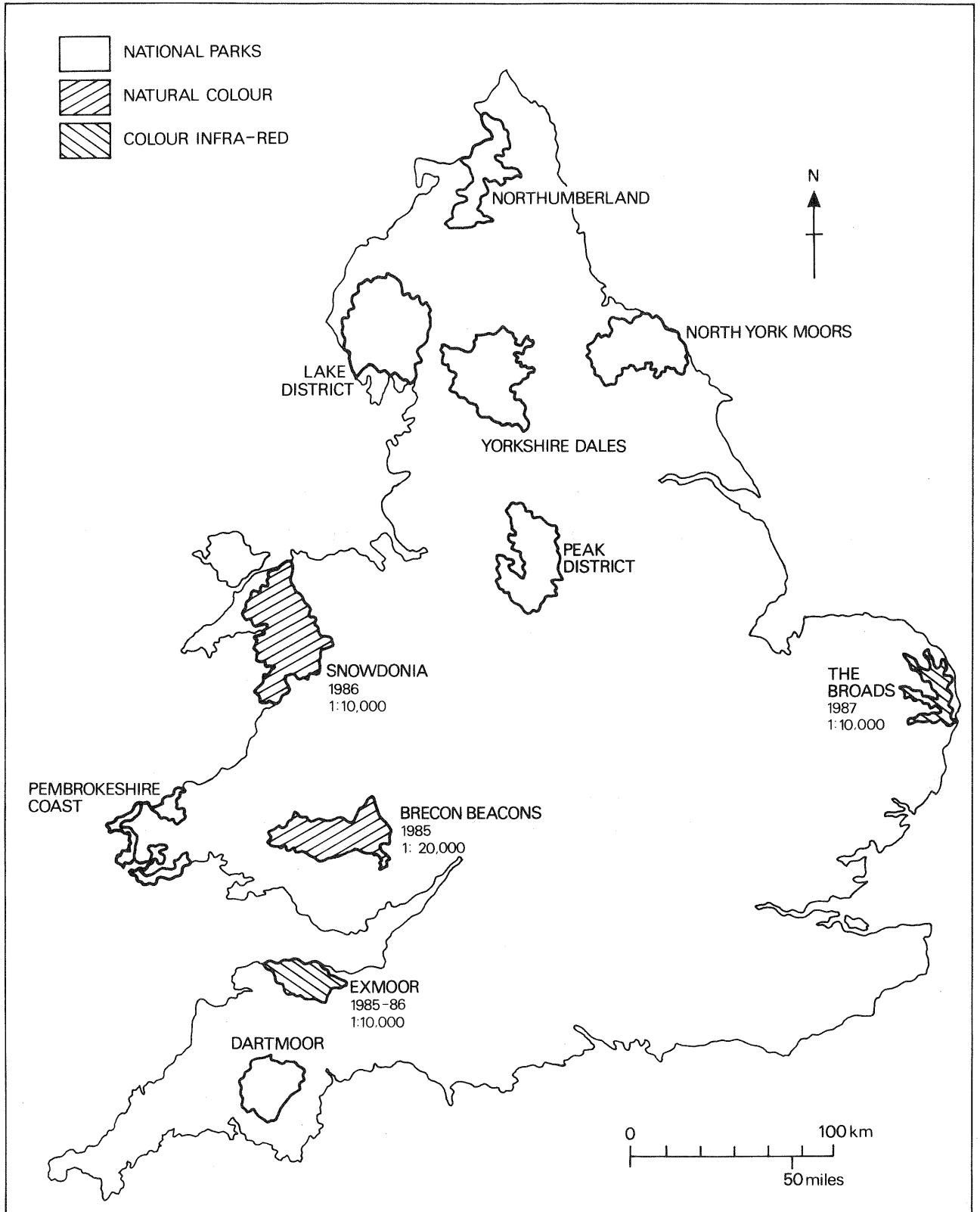


FIGURE 1: NATIONAL PARKS OF ENGLAND AND WALES, AND THE BROADS

survey of the whole of Scotland including the islands was begun in the summer of 1987.

This new photographic survey for Scotland is the first commissioned nationally for civil purposes and precedes any equivalent English survey. Commercial contractors are acquiring panchromatic photography in full-frame format at 1:24,000 scale, using a Wild RC10 camera, together with simultaneous natural colour photography in 70 mm format, using a Vinten camera.

At the 1:24,000 scale, all of the small features listed under B (Table 1) can be identified as well as such linear features as hedgerows, woodland fringe and urban boundary. The remaining linear features (fences, walls, banks and open ditches) cannot be identified accurately, but this remains true even with photography at 1:10,000 scale. The sizes of land parcels in Scotland are such that 1:24,000 is quite adequate to allow reasonable interpretation of the land covers contained therein; other constraints such as time of year and tonal/textural variety are more important than scale. The 1:24,000 scale is also adequate for digitising and areal measurements, while minimising the photographic flying time and the number of photographs to be handled.

For a national survey of land cover types and linear and small features (Table 1), where the answers can be given satisfactorily as statistical data rather than as maps, it is cheaper to conduct a sample survey rather than a full census. Therefore some slight economy could have been achieved in Scotland by photographing pre-determined sample sites rather than the whole country. In choosing in favour of total coverage, the SDD have recognized, firstly the advantage it affords for resampling should the original spatial sample be deficient in some respect and, secondly, the retrospective comparisons it allows, say in ten years time, for any fresh set of sample locations. Thirdly, there are obvious advantages in having a complete national high-resolution archive for the late-1980s, similar to the national high-altitude photography programme in the United States (Beetschen, 1984), as a yardstick for measuring the effective spatial resolution of any type of satellite imagery.

The results of the Scottish photographic survey in its first year are shown in Fig. 2. The limited progress in 1987 was due to the late start, the exceptionally bad summer weather in 1987, and contractor's equipment problems. Scotland's weather is significantly more cloudy than that of England and Wales, one of the reasons why full-format colour photography was not preferred to panchromatic. Given an estimated average of 15-20 suitable flying days per season, it is anticipated that at least two further flying seasons will be required to complete 95 per cent of the target area. Low winter sun angle and phenological constraints on natural vegetation restrict the flying season to between May and October.

Apart from these four schemes for Scotland and for England and Wales separately, there is one further national scheme, conducted by the Nature Conservancy Council, whose brief is concerned

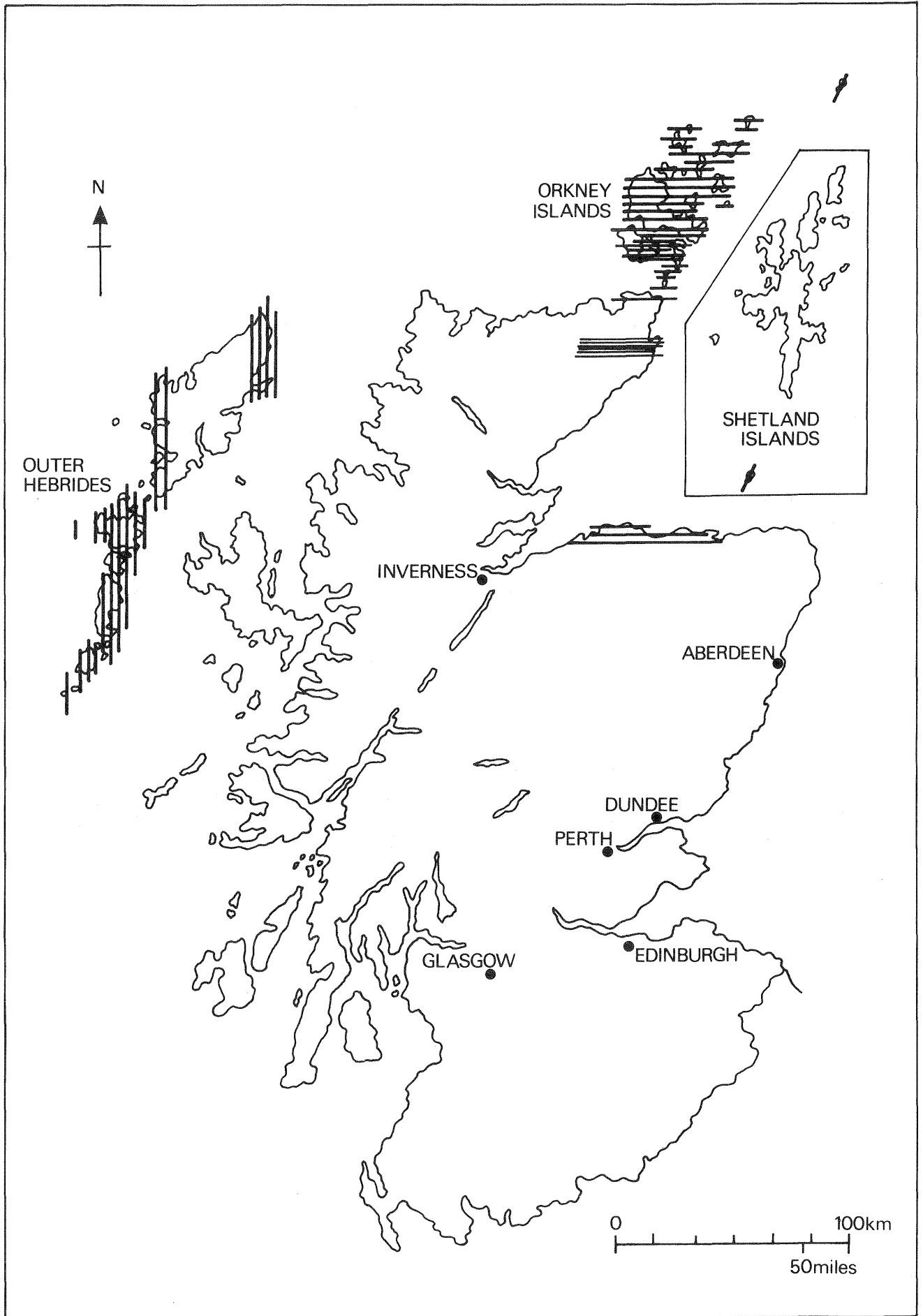


FIGURE 2 : SCOTTISH AERIAL PHOTOGRAPHIC COVERAGE ACCUMULATED ACQUISITION TO DECEMBER 1987

with areas of ecological significance and extends to the whole of Great Britain (Table 2). The NCC continues to monitor changes in the countryside by comparing archival aerial photographs of different dates (NCC, 1987) but as a contributing sponsor the NCC will make use of the new Scottish aerial photographs as they become available.

The lack of a modern national photographic cover in Great Britain hitherto has hindered attempts at monitoring changes in the rural and urban landscapes nationwide, but efforts are now being made to remedy the deficiency. Several different national organisations have a direct concern in such photographic coverages but although there may be scope for rationalisation, there is little indication that this will speedily come about.

References cited

- Beetschen, C.W. (1984) The national high-altitude photography program. U.S. Geol. Survey 1983 Handbook, 12-17.
- Coppock, J.T. and Kirby, R.P. (1987) Review of approaches and sources for monitoring change in the landscape of Scotland. Edinburgh: Scottish Development Department.
- Department of the Environment (1978) Developed areas 1969. A survey of England and Wales from air photography. London: DOE.
- Hunting Surveys and Consultants Ltd. (1986) Monitoring landscape change, 10 volumes. Borehamwood: Hunting Surveys and Consultants.
- Nature Conservancy Council (1987) Changes in the Cumbrian countryside. First report of the National Countryside Monitoring Scheme. Research and survey in nature conservation No. 6. Peterborough: Nature Conservancy Council.
- Roger Tym and Partners (1985) National land use stock survey: a feasibility study for DOE, 2 volumes. London: Roger Tym and Partners.
- Smith, T.F., van Genderen, J.L. and Holland, E.W. (1977) A land use survey of developed land in England and Wales. Cartographic Journal, 14, 23-29.
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