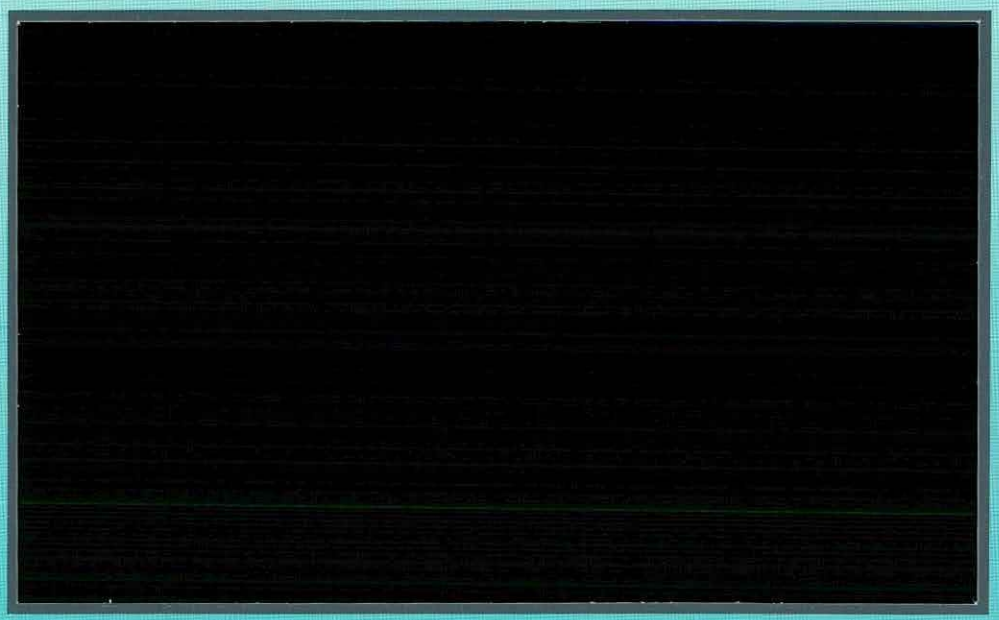
Institute of Terrestrial Ecology



Natural Environment Research Council

ITE has administrative headquarters north and south, and the geographical distribution of its 250 staff in six Research Stations throughout Britain allows efficient use of resources for regional studies and provides an understanding of local ecological and land use characteristics.

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The ITE Research Marketing Officers for ITE North and South are based at Banchory and Monks Wood, respectively.

INSTITUTE OF TERRESTRIAL ECOLOGY

(NATURAL ENVIRONMENT RESEARCH COUNCIL)

Project T02025M5

Quarterly Report to the British National Space Centre

COUNTRYSIDE SURVEY 1990
Mapping the land cover of Great Britain using imagery:
A demonstrator project in Remote Sensing
Quarterly Report to the British National Space Centre
July 1991

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INTRODUCTION

This is the fourth report, in a quarterly series, covering this project

AIMS OF THE PROJECT

1. To compile a digital map of land cover in Great Britain
2. To make quantitative assessments of accuracy
3. To integrate the map with other data in a GIS environment, with demonstrator output

METHODS

The methods were described in the First Interim Report (Fuller *et al.* 1990).

SCHEDULE OF WORK

The schedule of work and progress to date are summarised in Figures 1 & 2. The following paragraphs give brief descriptions of the currently active elements shown in Figure 1.

1. The sample-based **field survey** (to be used for validation) was successfully completed in late summer 1990.

2. The **digitising** of field survey maps is under way at ITE Merlewood. Sample data have been delivered to Monks Wood for initial developments of methods.

3. The **image search and scheduling** has recorded no new scenes of significant interest, since the last quarterly report. Winter 1990-91 failed to produce any new images of value. However, Figure 3 shows that we have already identified good images for more than 80% of Britain, that acceptable summer-winter cover exists for all but about 5% of Britain (ie with <5% cloud-cover): for the remaining 5%, which does not have summer/winter cover, at least one date is available. Purchases have been scheduled to maximise use of best images: hence we have moved into Scotland before completing coverage of England and Wales. It is intended that we examine winter 1991-92 coverage before making commitments to buy any second-quality images.

4. **Image orders** have been placed for this financial year and existing stock covers 80% of England and Wales (Figure 3). Some further purchases may be

needed to maintain continuity of production, but use of existing stock and diversifying the work towards validation and pattern analyses will provide enough work for the remainder of the financial year.

5. **Class selection** (Appendix 1) has been influenced, by user requirements, by reference to other surveys, but ultimately by what is feasible, with acceptable levels of error. A consultatative exercise has been undertaken in the last quarter using the list of consultees as given in the First Interim Report. This produced 15 written responses and several telephoned replies, all generally favourable. Some responses showed that users would like more detail, others felt the list over-ambitious, and comments on specific classes were often contradictory. The distinctions between upland/lowland heaths and upland/lowland grasslands were thought by some to be artificial, based on subdividing a continuum, where altitudinal effects were confounded with changing latitude and longitude. Knowledge-based separation would seem better than attempting to use spectral differences. Furthermore, a GIS, can tailor the definition to user-requirements. Some people noted that widespread classes (eg the agricultural grasslands) deserved further subdivision: this point is fully accepted, but comments of others noted how difficult it was to relate reflectance differences in grasslands to real agricultural meaning: management practices can easily obscure the nature of the sward. Some remarked on the rarity of some classes and questioned their choice as specific classes: this point is taken and in many cases we intend to simplify the classification by aggregating rarer classes into related, more common, ones, at least for display purposes.

The consultation, coupled with our own growing experiences of fieldwork and classification, now in upland areas of Britain, has led us to adopt the strategy which was suggested in the consultation exercise. The target classes will be achieved by defining a large number of spectrally unique subclasses. These will be aggregated to give the target classes (renamed to convey as exact a definition as is possible). However, because some may feel the separation of rarer or more difficult classes is inappropriate, we will present maps without the full range of distinctions - that is, like-classes will be coloured the same. Summary statistics could use the same approach. However, the greater detail would be resident in the top layer of the cover-database, accessible at all times. As before, the subclass data would remain available in archive, for consultation, but would not reside in target-class listings.

In summary, there would be three levels of classification: first, a new shortlist of 'key classes'; second, the original, longer list of target classes which we would not necessarily show in maps and data summaries; third, the subclass data, unvalidated as subclasses, not used for normal display or data summaries, but resident in archive for specialist consultation.

6. Nine summer scenes have been **geometrically corrected** and eight of the winter images have been corrected.

7. **Field reconnaissance** has been completed for all but the western extremes of England and Wales and has started in south-western Scotland (ie 201-023, 201-024, 202-022, 203-023, 203-024 and 204-022). This represents over half of all intended field reconnaissance. The classmaps of East Anglia, the South-east, the North York Moors and the Pennines (scenes 201-023, 201-024, 202-022 and 203-023) have been checked, field by field, using the field reconnaissance data for 3800 land parcels (note this is a rough measure of success, not to

be confused with the full validation exercise using data for the 533 one-kilometre squares). Results showed 84-86% success rates.

8. **Training and classification** has been completed for all scenes mentioned in section 7. In addition, the final classmap of the Severn valley 203-024 is complete and undergoing knowledge-based correction of the confusions between maritime and terrestrial habitats before quantitative checks are made. These scenes represent about three quarters of England and Wales, nearly half of the total area to be surveyed (Figure 4). Training has started on the Lake District scene, 204-022 (Figure 2).

9. **Accuracy assessment** will compare the Countryside 1990, 1 km field data, in their digital form, with the corresponding section of classmap. Meetings and field reconnaissance, between the field and Landsat survey coordinators has agreed that the field survey's 'primary codes' will provide an suitable basis for comparison. The only exceptions are, first, where secondary codes (on species and their cover) are required to subdivide the broad agricultural grassland class of the field survey, second, where field bracken-cover is needed to compare with Landsat bracken areas. Otherwise, the primary codes give a subdivision, equal to or greater than that of the Landsat map, and thus provide appropriate comparisons.

An example of the digitised field data has been imported as vectors from the ITE, Merlewood, ArcInfo system and rebuilt on Monks Wood's Laserscan system. However, the interactive procedures used to do this have been superceded by Laserscan's own purpose-written software. Using this, we have succeeded in importing and displaying line and attribute data, but need to ascertain the best route for rebuilding polygons. Experiments continue towards this end.

10. **Building a mosaic of full GB land cover** has so far involved merging the two completed scenes, 201-023 and 201-024. This procedure is planned to continue, but with the data stored as 100 km squares. Thus, it would provide much quicker and easier access to regions of interest; where such regions occupy parts of adjacent squares, these squares could be merged for analyses. Merging will be used to give maps and data covering of all Great Britain, but there may be advantages in subsampling and simplification for data handling purposes (see below). The procedures will be developed with user-consultation over the remaining period of the project.

11. **Hard copy production** will provide outputs at various scales and resolutions. Full resolution classmaps of small areas have been produced routinely and demonstrated to various end-users. A full resolution SPECTRASCAN plot has been made by the film-writer at the National Remote Sensing Centre. The image covers South-east England. Large format (c. 1 metre) prints have been displayed at the meeting on the 'Land Use Change: Causes and Consequences', Newcastle; at the Royal Agricultural Show, Stoneleigh; and at the Paris Air Show. DTI has a copy for display-purposes. It is intended to produce revised versions of hard copy images, once validation has confirmed the final choice of display-classes and their exact meaning in ground-cover terms.

12. **GIS demonstration** work has started with the export of sample areas from the IIS image analysis system to the LASERSCAN GIS, and this has included early trials of raster-to-vector conversion. These procedures have since been used on a 75 km x 50 km test area of classmap centred on the Thames estuary. This was successfully converted from raster to vector data. Such conversion

highlighted the problems of dealing with large databases, such as the cover map will provide. This relatively small area, one-sixtieth of all Britain, contained 80000 polygons. There is no commercial GIS which could realistically handle such detailed vector information for all of Britain. Simplification, by filtering out all small parcels, would be possible, but risks throwing away useful information. Simplification was a necessary part of conventional cartography when a cartographer had to draw and classify every parcel. It is not a necessary part of raster image classification, so, unless it can be shown that the fine detail is 'noise' rather than data, the detail should not be lost for mere convenience. It would be far better to examine ways of storing and accessing raster data, converting to vector only where necessary, perhaps temporarily. The Laserscan system may have such potential, and methods will be developed during the continuing GIS demonstration phase of this project.

GIS demonstration will also examine procedures of pattern analysis. Concepts of patch size, size frequency, perimeter length, fragmentation and isolation, boundary length, density and diversity will be used to look at patterns in sample areas representing, as far as possible, the variety of landscapes in Britain. To maximise the productivity in this exercise, it will be necessary to develop raster/vector handling techniques.

An additional GIS requirement for DoE and other users, and especially for analyses in conjunction with the field survey, is the summary of data at 1 km and other grid sizes. We have adapted existing software which can now provide proportional cover, per grid cell, of all land cover types in each cell. So, for example, Norfolk data have been provided to the British Trust for Ornithology, summarised as 23 arrays (for 23 cover types), with score per tetrad (2 km x 2 km square). Such data will be related to common bird census data, also collected in tetrads. Maps will be summarised per kilometre square for later use with land class maps and summary statistics.

There are a number of GIS pilot projects under way or advanced in their planning which will demonstrate the use of the cover data in GIS studies of the environment. These include:

- analyses of land cover and common bird census-data for Norfolk (with British Trust for Ornithology)
- comparisons with Macaulay Land Use Research Institute, airphoto-based, Land Cover of Scotland
- use of land cover data in the Newcastle University Land Use Project on river catchments
- comparisons with Ministry of Agriculture, airphoto-based, cover maps of Environmentally Sensitive Areas
- Terrestrial Initiative in Global Environmental Research proposals to estimate carbon pools (with Institute of Hydrology (IH))
- use of cover data in IH 'Water Information System'
- use of land cover data for Expert System on Pesticide Loading of Waters (with FARMSTAT, IH, Soil Survey Land Research Centre, Water Research Centre)

- ITE monitoring of the land used by radio-tagged birds
- mapping habitat sensitivity (ITE for Her Majesty's Inspectorate of Pollution)
- heath and moor survey (DoE, MAFF)

All the while such uses remain at the pilot-studies level, it is possible to undertake such commitments without significant impact on the production phase of the work. Insofar as these studies will be reported as GIS demonstrators (see above) they also fit with the general theme of the project.

13. The First Interim Report was produced for DTI/BNSC in December 1990, with quarterly reports in September 1990 and May 1991. This is the fourth progress report to DTI/BNSC, and a fifth quarterly report will follow in September 1991. An Interim Report in December 1991 will greatly expand the summary details given here. It will record the final choice of cover types, their descriptions, exact status of image processing, results of field-checks, accuracy/calibration measures, and GIS pattern analyses.

CONCLUSIONS

The rate of production continues to match original intentions. Rescheduling has sometimes been necessary to take best advantage of seasons for field work, image availability, software developments etc. However, on balance the project is going according to plan: slippages are counter-balanced by advances elsewhere. Every step involved in the project has now been tested and feasibility has been demonstrated. Perhaps most in doubt, at the start, was the availability of images; this no longer poses a problem. Also questioned was the difficulty of transferring techniques, developed mostly in lowlands, to the upland situation. We have now successfully classified areas up to nearly 1000 metres in South Wales, and closely examined areas of similar altitude in the Lake District, with no evident difficulties facing us in classification.

There are grounds for continued optimism as to the successful and timely completion of the project, with excellent levels of detail and accuracy.

FORWARD LOOK TO FIFTH QUARTER

The aims for the fourth quarter (1 July to 30 September 1991) will be to:

1. complete fieldwork and classifications of scenes 203-024, 203-025 and 204-022

2. extract 100 km squares of above data

3. derive correspondence between Landsat classes and field survey attributes

4. test ARCINFO to Laserscan export software

5. continue to develop and test methods for quantitative validation

6. to geometrically correct all stock-scenes

7. to undertake field reconnaissance of sufficient stock-images to provide ground reference data for the winter 1991/2.

LIST OF FIGURES

Figure 1. Planned schedule of activities and progress to date (black bars), July 1991.

Figure 2. Status of data processing, July 1991.

Figure 3. Summer-winter LANDSAT cover of Great Britain: October 1987 - July 1991.

Figure 4. Areas classified, July 1991.

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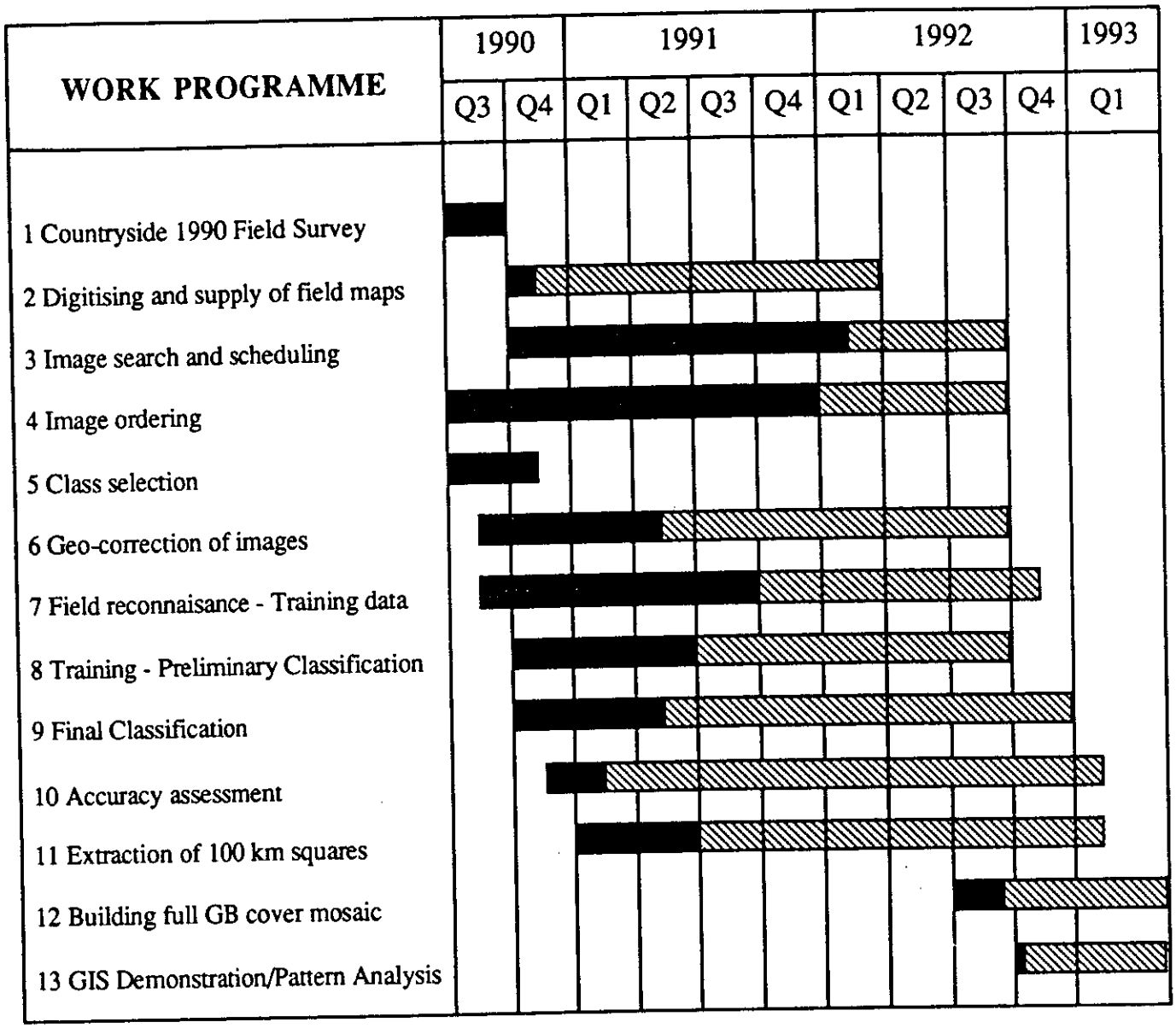


Figure 2. Status of data processing, July 1991.

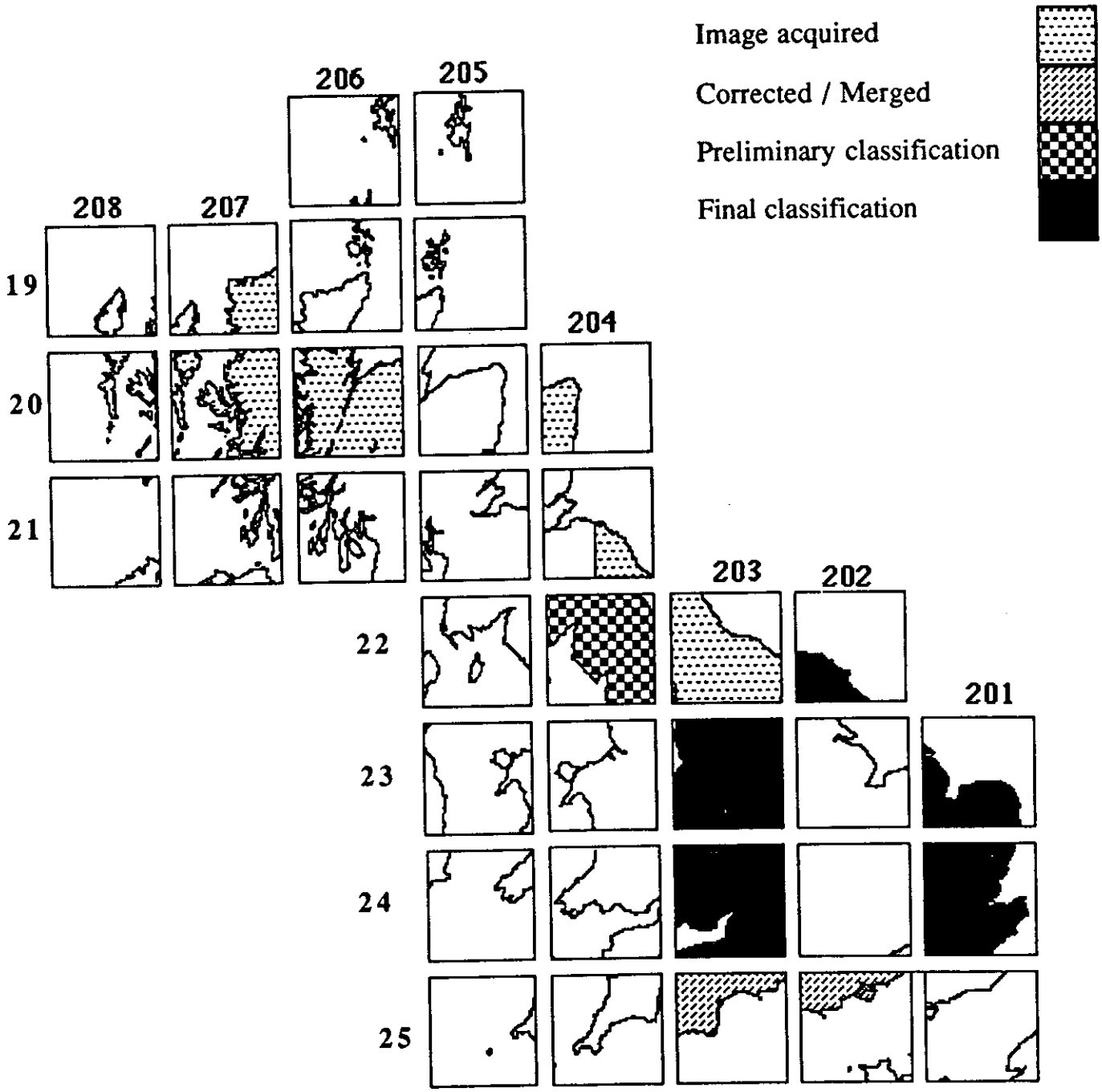


Figure 3. LANDSAT cover of Great Britain: OCT 1987 - JULY 1991.

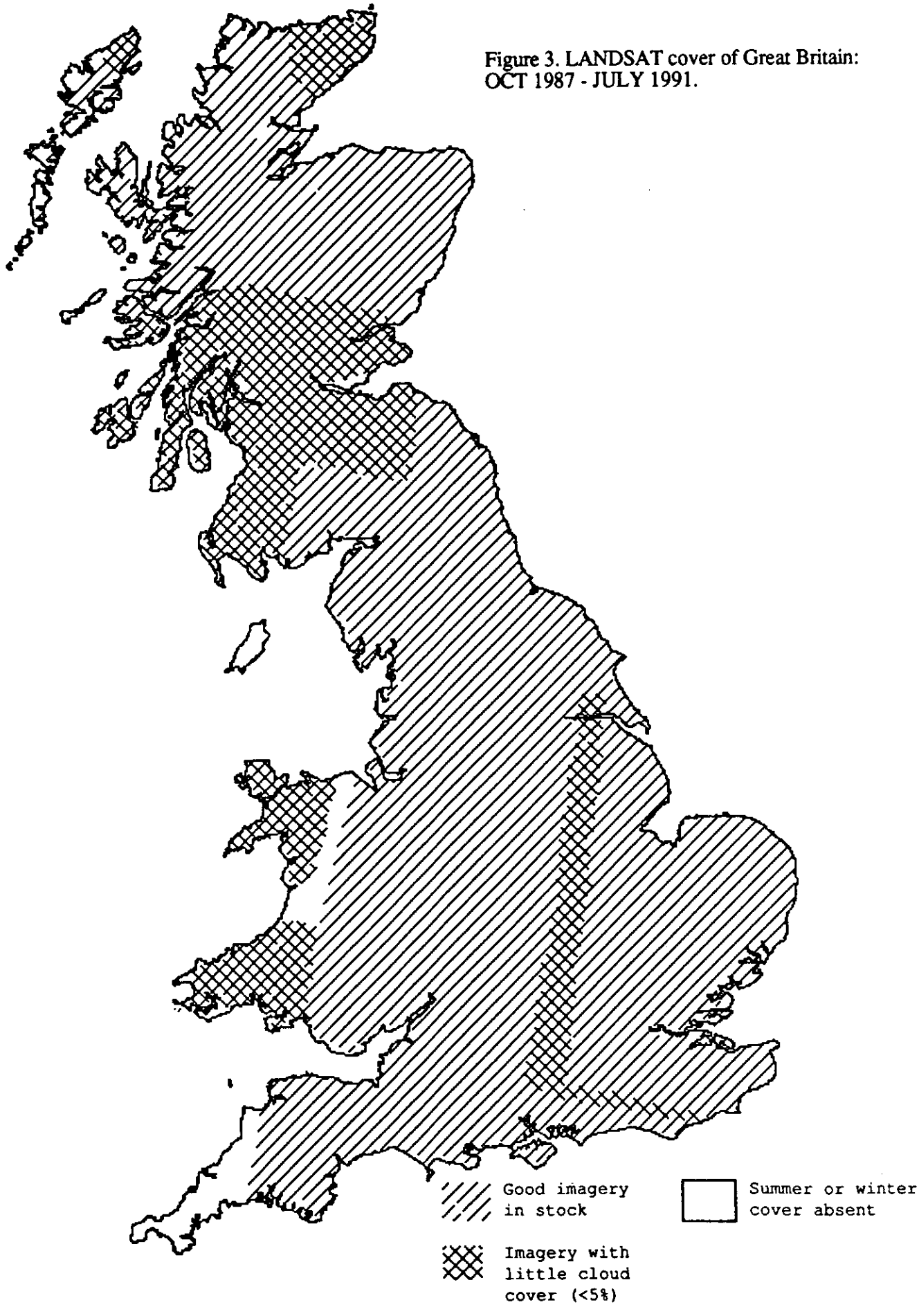
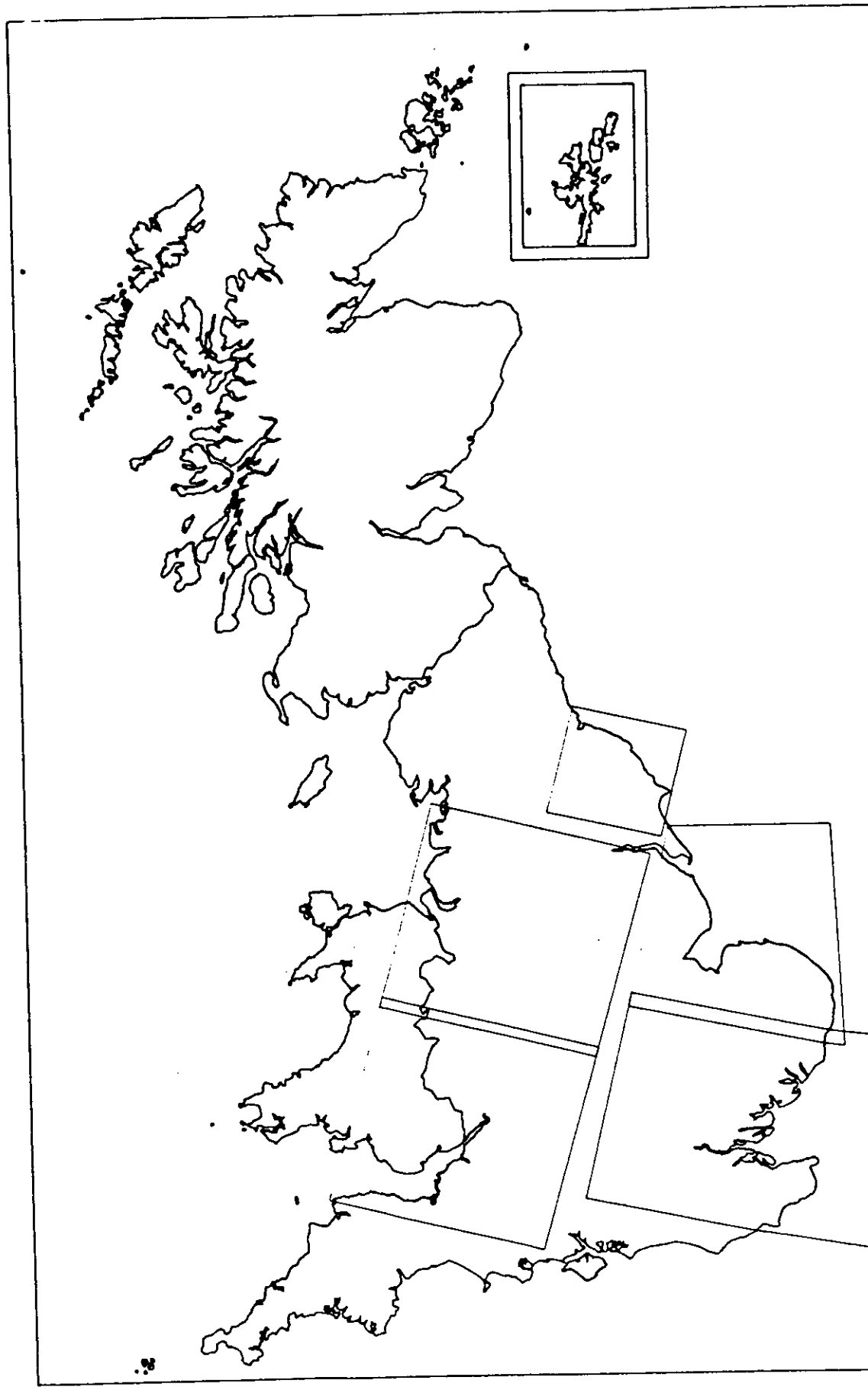


Figure 4. Areas classified, July 1991.

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