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The Scottish Blanket Bog Inventory: Bog Trotting from space

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1 Abstract

Active blanket bog is a priority habitat as identified in the EC Habitats Directive and the UK Biodiveristy Action Plan. In 1995 Scottish Natural Heritage (SNH) initiated the Scottish Blanket Bog Inventory (SBBI) to map the distribution, extent and condition of the blanket bog resource in Scotland. Following an in-depth economic and practicability assessment, a Remote Sensing / GIS approach was adopted. Seven Landsat TM scenes were ground-truthed and processed to derive a Scotland-wide map of National Vegetation Classification (NVC) and microtopographical information for blanket bog vegetation types. The SBBI was delivered to SNH's distributed office network using a customised ArcView interface: Local GIS Facility (LGF). The SBBI is now operational, providing SNH's Area Staff with a valuable tool set to assist them with day-to-day casework issues involving such items as planning and Woodland Grant Scheme applications.

2 Introduction

Blanket bog is a vegetation formation which probably reaches its extreme world development in western and northern Britain and in western Ireland, reflecting the cool, intensely oceanic climate of these islands. Under these conditions peat formation is possible on all but the more steeply sloping ground, occurring as a mantle of blanket bog vegetation over much of the more gently sloping upland areas.

The Scottish Blanket Bog Inventory (SBBI) evolved from the National Peatlands Resource Inventory project in the mid 1990s. Previous work by SNH and others had estimated the extent of the blanket bog resource to be 1.4 million ha in Great Britain with just over 1 million ha in Scotland, based on calculations using soil deposits indicating peat greater than 1m in depth. Past experience, however, had shown that it is not feasible in terms of time and cost to field-survey the vegetation of these areas by conventional means.

Remote sensing was therefore investigated as a means of gathering information from these vast areas of blanket bog. Indeed, remote sensing is the most economical means of characterising the relatively homogeneous blanket bog resource.

The purpose of the SBBI was to:

- determine the blanket bog resource in Scotland and to describe the range of variation of different types of peatland vegetation/characteristics;

- identify those areas of "active" blanket bog, an Annex 1 habitat within the EC Habitats Directive (EC 1994); and

- identify peatland areas ("Areas of Interest") which appear to satisfy the criteria for the selection of UK and EU designated sites.

3 Methodology

Scottish Natural Heritage identified in 1995 the scale of remote sensing systems that could be used to map semi-natural habitats (Pooley and Jones,1995). Blanket mire was identified as being intrinsically suited to large-scale mapping by Landsat and SPOT systems. This verified the approach to large-scale mapping

(small-scale in cartographic terms) that had been developed by the former National Peatland Resource Inventory (NPRI) and subsequently the SBBI. The research has resulted in a technique that not only maps vegetation types but also identifies some of the environmental characteristics associated with each type (Reid *et al.,*1994).

Five areas of work were highlighted in line with the overall aims of the SBBI :

- Identify the general ecological types/variability across the land surface within the extent of the blanket mire.

- Determine the range of variation of different blanket bog vegetation and environmental characteristics within existing peatland SSSIs.

- Relate the results to the criteria as set by:

    i) Guidelines for selection of biological SSSIs: bogs (JNCC, 1994), where the scale of interpretation is directed towards identifying mire margin/mire expanse structure and NVC communities as detailed within the guidelines. These areas will be referred to as Areas of Interest (AOIs) and are highlighted in a separate confidential report for SNH.

    ii) Interpretation of the Habitats Directive with particular reference to the Annex 1 type "active blanket bog".

- Identify and depict both high and poorer quality peatland areas of interest (AOIs). Details of these areas and their selection are held in a separate confidential report within the Uplands and Peatlands Group, Habitats and Species Unit, Advisory Services, SNH, Edinburgh.

- Statistically validate all the stages in the production of the above.

The classification process involved the unsupervised classification of 6-band Landsat TM imagery. Eight satellite scenes, processed in 7 blocks, were identified from 1992. Image scene selection was based on seasonality and cloud cover. Scenes from late spring/early summer were preferred because this time period provides good floristic diversity without the high haze values associated with imagery over peatland areas in the hotter summer months. Scenes from May 1992 were selected. Figure 2 shows the distribution of image scenes used for the SBBI.

The classification process was informed using specially comissioned field survey and existing landcover information (Figure 1).

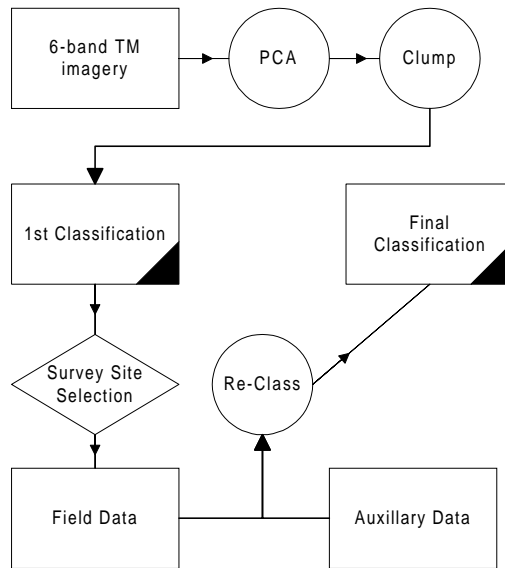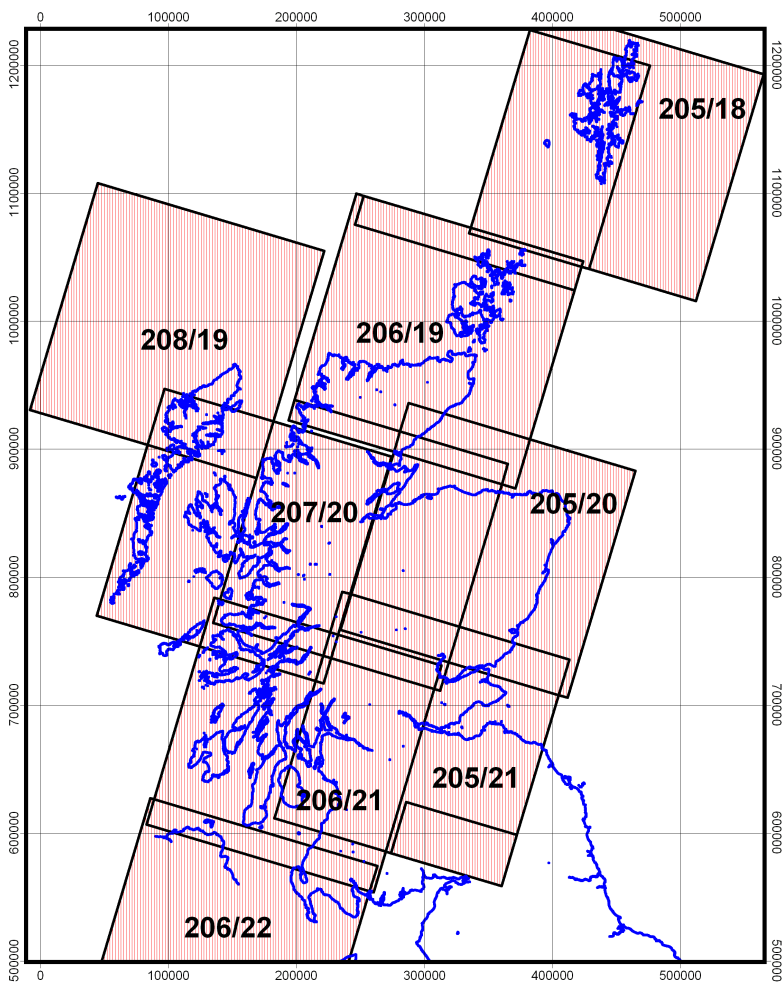*Figure 1 – Outline of the SBBI classification process*

Figure 2 – Outline areas for satellite images processed within the SBBI

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3.1 Pre-survey - image preparation and the 1st stage classification

The original satellite bands were converted to principal components and classified using an unsupervised ISODATA classification (Lillesand & Kiefer, 1987). Up to 50 classes were produced. The image was smoothed using a 'sieve' filter to remove areas smaller than 25 pixels in size. The classified raster image was converted to a vector (line) such that each polygon was assigned a point label containing an Ordnance Survey grid reference and the class number of the polygon as produced by the ISODATA classification. These polygons, together with their OS grid reference, land cover class and a 1 km grid, were plotted onto A4 sheets at approximately 1:10,000 scale .

3.2 Ground reference site selection

Ground reference sites were selected to enable the statistical validation of the final image classification. A stratified sample of sites were selected based on their geographic extent and spectral representation of different mire types.

3.3 Field survey

Sites chosen for survey were identified by marking acetate overlays on top of the aerial photographs. OS maps (1:25,000) and aerial photographs were used to navigate accurately to each survey block. Once confident of their position surveyors proceeded to walk through the survey block collecting information on the environmental and vegetation characteristics of each block.

Survey data collected included:

- Housekeeping – surveyor, location, aerial photograph etc.

- Survey data – National Vegetation Classification (NVC) code, dominant plant species, cover values for different plant species etc.

- Physical data – peat depth, aspect, amount of bare ground, vegetation height etc.

- Land cover – management regime, degree of erosion, damage etc.

Data were collected using standard recording forms. All vegetation data were checked using quadrats and validated using Twinspan.

3.4 Ancillary data input

In addition to project-specific survey information, exisitng SNH data holdings were employed to improve the classification. The following data types were used:
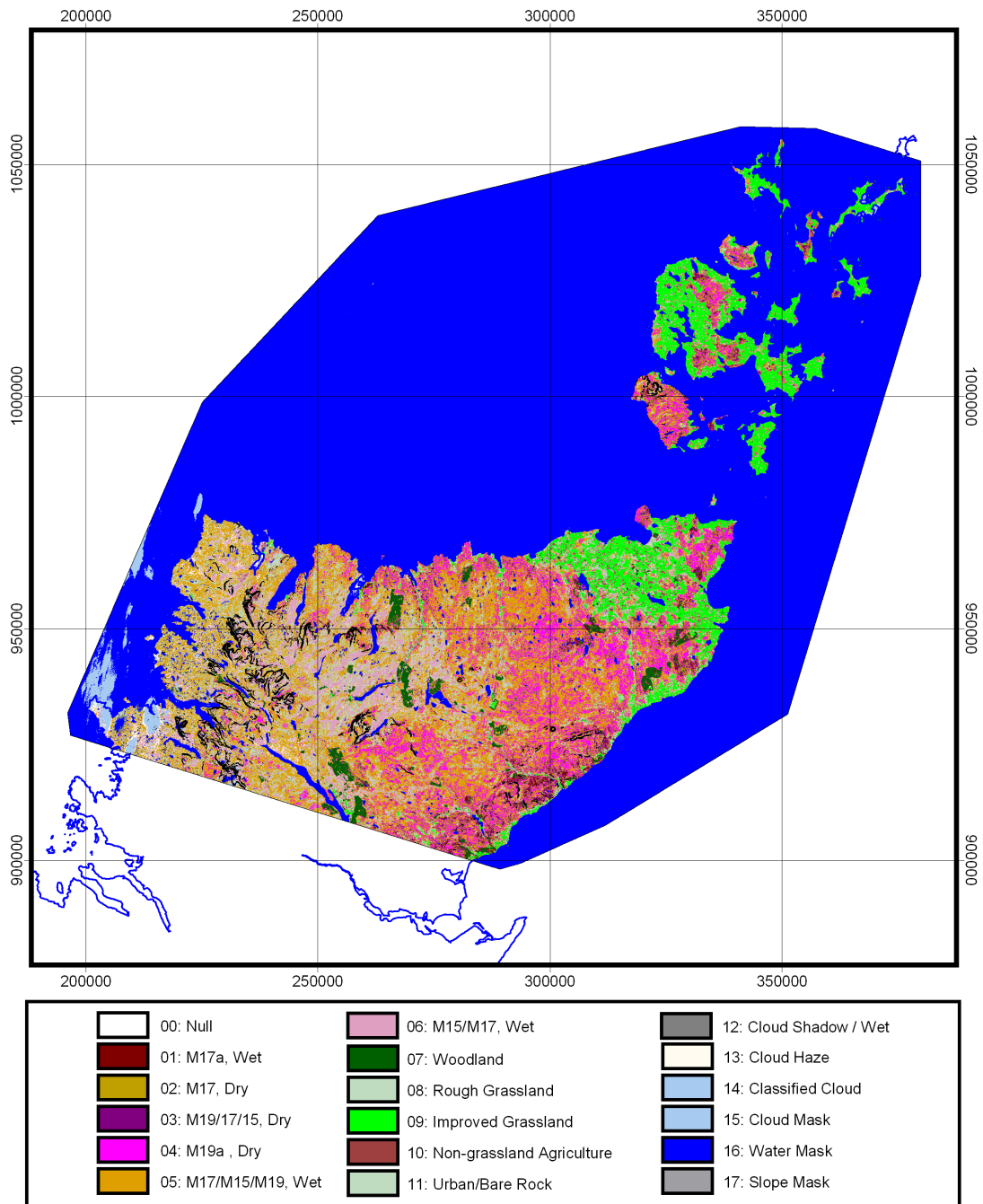
- Digital Elevation Model (DEM) data were used to mask out areas of slope greater than 20 degrees.

- British Geological Survey Deep Peat Boundary Data were used to identify potential peatland sites.

- Existing habitat National Vegetation Classification (NVC) and Phase 1 survey information were used to assist in the class interpretation.

- Macauly Land Use Research Institue (MLURI) Land Cover of Scotland 1988 (LCS88) data were used to identify some of the non-target land cover classes.

4 Outputs

4.1 Scene-by-scene classification

Interpretation of the classified image was concentrated towards the blanket bog communities. Each class was given a NVC description, an indication of the hydrological state, measurement of peat depth and observation of the microtopological condition of the surface (Lindsay et al, 1985). Figure 3 shows the SBBI scene for Caithness & Sutherland and Orkney. The breakdown of the individual classes is presented in figure 4.

	00: Null		06: M15/M17, Wet		12: Cloud Shadow / Wet
	01: M17a, Wet		07: Woodland		13: Cloud Haze
	02: M17, Dry		08: Rough Grassland		14: Classified Cloud
	03: M19/17/15, Dry		09: Improved Grassland		15: Cloud Mask
	04: M19a , Dry		10: Non-grassland Agriculture		16: Water Mask
	05: M17/M15/M19, Wet		11: Urban/Bare Rock		17: Slope Mask

Class	No.	Area (ha)	% Land Area
Null	0	666	< 1%
M17a, Wet	1	2322	~1%
M17, Dry	2	26145	7%
M19/17/15, Dry	3	8312	2%
M19a , Dry	4	73023	20%
M17/M15/M19, Wet	5	144484	39%
M15/M17, Wet	6	30362	8%
Woodland	7	10604	3%
Rough Grassland	8	52819	14%
Improved Grassland	9	4725	~1%
Non-grassland Agriculture	10	1898	~1%
Urban/Bare Rock	11	3234	~1%
Cloud Shadow / Wet	12	604	< 1%
Cloud Haze	13	5267	~1%
Classified Cloud	14	15	< 1%
Cloud Mask	15	587	< 1%
Water Mask	16	7472	-
Slope Mask	17	3558	~1%
Total		376098	
Total Land Area		**368626**	**100%**

Below is an example of a full class description

Class 1 - Smooth to microbroken ground, shrub-dominated, M17/M17a Scirpus cespitosus – Eriophorum vaginatum blanket mire, wet

Vegetation characteristics - This class is dominated by the M17 *Scirpus cespitosus – Eriophorum vaginatum* blanket mire, particularly the *Drosera rotundifolia - Sphagnum* sub-community (M17a).

The vegetation in the shrub layer remains short typically between 16 cm and 30 cm in height. *Calluna vulgaris* dominates, typically having cover values of 26% - 50%, occasionally as much as 75%. The shrub layer is dominant over the herb layer, with herb cover falling between 25% and 50%. Monocotyledons dominate the herb layer, typically *Eriophorum angustifolium, E. vaginatum* or *Scirpus cespitosus*. The herb element is generally of a similar height to the shrub layer or slightly taller.

Both the moss and *Sphagnum* layers rarely attain great cover values, never exceeding 50%. *Sphagnum* species are poorly represented, with *Sphagnum capillifolium* the only constant. The only other bryophyte that shows notable presence is *Hypnum cupressiforme*.

Physical features - This class is variable in the amount of erosion found. There are occasional instances of micro-erosion where the peat surface is broken, as well as areas where the ground is broken into deep erosion gullies. Peat depth is also extremely variable, with most records falling between 0.5 metres and over 1 metre in depth.

Large continuous areas of classes which are identified as being 'active' blanket bog and which occur outside existing Sites of Special Scientific Importance (SSSI) or sites which are Special Areas of Conservation (SAC) have been identified for possible future examination.

4.2 Scotland-wide statistics

The classification process has resulted in SBBI tiles which have unique and independent class descriptions. Class 1 from scene 207/020 is not the same as class 1 from any of the other image tiles. This means that it was difficult to mosaic the images to produce a seamless Scotland-wide blanket bog map. In order to derive Scotland-wide statistics therefore, it was necessary to approximate classes between scenes. Full class

descriptions were consulted such that classes of equal blanket bog quality were clumped together to produce a complete Scotland-wide image. The resultant image comprised 3 classes, the details of which are presented in figure 5.

Figure 5 – Scotland-wide SBBI classes

Class	Vegetation	Hydrology	Erosion
1	Blanket bog NVC types	Wet	Little or no erosion
2	Blanket bog and wet heath NVC types including mosaics	Variable	Low levels of erosion
3	Blanket bog and wet heath NVC types including mosaics	Variable - dry	Low to high levels of erosion including serious hagging

The breakdown of Scotland-wide figures for the various blanket bog and related classes is presented in figure 6. The map of the Scotland-wide classification is presented in figure 7.

Figure 6 – Scotland-wide classification statistics

Class	Area (ha)	% Land Area
1	1,368,900	17.37%
2	523,449	6.64%
3	1,092,003	13.85%

The numbers presented in Figure 6 demonstrate a considerable increase in the areal extent of blanket bog vegetation when compared to the pre-SBBI figure of 1,000,000 hectares. The areal extent of Class 1, representing the very best active blanket bog classes shows a 37% increase. This is in-line with the errors discovered in the BGS deep peat boundary data during the scene-by-scene classification

4.3 Documentation

For each scene processed, a technical document detailing the methodology and statistical validity of the classification was produced. In addition, summary statistics derived on a SNH management block (SNH Area) basis were produced. These portfolios include SBBI statistics in association with the MLURI LCS1988 and BGS deep peat boundary data information. Both these documents are available as paper publications and digital documents hosted on SNH's intranet. The processed SBBI images are delivered through SNH's own customised ArcView-based GIS - The Local GIS Facility (LGF).

Figure 7 – Scotland-wide classification