Improvement Programme for England's Natura 2000 Sites (IPENS) – Planning for the Future IPENS066

Analysing change in moorland management in the North York Moors Special Protection Area

North York Moors Special Protection Area (SPA)

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Foreword

The **Improvement Programme for England's Natura 2000 sites (IPENS)**, supported by European Union LIFE+ funding, is a new strategic approach to managing England's Natura 2000 sites. It is enabling Natural England, the Environment Agency, and other key partners to plan what, how, where and when they will target their efforts on Natura 2000 sites and areas surrounding them.

As part of the IPENS programme, we are identifying gaps in our knowledge and, where possible, addressing these through a range of evidence projects. The project findings are being used to help develop our Theme Plans and Site Improvement Plans. This report is one of the evidence project studies we commissioned.

Merlins that breed in the North York Moors Special Protection Area (SPA) are very well monitored, and their numbers appear to have declined by 40% between 1993 and 2008. Available evidence strongly suggests that similar declines in the numbers of breeding Merlins have occurred elsewhere in the English uplands and on other SPAs. The reasons for this apparent decline are not clear and this work was commissioned to investigate a potential link between changes in moorland management, particularly rotational burning of vegetation, and changes in the distribution of nesting pairs. This report details the methodology used for the aerial photographic interpretation to provide digital burn maps for analysis. The study indicates a significant and widespread change in the pattern of burning in the North York Moors, which may have implications for Merlin nesting habitats and prey availability.

It is hoped that this initial study will increase awareness amongst regulators and land managers of the potential effect of moorland management on breeding Merlins and other birds and that it will prompt further research into the causes of the decline. The results of the study will be made available to local Natural England staff and the North York Moors National Park Authority. Subject to resources and data availability, similar work should be undertaken to investigate changes to burning in other SPAs and to further explore potential relationships with Merlin habitat requirements, including prey availability.

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TECHNICAL REPORT

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NATURAL ENGLAND

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1 Project aims and objectives

Despite much debate about the impacts of rotational burning on upland habitats (e.g. Tucker, 2003; Stewart et al., 2004; Worrall et al., 2011; IUCN, 2011; Glaves et al., 2013) to date there have been few empirical studies relating moorland fire management to the status of raptors such as merlin (*Falco columbarius*).

This IPENS project aims to evaluate the intensity of management burning in 84 $1km^2$ squares over two time periods, 1995 and 2009, half of which contain records of merlin nests and half of which were randomised controls. To achieve this the following objectives were defined:

i: Source digital geo-referenced imagery for the sample squares.
These were provided by NE.

ii: Undertake manual digitisation of visible burn scars using the protocols defined in Yallop et al 2006.
These are summarised in Section 2.

iii: Undertake statistically appropriate error assessment of completed burn mapping.

iv: Provide digital burn maps for each sample square.

Note: No analysis of burn mapping or intensities related to Merlin nest data were requested and therefore this was not undertaken.

2 Methods

2.1 Methodology: Background to burn API

As with all aerial photographic interpretation (API) the only evidence for estimating the approximate extent and age of a burn in any imagery is the textural, spectral, and contextual information it contains. For evidence of burns to be visible some characteristic signature that separates these from unburned areas has to be manifest in the image. How quickly this signature disappears from the landscape, relative to the frequency of aerial imagery acquisition, as the burned community recovers, is clearly an important factor controlling the ability to detect and assess burn extent using this technique.

Even where patches of burn are readily apparent within aerial imagery characterisation of burn history within a sample segment is still not a trivial problem. Almost all large blocks of *Calluna*, for example, will at some stage have been managed by fire so the simple question 'how much has been burned?' would rationally return a value of 100% for almost all *Calluna* in an image. The question therefore requires re-staging as ‘how much has been burned within a given period?’ Many previous studies simply report an areal extent of 'burn'. It is apparent these reported 'burns' would be recognised as lighter features, with distinctive regular boundaries, within a matrix of darker mature *Calluna*. However, in reality these areas probably really represent newer burn within areas of older burn, hence should more correctly be identified as 'visible burn' or 'recent burn'.

Previous work undertaken by the authors for Cranfield University demonstrated that it is possible to extract more information than simple burn extent from 25cm resolution colour imagery. Within single images a number of factors can be used to estimate the time since each block was burned.

The texture and colour of *Calluna* regrowth together with the pattern of overlying burns allows a good estimate of at least the sequence of burns on a site. However, comparison between sites requires rather more stability than such an approach generates. It has been found that generally four classes of *Calluna* re-growth relative to burn can be identified consistently across most colour high resolution images. The features of these classes are presented in Table 2.1. overleaf.

Table 2.1 Classes of *Calluna* re-growth recognisable during API of high resolution colour aerial imagery and their main visual characteristics.

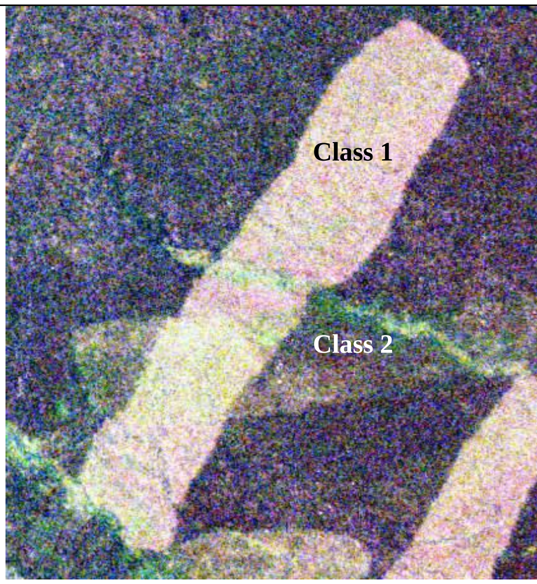
Class	Represents	Characteristics
1	Open, sparse, or nonexistent *Calluna* canopy *new burn*	colour varies according to substrate and sward mix - *i.e.* presence of fast regenerating grasses and presence or absence of visible burned remains texture varies with age of *Calluna* burned
2	Partial and closing *Calluna* canopy *recent burn*	presence of darker patches of regenerating heather
3	Dense even canopy - mature *mid-aged burn*	complete dark and visibly smooth canopy
4	Uneven canopy - degeneration phase *old burn or unmanaged*	complete canopy, looks both slightly lighter than 3 owing to presence of visible lighter stem material and has distinctive 'lumpy' texture no relic burns patterns are visible within this class - hence it is impossible to distinguish whether class 4 represent areas of old burn or unmanaged *Calluna*

There is much variation in both texture and colour of these burn classes resulting from factors such as the composition of the burned community, the age of *Calluna* when last burned and the abundance of other faster recovering vegetation such as *Poaceae*. Despite this variation, the four classes are consistently identifiable in aerial imagery with a 25cm resolution. However, reconstruction of the boundaries of overlap areas can still be problematic, especially where class 3 has been extensively re-burned.

Examples of each class are shown in Figure 2.1.

Areas of Class 1 (diagonal) overlying area of Class 2. The smooth texture and light colouration of a burn patch with no apparent *Calluna* regeneration defines Class 1.

The apparent, but incomplete, canopy of regenerating *Calluna* shown in the near horizontal patches define Class 2.



Two strips of Class 3 lying within a matrix of Class 4. The darker and smoother textured nature of a dense canopy of regenerating *Calluna* is clearly visible.

Once the late mature and degeneration stage of *Calluna* growth is reached the texture become noticeably 'lumpy' and the area lightens as stem and ground becomes visible.

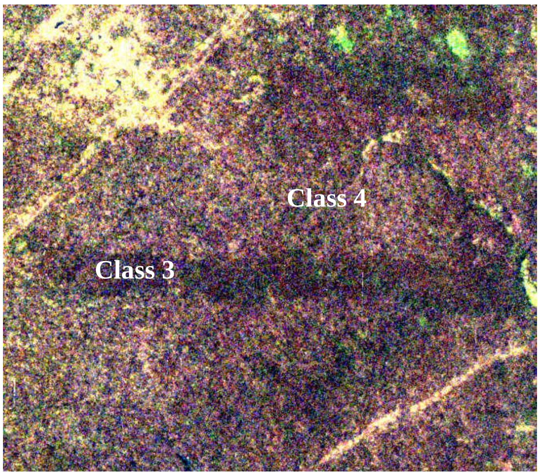
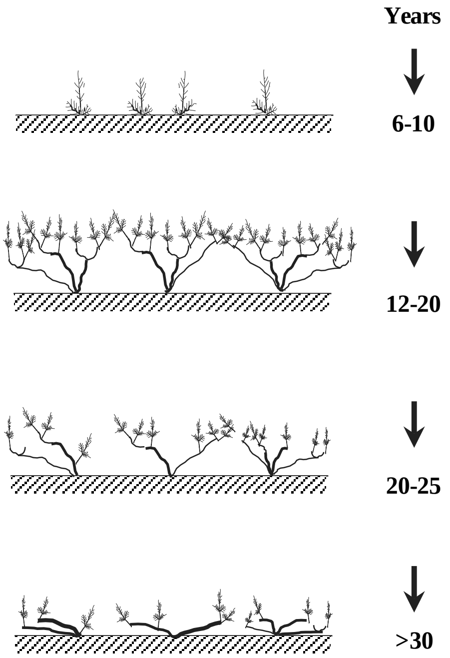


Figure 2.1 Examples of appearance of burn classes in 25cm aerial imagery.
It should be noted that no mapping of Class 3 was undertaken for this project and the area of 3 and 4 combined was reported.

While interpretation into these categories is consistently applicable the actual age or time since burn that each class represents is rather 'fuzzier' and varies according to the rapidity of *Calluna* regeneration. Although undoubtedly a simplification of very wide range of responses, especially resulting from meteorological and soil conditions, consideration of the suggestions by Gimingham (1959) allows a possible framework for interpreting growth classes into approximate age for *Calluna* re-growth, see Figure 2.2. Note however these are very approximate and in places sufficient regrowth to allow reburning may occur in 6 years or less.



Pioneer
seedling establishment to development of plant fully into a bush - long/short shoot differentiation

Building
from above until the plant is typically 15years old - the bush-like form grows to cover larger area

Mature
lasts until plant is typically 25 years old growth continues but less - centre of the bush thins and many shoots prostrate

Degenerate
growth declines much further - bush very 'thin' all shoots prostrate - ultimately death

Figure 2.2 Suggestions of growth phase and age in *Calluna vulgaris*

after Gimingham (1959)

Class 1 represents part of the early pioneer stage before plant size and density makes *Calluna* readily visible within the image. As such it most likely covers the period immediately after a burn to around 2-4 years following it. While re-growth from the burning of some stands of vigorous, healthy *Calluna* can be fast, older over-mature stands often recover slowly and, in some case where the peat surface is burned, little growth may be apparent even many years after a burn.

Class 2 represents a period between late pioneer and early building phases and probably covers years 2-7 since burning, depending on *Calluna* response and vigour.

Class 3 represents the mid to late building phase and into early mature, *i.e.* perhaps 7- 25 years. The smooth texture of this class identify it as being terminated by the change in appearance as stem length reaches the stage where central gaps begin to appear in the foliage of each plant. This textural change is readily apparent in 25cm imagery and defines class 4, which can be taken to cover perhaps the period of 22 years and onwards since burn. No upper age limit is placed on class 4 and, although it might perhaps be possible to deduce from the homogeneity of the stand whether it has been managed over a longer period, this has generally not been attempted.

It is usually possible to separate two sub classes within class 1 when near infra-red (NIR) data are available as in modern digitally captured airborne imagery. This additional information allows very new burns (1-2 years) to be distinguished from those of perhaps 3 and 4 years. However, while NIR was available for the later imagery used in this project, that for 1995 was ‘wet film’ RGB. For consistency therefore no sub-division of this class was made.

2.2 Methodology: modification from basic protocol for merlin study

The principles defined in 2.1 were utilised for burn mapping within all study squares. However, owing to the relatively poor quality of the imagery for 1995, together with the absence of a requirement to identify older burns no differentiation of class 3 and 4 was made. Instead class 3 and 4 were mapped as a single class and identified within data outputs as class 4.

2.3 Determination of mapping and burn area accuracy

Once manual burn mapping was complete accuracy of interpretation was assessed using an independent observer (i.e. one not deployed in creation of the burn map).

For each sample square a grid of 400 points was overlain on the imagery and each point assigned to a burn class. Once this process was complete the results were compared to the original mapping and an accuracy determined.

2.4 Data issues

Imagery for 1995 was supplied as geo-referenced (warped) jpeg images of original individual airphoto contact prints. These were of variable quality and many sample squares were not covered completely by a single image. As each individual image warp was not an ‘exact’ edge-matched ortho-correction this led to considerable apparent spatial shifts of objects *inc. burns* within some sample squares. In places, long burns required digitizing from two images, each showing an offset of tens of metres. As well as internal spatial displacement this also resulted in some objects moving across the sample square boundary.

Where this has occurred a ‘best-guess’ approach was adopted. Worse cases were also noted as a text comment field within the supplied shapefile.

3 Provision of digital data, format and content

The following datasets are provided in Arc shapefile format:

Two burn mapping files

Merlin_1995_v3.shp
Merlin_2009_v3.shp

These contain the following fields:

i: 1kmsq
Original supplied sample square identification

ii: ML_2008
Original supplied identifier related to merlin survey

iii: ML_1993
Original supplied identifier related to merlin survey

iv: ML_1994
Original supplied identifier related to merlin survey

v: Random
Original supplied identifier differentiating merlin survey squares from control squares

vi: Image_yr
Date of imagery used for burn mapping, data provided by NE

vii: Coverclass
Burn class as mapped. Provided as single feature per sample square. Zero used to identify all areas of non-heather dominated community

viii: Area_m
Area of each feature in m^2

ix: Comments
Text field containing any points of particular note

x: Accuracy
Overall mapping accuracy

In addition 'Merlin 1km error' is provided in Arc shapefile format.

This contain the following fields:

i: 1kmsq
Original supplied sample square identification

ii: Acc95
Mapping accuracy for all classes from 1995 imagery

iii: Acc09
Mapping accuracy for all classes from 2009 imagery

All shapefiles provided in British National Grid projection.

4 References

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