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HABITAT FRAGMENTATION AND HEATHLAND SPECIES

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SUMMARY

1. The present day occurrence of eight indicator species was examined on the same patches of heathland in Dorset as those surveyed by Moore in 1960 (Moore 1962).

2. Unlike Moore, who determined the presence and absence of the indicator species from field survey, the exercise described used records from existing data sets, chiefly those held by the Dorset Environmental Records Centre, the Royal Society for the Protection of Birds and the Institute of Terrestrial Ecology, Furzebrook.

3. Moore demonstrated that as isolation of the heathland patches increased the number of indicator species was reduced.

4. Using records of the indicators species since 1980, the same general pattern was found. In addition, over the last thirty years, there has been a trend for all heaths to loose species; however, the rate of loss has been greatest on the isolated heaths. This observation confirmed the prediction made by Moore (1962).

5. The results obtained are discussed in the context of developing a set of indicator species to assess heathland quality.

1 INTRODUCTION

In Britain most areas of conservation value are fragments of semi-natural communities which were formerly more extensive but have now been reduced as a result of modern patterns of land use. Because resources are limited only a selection of these patches can be adequately conserved.

Many early attempts assessed patches simply on their richness or diversity both in terms of species and the range of habitats contained with their boundaries (Ratcliffe 1977). Following developments in ecological theory, particularly the MacArthur & Wilson (1967) theory of island biogeography, size, degree of isolation from other similar patches and dynamics were added to the factors to be considered. The application of this theory was very attractive for the simplicity and clarity of the conclusions it suggested. Large patches would contain more species than small and the more isolated a patch from a source of colonists the fewer species it was likely to contain. The analogy between patches of semi-natural communities and oceanic islands was never satisfactory for a variety of reasons. First, patches were not isolated by an inhospitable sea, the matrix of land between the patches, and this enabled some species to survive while moving between patches. Secondly, dispersal to a patch was not from a single continent but from other islands (Webb & Hopkins 1984). There has been much discussion as to whether single large patches conserve more species than a suite of smaller patches (the SLOSS arguments: see for instance the review of Spellerberg 1991). There has however been less emphasis on the dynamic aspects such as population persistence and turnover within a patch, the interactions of species populations between patches, interspecific population interactions between patches and the surroundings (the matrix in which the patch is located) and the process of dispersal and the role of corridors and areas which provide linkages and stepping-stones between patches. Dynamic aspects have been emphasised much more with the development of theories of metapopulations (see Gilpin & Hanski 1991), although here also the theory is more attractive than the practice.

While there may be considerable interest to the ecologist in examining these theoretical positions, there remain simple practical needs of the conservationist who requires a straightforward way of apportioning resources to the conservation of the remaining patches of semi-natural communities. The concept of indicator species has long been regarded as a straightforward solution to this problem.

Indicator species fall into two categories. In the first, indicator species are used to recognise and define communities. For the most part, these species are widespread and abundant. Where additional evidence of conservation value is required for an area the presence of rarer species is usually considered. Although indicators, this first group of species defines the state of an area. To be indicators the second category of species must both be characteristic of the area (stenotypic) and also responsive to change in a known way. These species will indicate not only that an area has changed but in which direction. These are perhaps the most useful group of indicator species and are likely to be different from those used to describe and define a community. They may be the rare species, they are certainly stenotypic and they should respond rapidly to change. Further, they should be easy to identify and to monitor in the long term.

English Nature is embarking on a major programme of heathland conservation that includes proposals to restore former heathland areas and to improve the management of others. In choosing priority areas for restoration the possibilities of linking up or expanding sites may form some of the criteria to be used. Can this general presumption be made in terms of a series of indicator species that may be used to judge the success of the heathland programme and other initiatives which attempt to reduce the effects of the past fragmentation of the heathlands?

This study attempts to identify which species are most at risk from heathland fragmentation in practice and whether these species could be used as markers in assessing the success of heathland conservation and restoration programmes.

2 MOORE'S HEATHLAND INDICATOR SPECIES

The now classic studies of the heaths of Dorset by Moore (1962) set the scene for many of the subsequent studies. Moore's aims were i) to estimate how much heathland remained in Dorset; ii) to identify areas to be preserved; iii) to determine how large a heathland reserve needed to be to support viable populations of the species it was designed to protect; iv) to determine the extent to which species survival was affected by changes in the surrounding land and v) to develop reserve management policies.

Moore considered that the trends in reduction in area and fragmentation would continue and he speculated to what extent the original flora and fauna would survive in both the changed habitats (biotopes) and as a result of fragmentation and a reduction in size of the heathland patches.

For this he examined the distribution of ten heathland indicator species and their presence and absence under different forms of existing land use. These ten species were easy to identify and observe and hence their presence on a given area could be assessed reliably. The ten species consisted of five pairs, of which one species was confined to heathland in Dorset while the other occurred in a wider range of biotopes.

The indicator species chosen were *Erica ciliaris* (Dorset heath) and *Erica tetralix* (Cross-leaved heath); *Ceriagrion tenellum* (Small red damselfly) and *Pyrrhosoma nymphula* (Large red damselfly); *Plebejus argus* (Silver-studded blue) and *Hipparchia semele* (Grayling); *Lacerta agilis* (Sand lizard) and *Lacerta vivipara* (Common lizard); and *Sylvia undata* (Dartford warbler) and *Saxicola torquata* (Stonechat). In each case the first member of the pair is confined to heathland while the latter occurs more widely.

Moore's method involved searching for each species over a period of five years on the heaths. All of the heaths greater than 32ha and most over 8ha were searched together with many of the smaller ones. All of the main types of land use were visited and care was taken, by repeated visits, to confirm negative results.

Moore was able to show that:

1 The ten species were able to survive slight changes in the habitat.

2 The effect of afforestation was complex. All ten species survived the early stages of planting but the indicators declined as the forest grew, with the Dartford Warbler disappearing first and the heathers last. Many of the ten species were able to survive in rides and at forest edges, although this depended on the amount of shading.

3 Clear felled plantations regained most of their heathland species including the ten indicators.

4 The development of mineral workings destroyed the heath with the loss of all species, but when the workings were abandoned all ten returned. Particularly important were the small pools which were quickly colonised by dragonflies.

5 None of the ten indicator species survived agricultural conversion. Heath species could persist in hedgerows but here the animals disappeared first and the heathers last.

6 In urban conditions (gardens) the pattern of change was similar to agricultural land but more rapid.

Moore also showed, by considering the eight animals from his ten indicator species, that there was impoverishment of the faunas of the isolated heaths.

3 METHODS USED IN A NEW STUDY OF HEATHLAND INDICATOR SPECIES

3.1 Defining Patches of Heathland

To establish biologically meaningful criteria to define patches of heathland is difficult. Over the years, various authors have adopted a variety of criteria.

Moore (1962) considered there to be about 100 patches of heath with an area exceeding 4 ha, but he did not enumerate those smaller than this. Webb & Haskins (1980), while recognising that it was difficult to establish biological criteria to define a heathland patch, adopted a purely arbitrary system based on physical isolation. They estimated there to be 768 patches of which 14 exceeded 100 ha in extent and 680 were less than 10 ha. In an attempt to provide a more realistic picture, Chapman, Clarke & Webb (1989) defined heathland patches in terms of the cover of heathland vegetation. They drew upon survey data collected by Webb & Haskins (1980) which provided estimates of percentage plant cover from 3110 4ha-survey squares throughout the Dorset heathlands. They combined squares to form fragments using the following simple rule. Squares containing heathland vegetation were considered to belong to the same patch when they touched along their sides at any level of plant cover but where they touched diagonally they were only considered as part of the same patch when percentage cover exceeded 75% in at least one of the squares (Chapman *et al.* 1989).

The procedure for combining survey squares generated 141 patches of heathland throughout Dorset. The pattern and distribution was similar to that which would have been constructed from a map, or aerial photograph or a similar procedure. It was judged to have been a successful exercise since it produced a pattern of distribution which accorded with that which one recognised.

Using the procedure of Chapman *et al.* (1989), a map of the patches of heathland in Dorset was plotted to provide the base map on to which the records of heathland species abstracted from the various sources were plotted.

3.2 Data Sources

The principal data for these analyses were those held by the Dorset Environmental Records Centre. The Centre searched its archive for records since 1980 for the species listed in Table 1 from National Grid 10 km-squares SY78, ST71, SZ18 and SU11 (Figure 1). Records were extracted for the ten species used by Moore together with five others. Only records with at least a six figure National Grid reference were abstracted as this enabled them to be located within the 4-ha squares used by the Dorset Heathland Survey.

The Royal Society for the Protection of Birds supplied data on Woodlark, Nightjar, Dartford Warbler and Stonechat (Table 2). No new sites were added by these data to those available through DERC and the coverage of the heaths visited by Moore was complete.

Data for Dorset heath *Erica ciliaris* were availabe form the records from surveys conducted by ITE in recent years.

Few data were available showing the distribution of Cross-leaved Heath (*Erica tetralix*). However, it is a principal component of humid and wet heath

vegetation associations which were recorded in the Dorset Heathland Survey and its distribution has been inferred from these data. In practice *E. tetralix* was present on all of the 141 heathlands.

3.3 Distribution of Heathland Species

The overall distribution of heathland in Dorset is shown in Figure 1. Continuous areas of heathland greater than 100 ha are highlighted on this map. By inspection of Figure 9 in Moore's paper (Figure 2), it is possible to identify the patches of heathland which he examined and to relate them to the present day distribution of heathland patches. The extent of Moore's heaths in relation to the present distribution of heathland in Dorset is shown in Figure 2.

Using the names of the patches from the Dorset Heathland Survey, Moore's heaths correspond to the heaths in Table 3.

3.4 Distribution of Records in relation to the Patches of Heathland

Although variable, the distribution of records over the patchwork of the Dorset Heathlands is good. It was feared that records might have been concentrated on a few heaths which recorders visit regularly, but this appears not to be the case. The distribution of records for the species used by Moore is shown in Figures 4 - 14.

Erica ciliaris Dorset Heath

The records for this species can be regarded as giving a more or less complete representation of the current distribution of *E. ciliaris* in Dorset (Figure 4). The status of this species has been assessed recently (Chapman & Rose 1994 in press). The distribution of this species is on the heaths and remnant of heath within the forestry plantations on the southern shores of Poole Harbour. There are scattered outlying records which in many cases are single plants.

Erica tetralix Cross-leaved Heath

Despite is abundance and widespread occurrence, there are few records of *E. tetralix* in DERC. We have been able to generate a distribution map for *E. tetralix* by examining the plant associations recorded during the 1987 Dorset heathland Survey (Webb 1990). The map, Figure 5, can be regarded as a more or less complete representation of the distribution of this species on the Dorset heaths.

Ceriagrion tenellum Small Red Damselfly

Data on Odonata in Dorset are regarded as "fairly comprehensive" by Mahon & Pearman (1993?) as a result of the recording scheme which led to the publication of *The Dragonflies of Dorset* (Prendergast 1991). Figure 6 can therefore be regarded as a good representation of the distribution of this species.

Table 1

Records available from Dorset Environmental Records Centre for the Dorset Heathlands

Species	Number of Records
Moore's Indicator Species	
Erica ciliaris	3*
Erica tetralix	30*
Ceriagrion tenellum	127
Pyrrhosoma nymphula	141
Plebejus argus	132
Hipparchia semele	117
Sylvia undata	123#
Saxicola torquata	43
Lacerta agilis	42
Lacerta vivipara	50
Other Species	
Rhynchospora fusca	80
Rhynchospora alba	95
Lycopodiella indudata	29
Pholidoptera griseoaptera	10
Metrioptera brachyptera	74
Caprimulgus europaeus	68
Lullula arborea	24

* Data for *Erica ciliaris* and *E. tetralix* were derived from records held by ITE

Data for Dartford Warbler nest sites in 1984 were available from the RSPB.

Table 2

The number of sites from which records for heathland birds are available. Data supplied by the RSPB.

	1990	1991	1992	1993
Woodlark	14	36	23	24
Nightjar	6	22	17	16
Dartford Warbler	8	25	16	18
Stonechat	6	22	17	16

Table 3

The names and patch number used in The Dorset Heathland Survey of the heaths studied by Moore (1962)

Patch Number	Name
4	Duddle Heath
7	Warmwell Heath
12	Winfrith Heath
14, 15, & 17	Southover Heath, Pallington Clump, Pallington Heath
27	Blackhill
31	Povington Heath
40	Decoy Heath/Northport Heath
46	Middlebere/Creech Heaths
56	Arne Heath
81	Studland/Godlingston Heaths
91	Canford Heath
141	Hengistbury Head

Pyrrhosoma nymphula Large Red Damselfly

As with *C. tenellum* the number of records for this species must be regarded as fairly comprehensive giving a reasonable pattern of distribution on the Dorset Heathlands (Figure 7).

Plebejus argus Silver-studded Blue

The recording scheme for butterflies in Dorset which led to the publication of Butterflies of Dorset (Thomas & Webb 1984) continues and therefore the records of this species can be regarded as fairly comprehensive (Figure 8). In 1992 and 1993 detailed survey of the presence of *P. argus* in each of the Dorset heathland Survey squares for the Purbeck heaths was undertaken these records give a complete picture of this species in Purbeck; however, these data have not been used in the current analysis.

Hipparchia semele Grayling

As a result of the butterfly recording scheme in the County the records for this species can be regarded as fairly comprehensive (Figure 9).

Lacerta agilis Sand Lizard

The records available from DERC cannot be regarded as providing a reliable picture for the distribution of *L. agilis* on the heaths in Dorset (Figure 10). Nevertheless, a wide distribution and records are available for each of the heaths used by Moore. No doubt further records could be obtained especially if the herpetological organisations were to be consulted.

Lacerta vivipara Common Lizard

Few records are available for this species and the map must be regarded as incomplete (Figure 11). Again, data may be available for sources other than DERC.

Sylvia undata Dartford Warbler

Data for Dartford Warbler are available from two sources. First, there are those records of nest sites recorded by the RSPB during the national survey of this species in 1984 (Figure 12). These data are now rather old and in the intervening period the Dartford Warbler has increased considerably in numbers as a result of a long series of mild winters. This species will be surveyed nationally again in 1994. Secondly, DERC holds a number of records of sightings of this species (Figure 13). There is a good correlation between the locations of these sighting and the locations of the nest sites.

Saxicola torquata Stonechat

This species is regarded as "a locally common resident" in Dorset (Prendergast & Boys 1983). Relatively few records are available from DERC and the map (Figure 14) give an incomplete picture of its distribution over the heathland areas of Dorset.

Overall, the number and distribution of records available is satisfactory for most species to enable a re-calculation of Moore's ratios. The Common Lizard and Stonechat are the only species where there is a conspicuous absence of records.