6 INDICATOR SPECIES

The idea that a group of species can be used as indicators to assess and monitor environmental quality and change is a simple and attractive one and has been successful in a number of cases. The range of species is considerable and they can be used in a variety of ways.

The first group are those which are used to describe and classify communities. A good example of this is phytosociology, the National Vegetation Classification for instance. Here an assemblage of species is used to distinguish one community from another. Further sub-divisions of the main community and the relationships between vegetation types can be defined by considering the presence and absence of other (indicator) species.

A second group of species is used to assess quality and to monitor environmental change. Perhaps the best example of this is provided by freshwater communities which are used to assess river water quality. Here there have been three approaches; first, a simple biotic index in which the differential responses of species to a pollutant is used to asses quality. Secondly, diversity indices (species richness and equitability) provides a more refined approach. Finally, the most detailed approach relates community structure to environmental variables (RIVPACS) to provide target communities against which physical and chemical stresses can be assessed.

The group of indicator species which are used to identify ancient woodland or to date hedgerows is similar to a biotic index. In these cases persistence and susceptibility to disturbance are the variables which determine the presence or absence of these species.

Finally there are species which have a high conservation value. The value is recognised in various listings. Red lists and RDBs are examples although strictly they are mainly with threatened species, not those of conservation value as such. The presence of one or more of these species at a site gives it a high conservation value. Sites may be valued both as examples of particular biotopes and as places where certain rare or notable species occur.

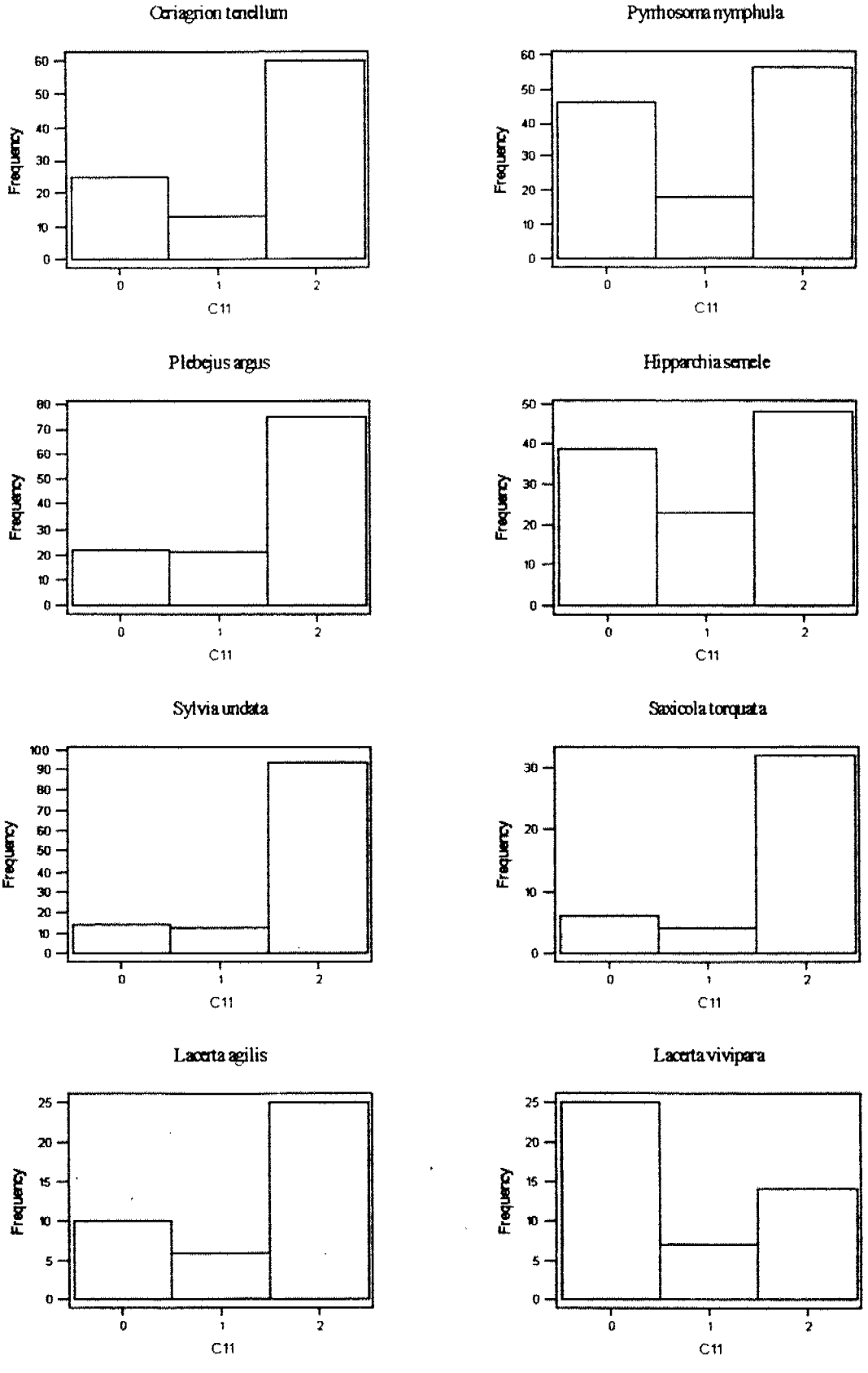
Generally indicator species have certain characteristics. They are taxonomically and ecologically highly diversified. They are restricted to the habitat, and are easy to observe, identify and to sample. Above all, they must show a direct and predictable response to change.

The heathland indicators used by Moore (1962) were primarily chosen to assess the effects of isolation. On isolated heaths, which were in general smaller than the less isolated, the chance of extinction was higher and the possibility of recolonization reduced. Hence, as Moore showed, fewer heathland species occurred on the isolated heaths than on the others.

What are the possibilities of developing a set of indicator species for heathland? First, there is little need to develop a list to describe and classify the vegetation. Secondly, those species which are rare and notable and which can be used to assign conservation value are well known. However, to draw up a list of species which can be used to assess habitat quality is more difficult. For this last named objective to be met it is likely that an examination of diversity or community structure will be required, in effect developing an approach similar to RIVPACS. Indicator species are used to

FIGURE 19

Frequency diagrams of the distribution of records for both heath and generalist species. The three categories are; 0 = No heathland within the 4ha square; 1 = less than 50% of the square heathland; 2 = 50% or more of the square heathland.



assess quality and change where these themselves are difficult to measure. However, when it becomes difficult to record community structure it may be simpler to measure habitat quality directly. To some extent this must be the case for heathland as it will be simpler to inspect the vegetation than to record the presence of indicator species, especially if these are invertebrate animals. Invertebrates which are easy to collect are often difficult to sort and identify. When indicator species work well they indicate changes which are otherwise difficult to observe, such as a pulse of a pollutant in a river or a very long period without disturbance in a woodland.

In conclusion we suggest that lists of species of possible value as indicators on heathland be assembled and an attempt made to develop a set of species useful in assessing habitat quality. This is likely to be a prolonged and iterative process.

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INSTITUTE OF TERRESTRIAL ECOLOGY
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Habitat Fragmentation and Heathland Species: Supplementary Report

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C O N T E N T S

SUMMARY

1. As a result of additional data becoming available, a further analysis of the occurrence of eight heathland indicator species in 1960 and at the present time has been made.

2. This analysis shows little change from the overall pattern reported by Webb & Rose (1994). The largest heaths still contain all 8 indicator species.

   There have been losses from the smaller isolated heaths with the generalist species showing marked declines.

   The smaller heaths tend to be more dynamic, both losing and gaining species.

3. Lists of species of possible use as indicators are presented. These cover spiders, butterflies and moths, ground beetles, bugs and plants.

1 INTRODUCTION

In the previous report (Webb & Rose 1994) an analysis was made of the occurrence of eight heathland species in relation to patch size and isolation. The eight species chosen were those used by Moore (1962). The repetition of Moore's exercise confirmed his finding that where heaths were more isolated they tended to lack characteristic species. In addition, the prediction made by Moore that the small and isolated heaths would continue to lose heathland species was confirmed.

Moore used only eight indicator species all of which were animals. It is of interest to consider what other species could be used both to examine the effects of fragmentation and isolation and also to assess habitat quality.

This supplementary report presents details of some further analyses. First, because additional data are now available, the basic exercise has been repeated and secondly, a wider range of species, mostly invertebrates, has been examined with a view to developing a set of heathland indicator species.

2 A FURTHER STUDY OF THE STATUS OF MOORE'S INDICATOR SPECIES

Webb & Rose (1994) presented a table (Table 4) comparing the presence between 1959-60 and 1980-93 of Moore's 8 heathland indicator species on twelve heathlands. This comparison was made almost entirely from records available from the Dorset Environmental Records Centre. Since that comparison was made, a number of other records have been located.

First, it was realised that the 1980-93 records were deficient particularly for the Common and Sand Lizards. The Herpetological Conservation Trust through K Corbett have now made available data on for the presence of both lizards on each of the twelve study sites and this has enabled a full comparison to be made between the two surveys.

Secondly, by making enquiries within ITE and the RSPB a number of other records for dragonflies and butterflies have been located.

Thirdly, Dr N W Moore has very kindly searched his own field notes in which he recorded which of the heathland species were present on the twelve sites in 1959-60. Previously, only the totals had been published (Moore 1962) and Webb and Rose (1994) confined their analyses only to changes in total numbers of species. It should be noted that Dr Moore has drawn attention to a misprint in his paper and that all eight species were recorded from Studland Heath. In his paper this was recorded as having 4 heathland species and only 3 of the generalist species.

These more complete data are reproduced in Tables 1 and 2 and summarized in Table 3.

The overall pattern remains the same as that described by Webb & Rose (1994). Warmwell Heath, Pallington and Hengistbury Head have lost both heathland and generalist species. In contrast, Povington Heath, Decoy/Northport Heaths, Middlebere/Hartland Heaths, Arne Heath, Studland/Godlingston Heaths and Canford Heath still contain all eight indicator species. These heaths are the largest areas.

Duddle Heath shows no change in the overall number of species between the two surveys. However, the composition of the fauna has changed with the loss of Stonechat and the gain of *Pyrrhomsoma nymphula*.

The species composition of the remaining five sites has changed to some degree. Warmwell Heath has lost its two heathland species (*Ceriagrion tenellum* and *Plebejus argus*) as well as *Hipparchia semele* and Stonechat from amongst the generalist species.

Winfrith Heath is an interesting site. In 1959-60 it may have contained all eight species although confirmation of the presence of *Plebejus argus* and *Pyrrhosoma nymphula* was lacking (N W Moore personal communication). The data for 1980-93 confirm the presence of *P. argus* and *P. nymphula*. The present status of Sand Lizard (*Lacerta agilis*) is uncertain. In 1960 the extent of this heath was less due to the construction of the atomic energy establishment. From his map, Moore surveyed only those parts of Winfrith Heath which today lie outside of the UKAEA security fence, the area inside the fence having almost no heathland. Since that time heathland has regenerated within the AEA site and the Sand Lizard was reported from the this area in the early

Table 1 1959-1960

Our No	Our Heath	Heath spp.				Total	General spp.				Total
		C.t.	P.a.	L.a.	S.u.		P.n.	H.s	L.v.	S.t.	
4	Duddle					0		✓	✓	✓	3
7	Warmwell	✓	✓			2	✓	✓	✓	✓	4
14,15,17	Pallington	✓	✓		✓	3	✓	✓	✓	✓	4
12	Winfrith	✓	(?)	✓	✓	3(4)	(?)	✓	✓	✓	3
27	Blackhill		✓	✓	✓	3		✓		✓	2
31	Povington	✓	✓	✓	✓	4	✓	✓	✓	✓	4
40	Decoy	✓	✓	✓	✓	4	✓	✓	✓	✓	4
46	Middlebere	✓	✓	✓	✓	4	✓	✓	✓	✓	4
56	Arne	✓	✓	✓	✓	4	✓	✓	✓	✓	4
81	Studland	✓	✓	✓	✓	4	✓	✓	✓	✓	4
91	Canford	✓	✓	✓	✓	4	✓	✓	✓	✓	4
141	Hengistbury	✓				1	✓	✓	✓	✓	4

C.t. = *Ceriagrion tenellum*
P.a. = *Plebejus argus*
L.a. = *Lacerta agilis*
S.u. = *Sylvia undata*
P.n. = *Pyrrhosoma nymphula*
H.s. = *Hipparchia semele*
L.v. = *Lacerta vivipara*
S.t. = *Saxicola torquata*

Table 2 1980-1993

Our No	Our Heath	Heath spp.				Total	General spp.				Total
		C.t.	P.a.	L.a.	S.u.		P.n.	H.s	L.v.	S.t.	
4	Duddle					0	✓	✓	✓		3
7	Warmwell					0	✓		✓		2
14,15,17	Pallington					0			✓		1
12	Winfrith	✓	✓	(✓)	✓	3(4)	✓	✓	✓	✓	4
27	Blackhill	✓	✓		✓	3	✓	✓	✓	✓	4
31	Povington	✓	✓	✓	✓	4	✓	✓	✓	✓	4
40	Decoy	✓	✓	✓	✓	4	✓	✓	✓	✓	4
46	Middlebere	✓	✓	✓	✓	4	✓	✓	✓	✓	4
56	Arne	✓	✓	✓	✓	4	✓	✓	✓	✓	4
81	Studland	✓	✓	✓	✓	4	✓	✓	✓	✓	4
91	Canford	✓	✓	✓	✓	4	✓	✓	✓	✓	4
141	Hengistbury	✓			(✓)	1(2)	✓		✓		2

C.t. = *Ceriagrion tenellum*
P.a. = *Plebejus argus*
L.a. = *Lacerta agilis*
S.u. = *Sylvia undata*
P.n. = *Pyrrhosoma nymphula*
H.s. = *Hipparchia semele*
L.v. = *Lacerta vivipara*
S.t. = *Saxicola torquata*

Table 3

A comparison of the presence of 8 heathland indicator animals between 1960 and 1980-93. H = stenotypic heathland species; G = more widespread species not completely dependent on heathland.

Heath No	Name	1960 H	1960 G	Area 1960	1980-93 H	1980-93 G	1987 Area (ha)
4	Duddle H	0	3	42	0	3	42.5
7	Warmwell	2	4	37	0	2	32.9
12	Winfrith	3	3	131	3	4	277.7
14	Southover)						(6.7
15	Pallington)	3	4	31	0	1	(1.8
17	Pallington)						(2.0
27	Blackhill	3	2	72	3	4	51.6
31	Povington	4	4	1159	4	4	499.3
40	Decoy/Northport	4	4	270	4	4	302.7
46	Middlebere	4	4	883	4	4	699.5
56	Arne	4	4	335	4	4	233.0
81	Studland/Godlingston	4	4	706	4	4	602.4
91	Canford	4	4	872	4	4	470.6
141	Hengistbury	1	4	37	2	2	33.7

1980s although there are no recent reports. It is absent from the areas outside of the UKAEA fence having become extinct as a result of the severe fires in 1976 (K Corbett personal communication).

As in the earlier study, the group of heaths at Pallington provide the most stark picture. In 1960 this was a single heath with an area of 31 ha; today it has been broken up into 3 separate areas of 6.7 1.8 and 2.0 ha respectively. As a result of this fragmentation three heathland species, (*Ceriagrion tenellum*, *Plebejus argus* and Dartford Warbler) and 3 generalist species (*Pyrrhosoma nymphula*, *Hipparchia semele* and Stonechat) have been lost since 1959-60; only the Common Lizard remains.

Dr N W Moore considered (personal communication) there to be no suitable habitat for *Ceriagrion tenellum* and *Pyrrhosoma nymphula* on Blackhill and he recorded their absence in 1959-60 together with that of the Common Lizard (*Lacerta vivipara*). The current records show all three species to be present and of the eight indicator species only the Sand Lizard is currently absent.

In 1959-60 on Hengistbury Head all four generalist species and only *Ceriagrion tenellum* of the heathland species were present. Today, *C. tenellum* remains while *Hipparchia semele* and Stonechat have been lost. Of considerable interest is the fact that a pair of Dartford Warbler established on the Head in 1993.

Small Red Damselfly (*Ceriagrion tenellum*) is still present on all the sites from which it was recorded in 1959-60 with the exception of Warmwell Heath and Pallington. As a result of intensive searching its presence on Blackhill has been confirmed in the last two years where there is a small area of suitable habitat with a strong colony. This is a relatively mobile species able to colonise new sites.

The Silver-studded Blue Butterfly (*Plebejus argus*) has been lost from Warmwell Heath. Its presence on Winfrith Heath in 1959-60 was not confirmed; however, today it is present. This species is known to be very sedentary.

The Sand Lizard (*Lacerta agilis*) appears to have been lost from Blackhill and possibly from Winfrith Heath. Otherwise it remains on all the sites from which it was reported in 1959-60. Like the Silver-studded Blue, the Sand Lizard must be regarded as a sedentary species.

The Dartford Warbler (*Sylvia undata*) has been lost from Pallington, otherwise it occurs on all of the heaths from which it was recorded in 1959-60. In addition in 1993 a pair established on Hengistbury Head. The Dartford Warbler is the most mobile of the eight species and its colonisation of Hengistbury Head reflects the fact that the population of this warbler has built up to from 121 pairs in 1984 to some 1200 pairs in Dorset today.

The Large Red Damselfly (*Pyrrhosoma nymphula*) has been lost from Pallington since 1959-60. However, it has been reported from Duddle and Blackhill in the later surveys.

The Grayling (*Hipparchia semele*), which was recorded from all sites in 1959-60, has been lost from Warmwell Heath, Pallington and Hengistbury Head. This species is known to have declined considerably in Dorset (Thomas & Webb 1984; Webb & Rose 1994) and its loss from these heathlands may be associated with this decline.

The Common Lizard (*Lacerta vivipara*) was reported from all sites in 1980-93 but in the previous survey was not reported from Blackhill.

The Stonechat (*Saxicola torquata*) has, perhaps, shown the greatest decline of the eight species. It was present at all sites in 1959-60 but has since been lost from Duddle Heath, Warmwell Heath, Pallington and Hengistbury Head. Its decline on the Dorset Heaths reflects is overall national decline in recent years (Gibbons, Reid & Chapman 1993).

The pattern of gains and losses provide an interesting picture. There has been a loss of species from the smaller, outlying heaths. Warmwell has lost two heathland species, Pallington three heathland species, while Blackhill has lost the Sand Lizard, which is not very mobile, and gained the mobile *C. tenellum*. Likewise, Hengistbury Head has gained the mobile Dartford Warbler and the relatively mobile *P. nymphula* has colonised both Duddle Heath and Blackhill.

Perhaps the surprising change has been the losses suffered by the two generalist species Grayling and Stonechat. Both have been lost from 4 sites, whereas of the four heathland species losses have been from no more than two sites for any one species (Table 4). These losses reflect national declines in both species and they have been lost from the areas between the heaths primarily as a result of habitat change. This pattern of change suggests that the populations of these species on the smaller and more isolated heath were dependent on populations of these species in the surrounding areas to maintain their heathland populations. With the decline of the species in the surroundings of the heathlands the chances of them becoming extinct on the small heaths has increased. In addition, the availability of the habitats of these species on the heaths may have declined through lack of or changes in management.

Although there has been an overall decline in the occurrence of the indicator species which has affected the small outlying heaths the most, there have also been gains even on outlying heaths. This emphasises the dynamic nature of these sites where, according to biogeographic theories, one would expect a greater rate of extinctions and a lower rate of colonisation. It also emphasises the stability of the large heaths, which have, retained their indicator species. However, even here there can be losses such as the Sand Lizard from Winfrith. The greater area of the large heaths will have masked local changes in species composition within them. Populations of species confined to patches of suitable habitat within these large heaths may have become extinct or have re-established at new locations within the heath.

Table 4

The number of sites from the 12 heaths surveyed by Moore (1962) from which the eight heathland indicator species have been lost or gained since 1959-60

Species	Sites Lost	Sites Gained
Ceriagrion tenellum	2	1
Plebejus argus	2	1
Lacerta agilis	2	-
Sylvia undata	1	1
Pyrrhosoma nymphula	1	3
Hipparchia semele	3	-
Lacerta vivipara	-	1
Saxicola torquata	4	-

3 SPECIES OF POSSIBLE USE AS INDICATORS

3.1 Introduction

This section will consider a range of other species which could be used to draw up a set of heathland indicators. At this stage they are no more than suggestions of species from various groups and a good deal of refinement and consultation with specialists is needed to develop a practical list of heathland indicators.

3.2 Heathland spiders

In 1979 under contract from the Nature Conservancy Council, ITE surveyed the invertebrates on 22 heathlands in Dorset which differed in size and the their degree of isolation (Webb 1981). Spiders (Araneae) were one of the groups analyzed. A total of 158 species were recorded during the survey and Dr P Merrett drew up a list of 60 species (Table 5.10 in Webb 1981) which he considered to be characteristic of heathland. These data are difficult to interpret. When all spiders (ie including the heathland group) were considered, no clear trends between site area and degree of isolation were detected. There was a weak positive relationship between site area and the richness of heathland spiders.

Hopkins & Webb (1984) showed by using ordination analysis that of all the spiders collected during their survey the first axis of variation, which accounted for 23% of the total variation, was dominated by species from the sub-set of heathland spiders which they had defined. This axis appeared to represent a change from "poor quality" to good quality heathland. They further tested the hypothesis that since spiders disperse by aeronauting or ballooning on a thread of web, the species absent or poorly represented on small or isolated heaths would be the poorer dispersers. They calculated an index of dispersability from five years of sampling on Hartland Moor NNR by Dr P Merrett. The surface living species were sampled by pitfall traps while the aeronauting species were collected in water traps placed above the canopy of the vegetation. The index of dispersability was calculated from

ln (number in water traps) - ln (number in pitfall traps)

A rank correlation between dispersal ability and species weight along axis 1 of the ordination produced significant correlations for both adult and juvenile spiders, so that species found on both large and small heath (ie those with a low score on axis 1) had a greater dispersal ability than those confined to large heaths (high scores on Axis 1). This analysis showed that those species of heathland spider with the poorest powers of dispersal were confined to the large heathlands and tended to be absent or in low abundance on the small heathlands. There was no species of heathland spider which occurred on small heaths that did not occur on any of the large heaths (Hopkins & Webb 1984).

This approach could be developed with a view to producing a group of heathland spiders the occurrence of which would be a measure of habitat quality. If for instance a site, especially a small or isolated one, had remained in a

suitable condition by providing the habitats of these species than one would expect a greater proportion of the heathland species to be present. If the habitat had been lost or had deteriorated in quality, then one would expect deletions from the list of heathland spiders with the poorest dispersers being absent first.

In the current study we have taken the 1979 list of spiders and drawn up a new set of heathland species (Table 5). Each species is described as 1) Rarely occurring in other biotopes; 2) more common on heathland than in other biotopes; and 3) ubiquitous (not mainly on heathlands. Species are also classified as 1) common; 2) Local; 3) rather scarce; 4) rare and 5) very rare.

3.3 Lepidoptera

Webb (1986) provided a list of 29 species of moth which are associated with heathland throughout Britain (Table 6). Of these species only 8 are monophagous on *Calluna vulgaris*; the other species while eating *C. vulgaris* also eat other plants. This list could provide a basis for a set of heathland indicator species.

More recently, a set of heathland moths appropriate to Dorset has been drawn up by Dr N R Webb and Dr P H Sterling (Dorset County Ecologist) (Table 7). This list could also form the basis of a set of heathland indicator species. The main draw-back with moths is the paucity of records not only for the heathlands but generally throughout Dorset; with the exception of a few favourite localities. However, the Dorset Environmental Records Centre is organising a new recording scheme for Dorset moths and this may well improve the situation.

In general moths are easy to collect, using a light trap, and easy to identify as there are now excellent identification guides available. However, since light trapping relies on activity, it is sometimes difficult to establish whether individuals caught represent species which are resident on a particular site or have been attracted from some distance. Nevertheless, despite these problems, moths are a group with a high potential to provide a set of indicator species.

Table 5

The set of heathland spiders derived from the total species list of spiders collected during the 1979 survey of the Dorset heathlands. For details of the classification see text.

Species	Biotope in which found	Rarity
Atypus affinis	3	2
Eresus niger	1	5
Dysdera erythrina	3	1
Drassodes cupreus	3	1
Haplodrassus signifer	3	1
Haplodrassus dalmatensis	1	2
Gnaphosa lugubris	2	4
Gnaphosa leporina	2	3
Micaria silesiaca	2	4
Clubiona trivialis	3	1
Scotina gracilipes	3	4
Scotina palliardi	2	4
Xysticus kochi	3	1
Xysticus robustus	3	4
Oxyptila scabricula	2	4
Philodromus aureolus	3	1
Philodromus histrio	1	3
Thanatus striatus	3	1
Heliophanus flavipes	3	1
Neon reticulatus	3	1
Euophrys petrensis	2	3
Euophrys aequipes	3	1
Evarcha arcuata	1	4
Pardosa palustris	2	2
Pardosa proxima	3	2
Xerolycosa nemoralis	2	3
Alopecosa accentuata	3	1
Arctosa perita	2	2
Hahnia nava	3	1
Episinus angulatus	3	1
Episinus truncatus	2	2
Euryopis flavomaculata	3	3
Theridion simile	2	2
Enoplognatha thoracia	3	1
Araneus adiantus	2	2
Hypsosinga albovittata	2	2
Cercidia promiens	3	2
Mangora acalypha	2	2
Walckenaera melanocephala	3	2
Walckenaera dysderoides	3	2
Walckenaera monoceros	3	2
Walckenaera corniculans	2	4
Walckenaera furcullata	2	4
Trichopterna thorelli	3	1
Mecopisthes peusi	2	3

Table 5 continued

Tapinocyba praecox	3	2
Tapinocyba mitis	2	4
Jacksonella falconeri	2	3
Micrargus laudatus	2	3
Porrhomma campbelli	3	3
Agyneta subtilis	3	1
Agyneta conigera	3	1
Sintula cornigera	3	3
Lepthyphantes mengei	3	2
Linyphia furtiva	2	3
Haplodrassus umbratilis	1	1
Ero aphana	1	1

Table 6

A list of the large moths occurring on heathland (from Webb 1986)

Pale Eggar	*Trichiura crataegi*	P	II	UL	X
Northern Eggar	*Lasiocampa quercus callunae*	M	II	UL	XX
Fox Moth	*Macrothylacia rubi*	P	II	UL	XX
Emperor	*Saturnia pavonia*	P	II	UL	XX
Ling Pug	*Eupithecia goossensiata*	M	I	UL	XXX
Narrow-winged Pug	*Eupithecia nanata*	M	II	UL	XXX
Double-striped Pug	*Gymnoscelis rififasciata*	P	I	UL	X
Horse Chestnut	*Pachycnemia hippocastanaria*	M	III	L	XXX
Bordered Grey	*Selidosema brunnearia*	P	III	UL	XXX
Ringed Carpet	*Cleora cinctaria*	P	III	L	XXX
Common Heath	*Ematurga atomaria*	P	I	UL	XXX
Dark Tussock	*Dicallomera fascelina*	P	II	UL	XX
Four-dotted Footman	*Cybosia mesomella*	P	II	UL	XXX
Scarce Footman	*Eilema complana*	P	II	L	XX
Speckled Footman	*Coscinia cribraria*	P	V	L	XXX
Wood Tiger	*Parasemia plantaginis*	P	II	UL	X
Clouded Buff	*Diacrisia sannio*	P	III	UL	XX
Lesser Yellow Underwing	*Noctua comes*	P	I	UL	X
Autumnal Rustic	*Paradiarsia glareosa*	P	II	UL	XXX
True Lover's Knot	*Lycophotia prophyrea*	M	I	UL	XXX
Ingrailed Clay	*Diarsia mendica*	P	I	UL	X
Small Square-spot	*Diarsia rubi*	P	I	UL	X
Neglected Rustic	*Xestia castanea*	M	II	UL	XXX
Heath Rustic	*Xestia agathina*	M	II	UL	XXX
Beautiful Yellow Underwing	*Anarta myrtilli*	M	II	UL	XXX
Black Rustic	*Aporophyla nigra*	P	II	UL	X
Dark Brocade	*Blepharita adusta*	P	II	UL	X
Yellow-line Quaker	*Agrochola macilenta*	P	I	L	X
Flounced Chestnut	*Agrochola helvola*	P	I	UL	X

M Monophagous, eating only *Calluna* and possibly species of *Erica*
P Polyphagous, eating a range of heathland plants including *Calluna*
I-V Scale of abundance, I = Common, V = Very rare
U Generally an upland species and frequently northern in distribution
L Generally a lowland species and southern in distribution
XXX Stenotopic, occurring only on heathland and not in other biotopes
XX Heathland species, but occurring in other habitats
X On heathlands, but occurring regularly in other biotopes.

Table 7

Lepidoptera: Dorset Heathland Specialists

Species	Great Britain Distribution
macrolepidoptera	
Chlorissa viridata Small Grass Emerald	Heaths/mosses in S. and Cumbria
Cyclophora pendularia Dingy Mocha	VCs 8,9,11 only
Idaea muricata Purple-bordered Gold	Fens/mosses heaths esp. in S.
Idaea sylvestraria Dotted Border Wave	Heaths in S. esp. VCs 9,11
Hydriomena ruberata Ruddy Highflyer	Widespread in N. & W.
Eupithecia goossensiata Ling Pug	Heaths/moors
Eupithecia nanata Narrow-winged Pug	Heaths/moors
Pachycnemia hippocastanaria Horse Chestnut	Heaths in S.
Dyscia fagaria Grey Scalloped Bar	Heaths/moors and mosses
Cleora cinctaria Ringed Carpet	Heaths
Coscinia cribraria Speckled Footman	VCs 9,11 only
Lycophotia porphyrea True Lover's Knot	Heaths/moors
Xestia castanea Neglected Rustic	Heaths/moors
Xestia agathina Heath Rustic	Heaths/moors
Anarta myrtilli Beautiful Yellow Underwing	Heaths/moors
Heliothis maritima Shoulder-striped Clover	Heaths in S. only

Stilbia anomala Anomalous	Heaths/moors rare in S.
Hypenodes humidalis Marsh Oblique-barred	Bogs/mires esp. in S.

microlepidoptera

Pachythelia villosella	Hants/Dorset heaths only
Stenoptilia graphodactyla	Hants/Dorset heaths only

3.4 Ground beetles

In the invertebrate surveys of Dorset heathlands in 1979 (Webb 1981) it proved difficult to identify a set of heathland ground beetles. As a result, a phytophagous set was drawn up and analyzed separately from a set called "All ground beetles" (see Webb 1989). Because of edge effects, small heathlands were found to be richer in phytophagous species than large heathlands.

The following is a list of heathland ground beetles (Carabidae) from which it might be possible to develop a set of indicators.

Cicendela campestris
Carabus nitens
Carabus problematicus
Carabus violaceous
Bembidion nigricorne
Bembidion quadrimaculatus
Pterostichus lepidus
Calthus erratus
Olisthopus rotundus
Amara aenea
Amara consularis
Amara tibilais
Harpalus anasius
Harpalus rubripes
Harplaus rufitarsus
Harpalus smagadinus
Dromus linearis
Metabeletus foreatus

Ground beetles are generally caught by pitfall trapping. Like light trapping this method is in part a measure of activity. Pitfall traps are generally thought to be useful in assessing the presence of a species at a particular location but do not give reliable estimates of abundance. While some ground beetles can be identified easily, the family as a whole is difficult and requires specialist knowledge and access to specialized taxonomic literature.

3.5 Hemiptera - Heteroptera

Some 35 species of Heteroptera are associated with heathlands. Eight of these feed on heather, a further fourteen on other heathland plants and ten are predatory. About half of these species are common but the remainder have restricted distributions. The list in Table 8 was prepared by Webb (1986) and could provide the basis for a set of indicator species.

Heteroptera can be collected by sweep netting, either hand nets or vacuum nets or by pitfall trapping. Many are straight forward to identify but others require some care. Currently, there is no easily accessible identification guide.

Table 8

A list of the typical heathland bugs (Hemiptera: Heteroptera)

Rhacognathus punctatus	C	III	UL	XXX
Alydus calcaratus	P	III	L	XXX
Rhopalus parumpunctatus	P	II	L	X
Rhopalus rufus	P	III	L	XXX
Nysius helveticus	M	IV	L	XXX
Ortholomus punipennis	P	V	L	XXX
Kleidocerys resedae	P	II	L	X
Kleidocerys truncatulus	M	II	L	XXX
Magalonotus dilitatus	P	III	L	X
Rhyparochromus pini	M	III	L	XXX
Trapezonotus arenarius	P	I	L	X
Macrodema micropterum	M	II	L	XXX
Stygnocoris pedestris	P	I	UL	XX
Ischnocoris angustulus	M	II	UL	XXX
Drymus sylvaticus	P	I	UL	X
Scolopostethus decoratus	M	I	UL	XXX
Eremocoris plebejus	P	V	UL	XX
Berytinus crassipes	P	II	L	X
Coranus subapterus	C	I	L	XX
Nabus ferus	C	II	L	X
Nabus ericetorum	C	II	UL	XXX
Stalia boops	C	III	L	X
Orius niger	C	II	L	XX
Deraeocoris scutellaris	C	V	L	XX
Systellonotus triguttatulus	P	II	L	XX
Globiceps crucuatus	C	III	L	XXX
Orthotylus ericetorum	M	II	UL	XXX
Mymecoris gracilis	C	III	L	XXX
Lygus pratensis	M	II	UL	X
Phytochoris varipes	P	II	L	X
Phytochoris insignis	P	V	L	XXX
Micracanthia marginalis	C	V	L	XXX

M	Monophagous, eating only *Calluna* and possibly other species of *Erica*
P	Polyphagous, eating other heathland plants besides *Calluna*
I-V	Scale of abundance, I = Common, V = Very rare
U	Upland species and frequently northern in distribution
L	Lowland species and mainly southern in distribution
XXX	Stenotopic, occurring on heathland and not in other biotopes
XX	Generally a heathland species, but occurring in other biotopes
X	On heathlands, but occurring regularly in other biotopes.

3.6 Orthoptera and related Orders

Compared with the lowland heaths on the mainland of Europe, the orthopterous fauna of British lowland heaths is very poor. Only three species can be considered to be associated with heathland, the Bog Bush Cricket (*Metrioptera brachyptera*), the Heath Grasshopper (*Chorthippus vagans*) and Large Marsh Grasshopper (*Stethophyma grossum*). The last two species have very restricted distributions on the heaths of Dorset and the New Forest. The Bog Bush-cricket is more widespread and is a species which is used currently in the assessment of heathland quality. Otherwise the Orthoptera, taken as a group, are not very useful as indicator species. However, the three rare species in combination with species from other orders could form part of a set of heathland indicators species.

3.7 Heathland Plants

Dry heathland has a relatively poor flora with few species. The greatest richness of species is to be found on the acidic grasslands associated with dwarf shrub heathland and on the wet heaths and valley mires.

Recently, in Dorset, Byfield & Pearman (1994) have visited all of the stands recorded by Good (1948) on heathland within the Poole Basin. They have determined the current presence and abundance of 31 rare heathland plants recorded by Good.

The species recorded were as follows:

Red Data Book Species

Eriophorum gracile
Erica ciliaris
Lobelia urens
Pulicaria vulgaris

Nationally Scarce Species

Cicendia filiformis
Crassula tillea
Deschampsia setacea
Gentiana pneumonanthe
Hammarbya paludosa
Hypochoeris glabra
Lotus subbiflorus
Lycopodiella indundata
Moenchia erecta
Persicaria minor
Potentilla argentea
Pilularia globulifera
Rhynchospora fusca
Trifolium glomeratum
Trifolium ornithopodioides
Trifolium suffocatum
Viola lactea

Dorset Red Data Book Species*

Carex lasiocarpa
Carex limosa
Chamaemelum nobile
Planthera bifolia
Sparganium natans
Whalenbergia hederacea

* Dorset Red Data Book = Mahon, A & Pearman, D (eds) Endangered Wildlife in Dorset

Other "Species of Note"

Anagallis minima
Apium inundatum
Baldellia ranunculoides
Drosera longifolia
Filago vulgaris
Genista anglica
Litorella uniflora
Pinguicula lusitanica
Potentilla palustris
Radiola linoides
Sagin subulata
Utricularia intermedia
Utricularia minor
Veronica scutellata

The survey by Byfield and Pearman was sponsored by the Royal Society for the Protection of Birds and by Plantlife. Many of the species are characteristic of wet heathland and valley mires, while other species area associated with sandy grass heaths.

The summary results are given in Table 8 (reproduced with permission). Which in general indicates a decline of most species. In further tables Byfield & Pearman analyse the species of the character types of heathland separately. Further analyses consider the effect that conservation designations of the sites has had on the persistence of these species. There is no analysis of species in relation to either heathland area or degree of isolation and this might be worth attempting as would a fuller statistical analysis of their data.

The 31 species survey by Byfield & Pearman provide the basis for a set of heathland plants which could be developed into a set of heathland indicators.

In general, higher plants are a group which are likely to provide a useful set of indicators.

Table 9

Overall decline in populations of indicator species from Byfield & Pearman (1993)

Species	Populations present 1990s/total number of stands in which plant recorded in 1930s	% decline (overall, from stands recorded by Good)
Anagallis minima	1/26	96.2%
Apium inundatum	3/10	70%
Baldellia ranunculoides	3/15	80%
Carex lasiocarpa	1/1	0%
Carex limosa	2/3	33.3%
Chamaemelum nobile	3/39	92.3%
Cicendia filiformis	0/12	100%
Crassula tillaea	0/7	100%
Deschampsia setacea	0/3	100%
Drosera longifolia	7/8	12.5%
Erica ciliaris	59/82	28%
Eriophorum gracile	0/1	100%
Filago vulgaris	1/23	95.7%
Genista anglica	5/28	82.2%
Gentiana pneumonanthe	23/46	50%
Hammarbya paludosa	1/2	50%
Hypochoeris glabra	1/10	90%
Littorella uniflora	1/11	90.9%
Lobelia urens	0/1	100%
Lotus subbiflorus	3/5	40%
Lycopodiella inundata	6/48	87.5%
Moenchia erecta	0/1	100%
Persicaria minor	0/3	100%
Pilularia globulifera	0/4	100%
Pinguicula lusitanica	6/26	76.9%
Platanthera bifolia	0/1	100%
Potentilla argentea	1/2	50%
Potentilla palustris	13/37	64.8%
Pulicaria vulgaris	0/1	100%
Radiola linoides	2/74	97.2%
Rhyncospora fusca	6/26	76.9%
Sagina subulata	0/16	100%
Sparganium natans	1/1	0%
Trifolium glomeratum	1/5	80%
Trifolium ornithopodioides	1/5	80%
Trifolium suffocatum	1/4	75%
Utricularia intermedia	2/2	0%
Utricularia minor	7/15	53.3%
Veronica scutellata	1/27	96.3%
Viola lactea	1/7	85.7%
Wahlenbergia hederacea	0/6	100%
OVERALL TOTALS/ OVERALL AVERAGE DECLINE	163/644	74.7%

4 GENERAL POINTS ON INDICATOR SPECIES

Indicator species and be used in a number of ways. First, as a simple inventory which can be used to assess the overall quality of a site. Alternatively a set of species can be drawn up which are known to respond to particular types of change affecting a habitat (biotope). For both purposes it is wise to restrict the set of indicator species to easily recognizable groups such as higher plants and invertebrate groups such as Orthoptera, Formicidae, some of the Lepidoptera especially the easily identifiable moths, ground beetles from the genera Carabus and Cicendela, Heteroptera and some of the larger spiders.

When drawing up a set of indictor species the following points need to be borne in mind.

First, the extent to which a species is restricted to the biotope. This can be expressed by a scoring system such as i) stenotopic, restricted to the biotope and not occurring in other biotopes; ii) generally found in the biotope but occurring in other biotopes in small numbers; and iii) preferring the biotope but also found regularly in other biotopes.

Secondly, the abundances of the indicator species should be assessed. Species can be described as i) common; ii) locally occurring, iii) scarce; iv) rare and v) very rare.

Thirdly, when drawing up a list of indicator species it is useful to have an assessment of the ease with which the species may be identified. Again a simple scoring system could be used, for example i) cannot be identified in the field but easy to identify in the laboratory using a microscope; ii) can be recognized in the field using a hand lens and following some instruction and experience; iii) easily recognizable in the field without a hand lens; vi) very easily recognizable in the field with no possibility of mis-identification.

Fourthly, for invertebrates the ease with which they may be observed or sampled should be assessed: i) species which can be observed, identified and counted along a transect or by waiting for a given period of time near a flowering plant and without the necessity of capturing a specimen; ii) species can be collected or sampled using a sweep or similar type of net; iii) the species is best investigated by the use of pitfall traps; iv) species can only be investigated by the heat extraction of soil cores; v) the species can be observed mainly during their larval stages; vi) the species which visit flowers and can be observed by waiting near a suitable plant or by walking transects through the food plants and vii) species which can be detected by their sound.

The aim of the foregoing account has been to list a range of species with the potential to be heathland indicators and to make some general points which need to be considered when drawing up a set of indicator species.

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