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The Butterfly Monitoring Scheme

Progress Report for 1998/99

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SUMMARY

1. The report reviews the national Butterfly Monitoring Scheme (BMS) in 1998/99 and marks the twenty-third year of monitoring since the scheme started in 1976.

2. The scheme continues to be run by Mr Nick Greatorex-Davies as part of the Biological Databases Unit at the Institute of Terrestrial Ecology, Monks Wood. Mr David Roy gives technical assistance with database management and programming. The BMS is partly funded by the Joint Nature Conservation Committee and partly by ITE. Dr Ernie Pollard retired at the end of March 1998 from his work on the scheme in association with ITE, acting as an independent consultant to JNCC, though he still walks a transect as part of the scheme and is available for advice when needed. Dr Dorian Moss has taken over the overall responsibility for management of the BMS from Mr Paul Harding.

3. Usable datasets were received from 97 sites in 1998 including six Environmental Change Network (ECN) sites. Data from several ECN sites have been incorporated into the calculation of the Annual Indexes of butterflies since 1995. There were three new sites added to the scheme in 1998, one regained and two sites lost from the scheme.

4. Changes in abundance of species are examined. 1998 was considered to be a poor year for butterflies generally and the collated indices of the majority of species were down on those of 1997, some indices were more than halved. The cool and very wet weather in April, June and July was very likely a major factor in depressing the numbers of butterflies recorded on transects. The poor weather probably caused high larval mortality and reduced opportunities for breeding and oviposition. The weather improved markedly in August but this was too late to benefit most species. Just nine species, of the 34 for which indices were produced, showed an increase in their collated indices.

5. Species that showed the largest decreases in their collated index included the brown argus, common blue, small tortoiseshell, comma, dark green fritillary and silver-washed fritillary. The small tortoiseshell produced the second lowest index since the scheme began. Of the species that increased, the wall brown, after last years all-time low, showed the first big increase in numbers for nine years. Numbers of the migrant species were higher than in 1997.

6. Recent publications using data from the Butterfly Monitoring Scheme are listed.

8. Appendix 1 contains graphs showing fluctuations in the collated indexes of 34 species from 1976-98.

7. Appendix 2 gives information on twelve sites that were visited in 1998. These included the three new sites to the scheme and seven long-running sites that have been in the BMS since 1976 or 1977. There has been some deterioration in the quality of data received from two of these sites in recent years; due largely to increased time commitments on the part of the recorders, but for the other sites the quality of data has remained high.

8. Appendix 3 provides information on some of the differences and similarities between the Dutch BMS and the UK BMS following a visit to Vlinderstichting at Wageningen in the Netherlands where the DBMS is based.

1 INTRODUCTION

1998 was a very poor season with regards to the weather with April, June and part of July being particularly wet and cool. This inevitably had a detrimental effect on butterfly numbers and predictably there was a fall in the national collated indices of the majority of species. However, numbers of some species remained relatively unaffected and a few species even showed an increase.

1.1 SITES FROM WHICH THE BMS RECEIVES DATA

1998 was the 23rd year of the Butterfly Monitoring Scheme (BMS). At least some data were received from 108 BMS and 11 Environmental Change Network (ECN) transects (two of the BMS transects are also ECN transects, making a total of 13 ECN transects, these were part of the BMS before joining the ECN).* However only 97 transects provided sufficient data to produce at least some index values.

During the rest of this report BMS and ECN transects will simply be referred to as BMS transects as all potentially contribute to the scheme in providing data for the calculation of the collated annual indices.

1.2 SITES LOST AND GAINED FROM THE BMS IN 1998

Two transects were lost to the Scheme in 1998; Craig y Cilau, which first started to contribute to the BMS in 1976, and Pengelli Forest which joined the scheme in 1994. Both sites are in Wales. However, St. Margaret's Bay in Kent, out of the scheme for only one year, came back into the scheme.

Three new transects were added to the BMS in 1998: Gunthorpe (Gravel Pits) near Nottingham; Bishop Middleham Quarry, an old limestone quarry in County Durham; and Mabie Forest owned by Forest Enterprise in Dumfriesshire. The sites were chosen because to some extent they fill geographic gaps in the distribution of BMS sites and in two cases they provide another site for the scheme for some rare species. Each transect has already produced at least one years good data before entering the scheme and there is a desire by those involved to continue the transects in the longer term. A fuller acount of these sites is given in section 8.2.2.

1.3 A CHANGE IN THE MANAGEMENT OF THE BMS

As we wrote in last years report, Ernie Pollard has now almost retired from his involvement in the BMS (he remains recorder of the Springhill Farm transect in Kent and is still available for advice if required). Another change this year is that Paul Harding, who was until recently responsible for the overall management of the BMS, has now been replaced in this particular role by Dorian Moss. Dorian is not new to the BMS, and those of you who have been with the scheme a few years will recognise his name from various scientific papers involving the BMS, references to which can be found in the bibliographic updates in previous Reports to Recorders. Of particular

* the Environmental Change Network (ECN) was set up in 1993 with funding from the Department of the Environment in conjunction with a number of research organizations (including the Institute of Terrestrial Ecology) to monitor changes in the environment, particularly in relation to climate change. Butterfly monitoring is just one part of this program. ECN transects are not officially part of the BMS, but data from some of the ECN sites are now used together with the BMS data to calculate the annual national collated indexes.

note is the paper by Moss & Pollard (1993) in which the improved method that is now used for calculating the national and regional collated indices is described.

1.4 DEVELOPING THE ANALYSIS AND INTERPRETATION OF BMS DATA

With the departure of Ernie Pollard and the demise of the VAX computer on which all the BMS data used to be held and analysed, during the past year it has been necessary to rewrite the various programs which summarise the site data and produce the regional and collated indices. We have been fortunate to have the help of David Roy, a database specialist, to do this work. All BMS data are now held in an ORACLE database and are much easier to manipulate and query than previously. We have also decided to automate the process of calculating values for missing weeks (estimates) as far as seems reasonable. This process used to be done entirely by hand by Ernie observing basic rules. However it is complex, and whether an estimate is calculated or not depends on such factors as when in the flight period of a given species the data are missing, how many weeks are missing, the particular species involved, comparison with data on the same species at nearby sites. This inevitably involves some subjective judgements. A program has been written by David Roy that partly automates the estimation process. We plan to develop this further in time for the autumn 1999 influx of data and so reduce the time taken to complete this aspect of the work to a minimum. This will also remove inconsistencies introduced through subjective judgements and make the methodology available and readily repeatable by others monitoring butterflies. Comparisons with other similar data using the same methods will then be more valid.

1.5 VISIT TO THE NETHERLANDS: DUTCH BUTTERFLY MONITORING SCHEME

In September one of us (NGD) visited Vlinderstichting, also known as Dutch Butterfly Conservation, at Wageningen in the Netherlands, where the Dutch Butterfly Monitoring Scheme is based. The purpose was to meet Chris van Swaay, the co-ordinator of the Dutch BMS, in order to find out more about the scheme and to learn from their experience in a way that might help us to improve the British scheme. The trip proved to be very useful and has given us much food for thought. An account outlining some of the main differences between the Dutch and the UK BMS is given in Appendix III.

2 SUMMARY OF THE 1998 SEASON

2.1 IMPORTANT FEATURES OF THE WEATHER IN 1998

There were several features of the weather in 1998 that are of particular note. First there was some exceptionally mild weather in February and March which resulted in many butterflies coming out of hibernation early and a number of early emergences of several spring species, including orange tip, small white, large white, holly blue and speckled wood[*]. All of this happened before the official transect counts began and raises the question again as to whether the recording period should be extended for some species both in the spring and in the autumn, particularly in southern Britain. If milder weather becomes the norm then this should certainly be considered.

Then came a very cool April which was one of the wettest on record. Parts of the UK experienced exceptional flooding and elsewhere the ground was extremely wet. It seems likely that this will have caused high mortality, by drowning spring feeding butterfly larvae, especially those feeding on or near the ground. Many transect recorders missed two or more weeks recording in April. Here at Monks Wood the temperature did not get above 13 °C at any time during the second week of April, and the third week was little better.

Table 1. Shows a summary of UK weather in 1997/98 and is taken from a weather summary provided by Dr M. Hulme of the University of East Anglia on the internet at web site: http://www.cru.uea.ac.uk/~mikeh. The information is also published in *The Guardian* newspaper. The summary is for the UK as a whole and so will not necessarily describe weather in particular regions precisely. [Anomalies are with respect to the 1951-80 average]

1997	Daytime temp (^{0}C)	Rainfall (%)	Sunshine (%)	Brief description
September	+0.8	-48	+24	Dry and very sunny
October	+0.3	-21	+27	Sunny, warm in the south
November	+1.6	+25	-18	Mild, cloudy and quite wet
December	+0.7	+20	-7	Rather wet and mild
1998				
January	+1.0	+27	+7	Mild and wet
February	+3.5	-33	+2	Very mild, dry except for the NW
March	+1.7	+35	-24	Mild, wet and cloudy
April	-0.5	+102	-9	Very wet and rather cool
May	+1.5	-47	+5	Warm and very dry
June	-0.5	+74	-16	Very wet, rather cool and cloudy
July	-0.7	+24	-24	Cool, dull and rather wet
August	+0.2	-29	+10	Rather dry and sunny
September	+0.6	+7	-3	Mild, wet in the south

[*] see Bowles, N (June 1998) Wildlife Reports: Butterflies, *British Wildlife*, **9,** (5) 323-324

The weather improved temporarily in May and there was some fine weather. However, for the second year running June was both cool and very wet. Unlike 1997, the cool wet weather continued for much of July, only finally improving significantly during early August. This second cool wet period is likely to have caused further high mortality of butterfly larvae and reduced the breeding success of species on the wing at the time.

2.2 SOME COLLATED INDICES HALVED

The poor and very wet weather during April, June and July was undoubtedly a very important feature of 1998 in terms of its effect on butterfly numbers. There was very little "summer" weather for many areas until August. After several good years for many species, the collated indices for 24 of 34 species for which these indices were calculated dropped. The **small tortoiseshell**, **comma**, **dark green fritillary** and **silver-washed fritillary**, which in 1997 had their highest index since the scheme began, showed a 50% or greater drop in their national collated index. The **small tortoiseshell** dropped to 19% of its 1997 index, producing the second lowest index since the scheme began.

2.3 MANY OTHER INDICES DOWN

The national indices of the **grizzled skipper**, **small white**, **common blue**, **brown argus, small pearl-bordered** and **pearl-bordered fritillaries** also fell by about 50% or more. The **small / Essex skipper**, **dingy skipper**, **green hairstreak**, **small copper**, **chalkhill blue**, **peacock** and **small heath** also showed appreciable drops in their national indices.

2.4 ONLY A FEW SPECIES INCREASED

There were nine species that showed an increase in their national index and for several of these the increase was very small. The biggest increase was for the migrant **painted lady** - more than 700%. However the 1997 index was one of the lowest and discounting the exceptionally high index of 1996, this species' index was similar to values in 1994 and 1995. Numbers of this species in the UK are, of course, influenced by breeding conditions in North Africa and the Mediterranean. The **clouded yellow** also had a reasonably good year though no index has been produced.

The next biggest increase was for the **wall brown**, which increased by 78% from its all-time low in 1997. This species has been showing a steady decline, mainly at inland sites, after a high in 1989. Records for this species so far received by the Butterflies for the New Millennium atlas project confirm the decline at inland sites. The **meadow brown** also had an above average season with a 22% increase on the 1997 figure producing its 7th highest index. Contrary to expectations following the small drop in the summer index last year the **holly blue** did well and had similar indices in both generations. The spring generation was down on the very high spring index of 1997 but the summer index was higher than that of 1997.

Other species that increased included **brimstone**, **red admiral** and **speckled wood**. Species that remained virtually unchanged from 1997 (going only slightly up or down) included **large white**, **green-veined white**, **orange tip**, **grayling** and **ringlet**.

3 PERCENTAGE OF COUNTS COMPLETED

The overall percentage of counts completed was 71%, which was the lowest since this figure was first calculated in 1988.

Table 2. Percentage of counts completed 1988-98

Year	1988	98	90	91	92	93	94	95	96	97	98
% completed	77	79	82	75	79	73	74	80	76	76	71

As can be seen in Figure 1 the worst affected weeks were 1-3, 10 and 11 and 24. A histogram for 1997 is shown for comparison (Figure 2). For details of regions see Map1 on page 8.

Figure 1. Number of sites with completed transects in each recording week 1998

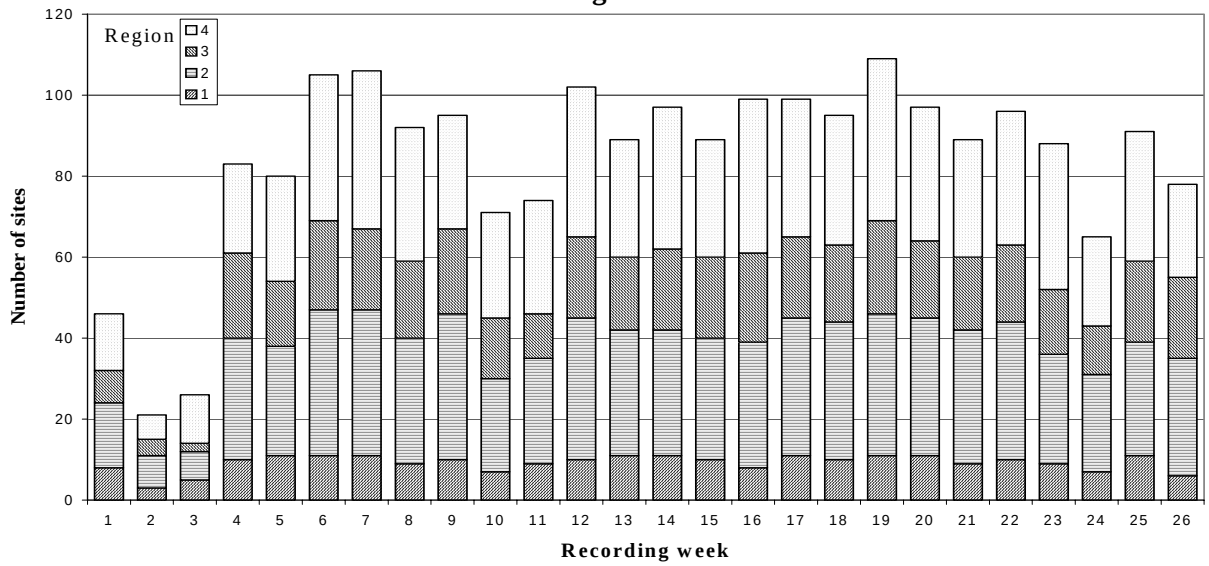
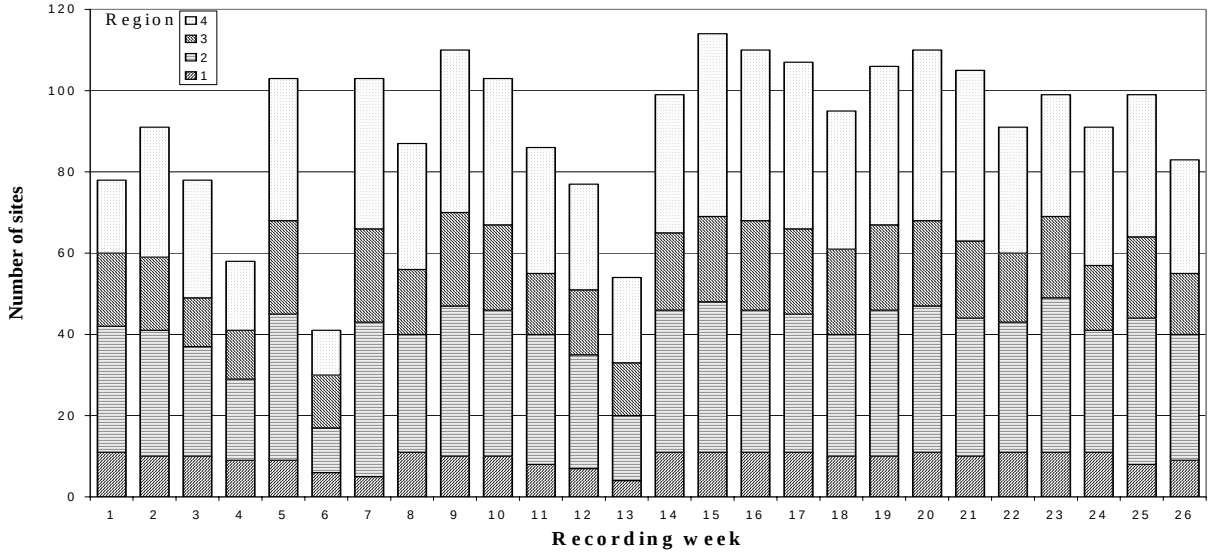


Figure 2. Number of sites with completed transects in each recording week 1997



4 PROPORTION OF ANNUAL INDICES CALCULATED

Site annual indices are calculated for each species for each transect where the species occurs and where data are sufficient.* With a lower percentage of counts completed fewer annual indices could be calculated for each species in 1998 than in 1997, as in more cases there were just too many weeks data missing for estimates to be justifiably calculated (Table 3).

Table 3. The proportion of annual indices that could be calculated for 115 transects in 1997 and 119 transects in 1998.

	0%	1-20%	21-40%	41-60%	61-80%	81-99%	100%	Total
No. of transects in 1997	7	7	12	7	12	25	45	115
No. of transects in 1998	22	0	8	14	15	36	24	119

Note that in 1997 data from 45 sites were sufficient for annual indices to be calculated for *all* species recorded. In 1998 this figure was 24.

Note that in 1997 no annual indices could be calculated for any of the species recorded on 7 transects. In 1998 none could be calculated from 22 transects. As might be expected a high proportion of these transects were in Scotland and northern England (17 in 1998) where opportunities for butterfly counts are usually more limited due to poorer weather conditions and sometimes by the distance needed to travel to get to a site to walk a transect.

As mentioned in the introduction to this report, the process of calculating estimates has now been partly automated. Generally no estimates have been calculated for a species, (and therefore no annual index), when estimates would comprise 30% or more of the annual index, except in some cases where numbers were very low. This has meant that in a few cases where a week has been missed at the peak of the flight period no estimate has been calculated.

In the past estimates were calculated by simply taking the mean of the values from the weeks on either side of the missing week(s). The semi-automated method takes three recorded values and interpolates the missing value from these. Although the two methods are slightly different we believe that the results of the two methods compare favourably and differences in figures obtained are likely to be insignificant. This will be fully tested during the coming year.

* An annual index for a species is simply the total mean weekly count on a transect for the year including estimates. Where a species is double-brooded or, in the case of the hibernating species peacock and brimstone where there is a separate spring and summer flight, two separate indices are calculated. Where species produce a third brood (notably small copper and wall brown) third brood figures are combined with those of the second brood. In some cases the divisions between the broods are indistinct and a single index is given for the year. These species are: red admiral, painted lady, small tortoiseshell, comma, speckled wood and small heath.

Figures 3 and 4 show, for 1998 and 1997 respectively, the number of transects with a given number of weeks recorded. Note that there were no transects in 1998 where all 26 weeks were recorded.

Figure 3. Number of sites with given number of weeks recorded 1998

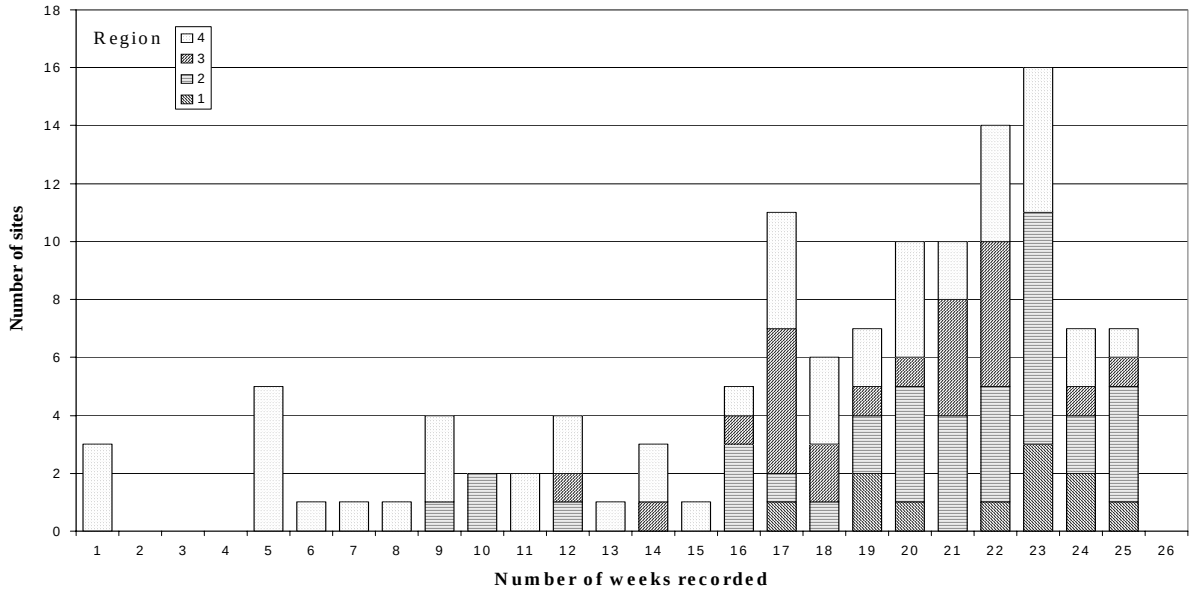
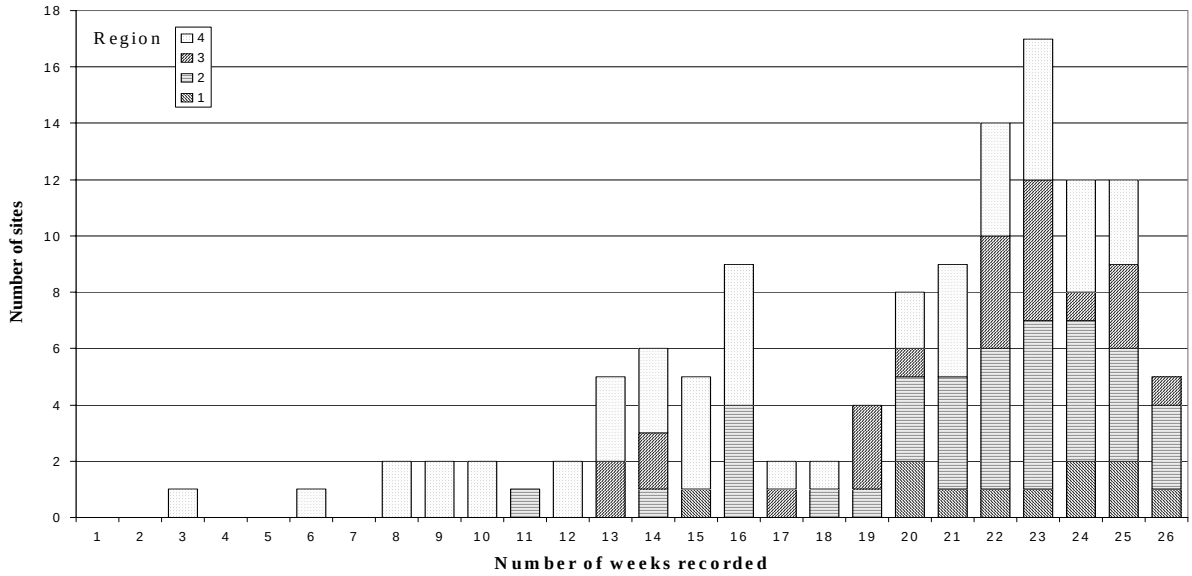
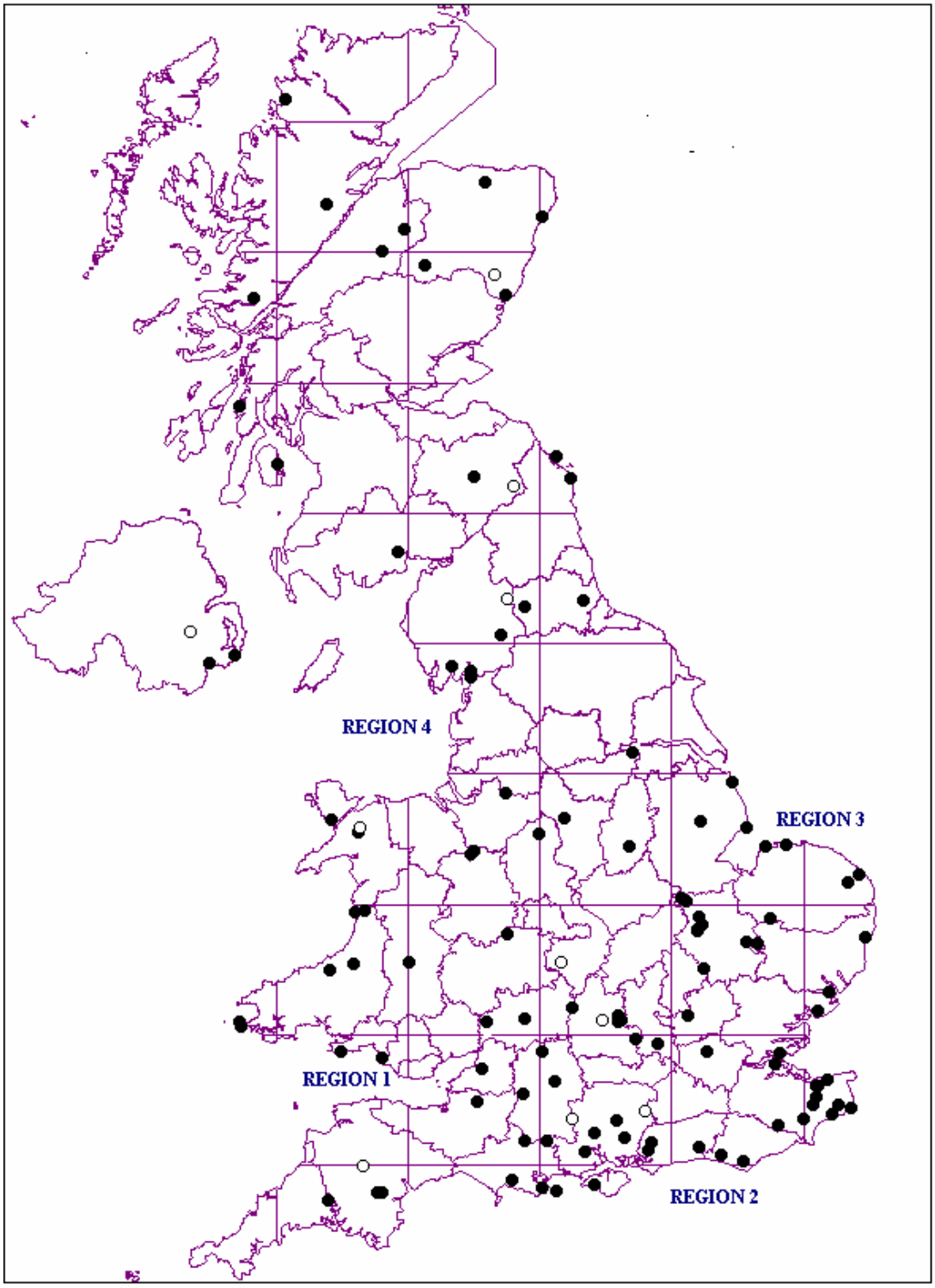


Figure 4. Number of sites with given number of weeks recorded 1997



Map 1. Butterfly Monitoring Scheme and Environmental Change Network sites monitored for butterflies in 1998, (BMS = Solid circles, ECN = open circles), showing county boundaries (*not* Vice-counties) and the four BMS regions.



5 NUMBER OF SITES CONTRIBUTING DATA TO THE BMS

The BMS was officially launched in 1976 with just 36 sites contributing to the scheme. However three years of trials preceded this when data were being gathered to test the methodology. Seven sites still in the BMS, which were monitored during this period as part of this process, have data going back to 1974. The number of sites contributing to the BMS (Figure 5) gradually increased over the years with at least one site being added to the scheme in almost every year. 119 sites submitted at least some data to the scheme in 1998 and a further three sites remain in the scheme, though no data were submitted from them in 1998. The distribution of the sites currently contributing to the BMS is shown on Map1.

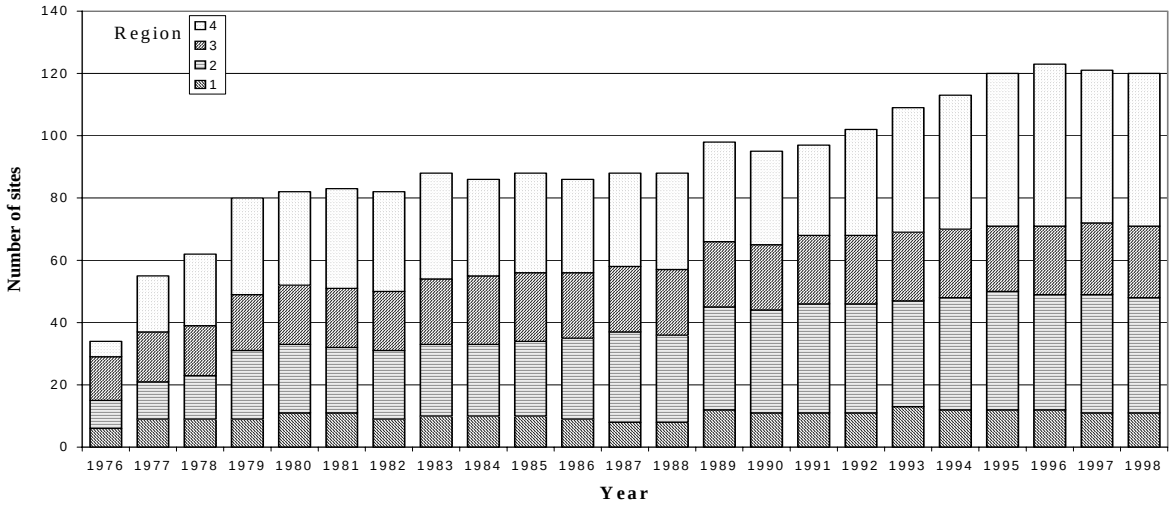
Table 3 below summarises the length of time sites currently in the BMS (including ECN sites) have been contributing data to the scheme. Most, but not all, of these have been submitting data to the scheme continuously since they came into the BMS.

Table 3. The length of time current sites have been contributing data to the scheme.

Date periods when sites entered scheme	Period of years	Sites in scheme in 1998	Sites lost from the scheme
1994-1998	1-5	15	1
1989-1993	6-10	27	1
1984-1988	11-15	8	0
1979-1983	16-20	24	8
1974-1978	>20	48	16
TOTAL:		122	26

NB. In the right hand column of the table above the numbers of 'sites lost from the scheme' only takes account of those that produced two or more years data. A number of other sites joined the scheme and either failed to produce any usable data, or only operated for one year. The numbers lost in each case correspond to the time period (indicated in the left hand column) during which the sites entered the scheme, not when they left the scheme.

Figure 5. Number of transects contributing data to scheme



6 NUMBERS OF BUTTERFLIES RECORDED

The number of sightings of butterfly species recorded on BMS transects in 1998 are listed in Table 4. Numbers included in this analysis are only those where sufficient data were provided in either 1997 or 1998 for site annual indices to be calculated. This table replaces the "Top Ten" table of previous years as we thought recorders might be interested to see what sort of numbers of other species are recorded on BMS transects. Although swallowtails and Glanville fritillaries were recorded in 1998 at the single sites monitored for each of these two species, key weeks were missed during their flight periods and therefore no annual index could be calculated in either case.

Table 4. Sum of site indexes and order of abundance for 1997, 1998

Species	1997	1998	1997 order	1998 order
Meadow brown	43127	61255	1	1
Ringlet	12843	10315	3	2
Hedge brown	15343	10192	2	3
Green-veined white	10839	9442	6	4
Speckled wood	5962	6956	13	5
Small heath	9808	6495	8	6
Marbled white	6906	6345	12	7
Chalkhill blue	11124	6334	5	8
Common blue	10111	5514	7	9
Peacock	7964	4840	10	10
Small / Essex skipper	7915	4803	11	11
Large white	3581	3713	15	12
Small white	12688	3089	4	13
Large skipper	3681	2432	14	14
Brimstone	2857	2146	16	15
Small copper	2739	1935	17	16
Common blue (northern)	1181	1893	23	17
Small tortoiseshell	8192	1769	9	18
Scotch argus	2045	1347	20	19
Red admiral	1150	1186	25	20
Silver-spotted skipper	1175	1071	24	21
Wall brown	473	1035	33	22
Orange tip	878	1023	27	23
Adonis blue	2419	901	19	24
Dark green fritillary	2472	882	18	25
Brown argus	1575	739	21	26

Species	1997	1998	1997 order	1998 order
Holly blue	758	726	28	27
Dingy skipper	719	657	30	28
Heath fritillary	755	582	29	29
Grayling	583	534	31	30
Comma	1462	485	22	31
Marsh fritillary	311	381	38	32
Grizzled skipper	578	317	32	33
Northern brown argus	297	316	39	34
Pearl-bordered fritillary	471	305	34	35
Silver-washed fritillary	881	305	26	35
Green hairstreak	323	274	37	37
High brown fritillary	334	216	36	38
Painted lady	33	190	48	39
Clouded yellow	3	161	54	40
White admiral	167	129	40	41
Small pearl-bordered fritillary	376	109	35	42
Purple hairstreak	83	90	45	43
Small blue	92	70	44	44
Wood white	129	66	42	45
Duke of Burgundy	58	65	46	46
Silver-studded blue	115	58	43	47
Large heath	135	38	41	48
Brown hairstreak	10	18	51	49
Lulworth skipper	4	6	53	50
Purple emperor	12	3	50	51
White-letter hairstreak	10	1	51	52
Glanville fritillary	48	0	47	53
Swallowtail	32	0	49	53
Black hairstreak	3	0	54	53
Camberwell beauty	1	0	56	53

7 SUMMARY OF CHANGES 1997/98

Table 5. This table summarises the changes in the site indexes from 1997 to 1998 (number of sites for which site annual indices could be calculated, increases, decreases, no change). The national collated indices for 1997 and 1998 are shown where these are calculated and the species names shown in bold type. Many of the rarer species do not have collated indices because they are recorded on too few BMS transects for a meaningful index to be calculated. Where collated indices have been calculated for species recorded on relatively few transects (in general less than 20 transects) these figures should be treated with caution. These include grizzled skipper, chalkhill blue, small pearl-bordered and pearl-bordered fritillaries and grayling. For species with two distinct flight periods the second is used here.

Species	No. of sites	Increases	Decreases	No change	National collated index 1997	National collated index 1998
Small / Essex skipper	**62**	13	48	1	237	149
Lulworth skipper	**1**	1			-	-
Silver-spotted skipper	**5**	1	4		-	-
Large skipper	**55**	17	38		212	145
Dingy skipper	**21**	5	15	1	24	15
Grizzled skipper	**17**	2	13	2	100	49
Wood white	**4**		4		-	-
Clouded yellow	**17**	17			-	-
Brimstone	**51**	31	17	3	83	101
Large white	**71**	29	36	6	147	138
Small white	**64**	9	55		168	62
Green-veined white	**64**	33	29	2	412	398
Orange tip	**50**	24	23	3	118	120
Green hairstreak	**25**	7	17	1	209	143
Brown hairstreak	**5**	3	2		-	-
Purple hairstreak	**25**	13	9	3	-	-
White-letter hairstreak	**4**		4		-	-
Black hairstreak	**2**		2		-	-
Small copper	**59**	10	44	5	150	84
Small blue	**5**	1	4		-	-
Silver-studded Blue	**1**		1		-	-
Brown argus	**32**	6	25	1	143	66

Species	No. of sites	Increases	Decreases	No change	National collated index 1997	National collated index 1998
Northern brown argus	**3**	1	2		-	-
Common blue (bivoltine)	**55**	10	44	1	114	43
Common blue (univoltine)	**4**	1	3		-	-
Chalkhill blue	**13**	5	8		167	104
Adonis blue	**10**	3	7		-	-
Holly blue (bivoltine)	**47**	27	14	6	545	687
Holly blue	**2**		2		-	-
Duke of Burgundy	**6**	3	3		-	-
White admiral	**19**	8	10	1	27	23
Purple emperor	**4**	1	3		-	-
Red admiral	**59**	32	24	3	80	87
Painted lady	**38**	32	3	3	66	448
Small tortoiseshell	**47**	2	45		290	56
Peacock	**70**	20	49	1	324	191
Comma	**46**	10	34	2	316	153
Small Pearl-bordered fritillary	**12**		11	1	47	21
Pearl-bordered fritillary	**9**		9		7	3
High brown Fritillary	**3**	1	2		-	-
Dark green fritillary	**21**	2	19		157	61
Silver-washed fritillary	**20**	2	17	1	110	47
Marsh fritillary	**5**	1	4		-	-
Heath fritillary	**3**		3		-	-
Speckled wood	**60**	34	25	1	203	228
Wall brown	**31**	16	11	4	12	21
Scotch argus	**3**	2	1		-	-
Marbled white	**32**	8	24		380	307
Grayling	**15**	8	6	1	40	41
Hedge brown	**70**	23	47		111	85
Meadow brown	**79**	49	29	1	114	139
Small heath	**46**	10	33	3	48	30
Large heath	**1**		1		-	-
Ringlet	**55**	24	31		462	424

There are rather more decreases (24) than increases (9) in the collated annual indices from 1997 to 1998 (Table 6).

Table 6. Summary of changes in indexes 1997-98. (Species in italics are those where the collated indices were derived from data from less than 20 sites).

Decrease greater than 2-fold	Decrease less than 2-fold	Increase less than 2-fold	increase greater than 2-fold
Grizzled skipper	Small / Essex skipper	Brimstone	Painted lady
Small White	Large skipper	Orange tip	
Brown Argus	Dingy skipper	Holly blue	
Common blue	Large white	Red admiral	
Small tortoiseshell	Green-veined white	Speckled wood	
Comma	Green hairstreak	Wall brown	
Small pearl-bordered fritillary	Small copper	*Grayling*	
Pearl-bordered fritillary	*Chalkhill blue*	Meadow brown	
Dark green fritillary	*White admiral*		
Silver-washed fritillary	Peacock		
	Marbled white		
	Hedge brown		
	Small heath		
	Ringlet		

8 INDIVIDUAL SPECIES ACCOUNTS

The following accounts should be looked at in conjunction with Table 5 (pages 11 and 12) and Figure 6 (Appendix II starting on page 24).

In the tables below showing site data: * indicates that the species is present, but that there were too few counts for the calculation of an index, . indicates either no counts in that year, or that the species was not recorded, but that there were too few counts made for a zero index to be assumed.

Small/Essex skipper: a substantial drop in the combined collated index for these two species. There were increases at some sites however, and very large numbers were recorded at Gibraltar Point, where the small skipper was first recorded on the transect in 1979 and the Essex skipper in 1983, making this the fifth highest count for these species on any transect since the BMS began, exceeded only by Castle Hill (East Sussex) in 1986 (1134), Shabbington Wood (Oxfordshire) in both 1984 and 1986 (1462 and 1169 respectively) and Weeting Heath (Norfolk) in 1982 (1362).

Gibraltar Point (Lincolnshire)

1974	75	76	77	78	79	80	81	82	83	84	85	86
0	0	.	0	0	9	84	75	88	180	343	197	230

1987	88	89	90	91	92	93	94	95	96	97	98
*	38	43	107	433	722	429	685	780	651	789	1088

Lulworth skipper: numbers were still very low in 1998 at Swanage (Ballard Down), (Dorset), the only BMS site for this species.

Silver-spotted skipper: this butterfly is recorded on nine current transects. Of the five sites that produced annual indices in both 1997 and 1998, only Lullington Heath (East Sussex) recorded an increase in numbers.

Large skipper: a moderate decline in the collated index, with declines at about two-thirds of the sites.

Dingy skipper: following a good year in 1997, numbers were down on most transects in 1998 and the collated index dropped from 24 to 15, only a little higher than the lowest index of 12 in 1996. After two years of absence at Kingley Vale (West Sussex) a single individual was recorded on the transect, a site where relatively high numbers used to be recorded. Transect results indicate that this species may have become extinct on at least four sites within the last four to ten years; Ampfield Wood (Hampshire), Barnack Hills and Holes (Cambridgeshire), Picket Wood (Wiltshire) and Wyre Forest (Worcestershire).

Picket Wood (Wiltshire)

1981	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
7	37	29	18	12	3	2	6	0	15	*	2	3	0	0	0	0	0

Grizzled skipper: a substantial drop in the collated index, falling to less than half of the high index reached in 1997. There were declines at 13 of the 17 sites for which comparisons were possible and increases at two. Interestingly numbers remained constant at West Dean Wood (West Sussex) where numbers have been improving with the national trend in recent years.

West Dean Wood (West Sussex)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
0	6	1	1	2	4	2	2	1	2	7	5	0	1	1	1	4	6	18	18

Wood white: recorded numbers dropped at all four BMS sites where this butterfly is recorded regularly.

Clouded yellow: quite a good year for this migrant species with numbers on average about half those of the exceptional year of 1996. It was not recorded further north than Newborough Warren (Anglesey) in the west of Britain and Wicken Fen in the east. However it was recorded at Murlough in Northern Ireland.

Brimstone: there was a drop in the spring collated index but an increase in the summer index. Overall the collated indices have remained relatively stable over the monitoring period. Major fluctuations in numbers are most apparent at sites near the northern limit of the butterflies' range, as would be expected where unfavourable weather conditions are likely to occur more frequently.

Leighton Moss (Lancashire)

1977	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
56	62	13	31	18	37	47	105	95	10	4	3	3	4	10	8	22	5	10	47	37	65
79	36	20	41	27	56	59	*	*	2	3	*	1	5	1	*	*	16	8	37	50	66

Gait Barrow (Lancashire)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
41	6	12	11	5	18	56	31	4	3	1	3	5	6	8	15	12	9	24	65	58
24	27	23	14	80	45	67	22	3	11	0	2	8	9	10	21	22	4	43	24	45

Large white: the collated index for the first generation increased significantly from that of 1997, but there was a slight fall in the second generation index from the previous year, with decreases at about 50% of the sites for which comparisons were possible. This pattern was repeated in all the regions except region four where there was an increase in the second generation index.

Small white: there was a substantial drop (>60%) in the second generation collated index, but it was not outside the rather regular fluctuations that have occurred since 1976. Numbers decreased on 55 out of 64 sites. The first generation index also dropped slightly, though at a regional level there was a slight increase in regions three and four.

Green-veined white: as with the large white, the first generation collated index increased and there was a slight drop in the second generation index. However the latter index remained high and there were about equal numbers of increases to decreases at individual sites.

Orange tip: another year of very little change in the national index. This species' collated index has been more constant over the 23 years than any other.

Green hairstreak: a relatively small drop in the collated index from last years all-time high, with the index remaining fairly high making this a better than average year for this species on BMS sites overall.

Brown Hairstreak: although not a species suited to being monitored by the BMS transect method (due to its sedentary behaviour and because it spends much of its time in the tree canopy), it occurs on about nine transects currently in the BMS. Some are recorded on transect counts every year. At two long-running sites in West Sussex it only began to be recorded on the transects in 1990 and 1991 suggesting that the species has colonised locally.

West Dean Wood (West Sussex)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
0	0	0	0	0	0	0	0	0	0	0	2	4	1	0	2	3	3	3	12

Kingley Vale (West Sussex)

1976	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	3	2	3	1	0	3

Purple Hairstreak: although, like most of the hairstreaks, this butterfly does not lend itself to the transect method it has been recorded on 48 of the transects that have been contributing in the scheme over the last 10 years. Of these there are complete runs of data (i.e. no estimates or missing values) for 28 sites. The following table shows the total number of individuals recorded at these sites for each of the 10 years. The total number recorded at each site, over the 10 years, varied considerably from just 1 at three sites, to 132 at Ham Street Wood (Kent). The 28 sites are scattered throughout the 4 regions.

1989	90	91	92	93	94	95	96	97	98
52	71	74	140	69	65	98	101	76	69

Small copper: both spring and summer collated indices fell, the spring index by about a third and the summer index was almost half of the 1997 figure.

Small blue: this species is only regularly recorded on transects at about 10 sites in the BMS. At about half of these sites the species appears to be declining and it may have become extinct at Swanage (Dorset) at least in the vicinity of the transect route. On the other five sites populations may be more stable though numbers recorded on three are small. At Martin Down (Hampshire) and Kenfig (Mid Glamorgan) larger numbers are recorded, though numbers at Martin Down fluctuate considerably. In 1998 numbers declined on four of the five transects for which comparisons were possible.

Martin Down (Wiltshire)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
11	5	8	9	7	15	28	15	31	6	1	*	9	7	15	11	2	7	29	7

Silver-studded blue: a second decline at Studland Heath (Dorset), and for the first year none have been recorded on the Tadnoll (Dorset) transect, now the only two sites currently in the scheme where this species is recorded regularly.

Brown argus: there was a substantial drop in both the spring and summer collated indices for this species with counts down at nearly all sites. It was again recorded at 11 of the 16 sites colonised or apparently being colonised in recent years. The butterfly was not recorded at a further two sites where it has been recently, but data were incomplete.

Northern brown argus: there was a substantial drop in the counts at the two sites where the highest numbers are recorded; Leighton Moss (Lancashire) and Smardale Gill (Cumbria).

Leighton Moss (Lancashire)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
143	84	15	60	100	58	32	*	126	164	87	88	38	98	282	273	100	81	126	50

Common blue (bivoltine, southern): one of the biggest recorded drops in the collated index of this species, falling by more than 60%. The first generation index also fell substantially. This decline was not unexpected because of the very poor weather in both April and June and the first part of July, which undoubtedly affected spring larval survival and breeding success of the first generation adults.

Common blue (univoltine, northern): comparisons were possible for only four out of 22 sites (contributing to the BMS for more than one year) where this butterfly occurs due to a lack of suitable data. This was due, at least in part, to the particularly poor weather in the north.

Chalkhill blue: decreases occurred at the majority of the 13 sites for which comparisons were possible, and the collated index fell by about a third but still remains at a relatively high level. Populations giving an index of over 100 occur on seven transects. Largest numbers were recorded at Fontmell Down (Dorset) with a slight increase from 1997.

Fontmell Down (Dorset)

1989	90	91	92	93	94	95	96	97	98
968	1372	1100	2340	159	1694	1745	963	3412	3467

NB. Results before 1995 and after 1996 at Fontmell are not strictly comparable at a site scale due to some section changes in 1996.

Adonis blue: numbers were down at the majority of the 10 sites where comparisons were possible. It appears to be establishing at Wye (Kent), where this is the third consecutive season it has been recorded on the transect and numbers are increasing annually so far.

Holly blue (bivoltine, southern): The collated index remained high in both generations, and the second generation index was slightly higher than in 1997 (Figure 6e), which was contrary to the expected decline following the apparent peaking in 1996 and 1997. Although this species is recorded at many sites in southern Britain, recorded numbers are mostly small reflecting the fact that this is a widely dispersed, wide-ranging and generally non-colonial species.

Holly blue (univoltine, northern): largely univoltine populations occur at only five sites currently in the BMS. There were large numbers in the *second* generation at Coombes Valley as in 1992. Some second generation individuals were also recorded at Leighton Moss and Gait Barrow in Lancashire.

Coombes Valley (Staffordshire)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
19	26	2	21	17	12	18	*	*	5	20	14	40	39	.	99	79	37	.	*
0	0	0	6	0	2	0	.	0	0	0	8	0	29	.	0	0	0	.	67

Leighton Moss (Lancashire)

1977	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
0	1	0	6	3	8	7	11	3	3	11	2	6	11	9	3	10	9	4	7	3	2
0	0	0	0	0	1	1	0	.	0	0	0	0	1	1	4	0	1	9	1	1	5

Gait Barrow (Lancashire)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
0	0	0	3	0	2	4	7	10	6	2	2	3	9	0	6	7	7	10	3	2
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3

Duke of Burgundy: occurs on perhaps 11 sites currently contributing to the BMS and has probably become extinct on at least three sites: Wye (Kent), Shabbington (Oxfordshire) and Pewsey Down (Wiltshire). It occurs regularly (almost every year) on only four transects with the highest numbers being recorded at Denge Wood (Kent). Of these transects only Gait Barrows (Lancashire) showed an increase in 1998. There have been severe declines at both Picket Wood (after four successive zeroes, a single individual was recorded in 1997) and Somerford Common (Wiltshire). It was recorded for the first time for many years (single individual) at Leighton Moss (Lancashire).

Gait Barrow (Lancashire)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
2	1	0	0	0	0	0	0	3	0	2	0	4	2	5	2	3	0	6	10	38

White admiral: there were more decreases than increases and this was reflected in the slight drop in the collated index from 27 to 23.

Ham Street Wood (Kent)

1986	87	88	89	90	91	92	93	94	95	96	97	98
51	104	46	66	49	76	203	82	12	*	25	16	14

Purple emperor: just three individuals recorded on transects at two of the nine sites where this species has been recorded within the last 10 years. Only at West Dean Woods (West Sussex) is it recorded in most years.

Red admiral: a slight increase in the collated index after the drop in 1997 from the high of 1996. Potton Wood (Cambridgeshire) recorded the highest site index of the year and its highest index since the transect began there in 1974.

Potton Wood

1974	75	76	77	78	79	80	81	82	83	84	85	86
0	.	8	2	1	*	7	4	46	6	*	8	52

87	88	89	90	91	92	93	94	95	96	97	98
17	20	21	38	6	41	26	21	22	43	14	85

Painted lady: an increase in the collated index for this species, and although only 129 individuals were recorded it was a slightly better than average year. It was recorded on transects throughout the United Kingdom.

Small tortoiseshell: A very poor year for this species at most sites. After the all-time high of 1997, the national index plummeted to its second lowest since the scheme began, and this despite the high early summer rainfall that is thought to benefit this species.

Peacock: an approximately 40% decline in the collated index, with declines at the majority of sites throughout all regions. At about half of the sites too few weeks were recorded early in the season for spring site indices to be calculated. This was undoubtedly largely due to the very poor April weather. The butterfly was recorded for the first time at St Cyrus (Grampian), the most northerly site it has been recorded in the BMS.

Comma: the collated index fell to less than half of the all-time high index of 1997, annual indices falling at more than 75% of sites where comparisons were possible. The butterfly has been recorded on the transect at Smardale Gill (Cumbria) for each of the last four years, and although numbers are small it appears to have colonised the area. Records submitted to the Butterflies for the New Millennium atlas project show that the butterfly is already moving further north. The butterfly also appears to be becoming well established at Gait Barrow and Leighton Moss (Lancashire).

Smardale Gill (Cumbria)

1990	91	92	93	94	95	96	97	98
0	0	0	0	0	1	3	1	4

Small pearl bordered fritillary: a poor year for this species with counts down at nearly all 12 sites for which comparisons were possible, giving the lowest index since the scheme began. Counts for this species have been relatively stable over the years at Newborough Warren - a dune grassland site, but show interesting fluctuations at Gait Barrow - a primarily woodland site that relies on active coppice management to maintain high fritillary populations.

Newborough Warren (Anglesey)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
32	50	54	33	105	69	96	109	97	105	65	41	42	48	53	50	48	42	27	52	39

Gait Barrow (Lancashire)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
35	32	10	11	22	0	19	0	0	0	11	40	21	*	0	53	46	44	33	11	9

Pearl-bordered fritillary: This species has fared particularly badly in England and Wales in recent decades with countless colonies lost. It has been recorded on 31 of the transects currently contributing to the BMS. It has only been recorded on the transects of 13 of the 24 English sites in the last four years, and in good numbers at only three sites (Leighton Moss and Gait Barrows in Lancashire and Wyre Forest in Worcestershire). This butterfly has almost certainly become extinct at six BMS sites within the last seven years, all sites in southern England. If not already extinct it is perilously close to extinction at a further two sites. The species may be faring better in Scotland but BMS data are insufficient to confirm this. Counts were down at all nine sites for which comparisons were possible.

High brown fritillary: only recorded on the transects at six sites in the scheme in recent years and only three in 1998. Counts were down at both sites with large populations (Leighton Moss and Gait Barrows in Lancashire.

Dark green fritillary: Down at all but two of the 21 sites where comparisons were possible. Numbers continued to increase at Smardale Gill where the species has been steadily increasing on transect counts since 1992.

Smardale Gill (Cumbria)

1990	91	92	93	94	95	96	97	98
0	0	4	16	35	42	158	145	171

Lullington Heath (East Sussex)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
23	32	4	15	13	22	19	36	*	20	12	15	*	6	13	16	56	57	239	176

Silver-washed fritillary: after a steady increase in the collated index for several years counts were down at nearly all sites giving the lowest collated index since 1990.

Marsh fritillary: recorded in recent years on the transect counts of 10 BMS sites, but good numbers in 1998 were only recorded at Rhos Llawr Cwrt (Ceredigion), Taynish (Strathclyde) and Murlough (Northern Ireland).

Heath fritillary: indices could only be calculated for three of the four sites in the BMS where the species occurs and there were declines at all three sites, but transect counts remained high at East Blean Wood (Kent).

East Blean Wood (Kent)

1989	90	91	92	93	94	95	96	97	98
66	168	*	1539	326	322	241	290	545	539

Speckled Wood: increases occurred at about 60% of sites resulting in the second consecutive increase in the collated index and this was one of the few species that increased overall in 1998. There was a big increase in numbers recorded at Gait Barrow (Lancashire) where the species now seems to be becoming well established after the first transect records in 1994 and a good increase at another recently colonised site, Moor Farm (Lincolnshire). The species appears to be at least holding its own at most of the 14 sites that have been colonised since they came into the scheme, however numbers have mysteriously crashed at Woodwalton Fen. Several other sites also appear to be being colonised, for example it was again recorded at Coombes Valley (Staffordshire) where it was first recorded on the transect in 1996, a site that has been in the scheme since 1979. Other sites include Holme Dunes (Norfolk), Leighton Moss (Lancashire), Derbyshire Dales (Derbyshire) and Culvie Wood (Grampian).

Gait Barrow (Lancashire)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	2	25	144

Moor Farm (Lincolnshire)

1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
0	0	0	0	.	0	0	0	0	0	0	0	0	2	10	40	9	20	69

Wood Walton Fen (Cambridgeshire)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
0	0	0	0	0	0	0	0	*	0	5	21	42	171	243	253	*	116	42	76	5

Wall Brown: an increase in the collated index from an all point low in 1997 following four consecutive declines and an overall nine year decline from a high point in 1989, bringing the index back to approximately the 1995 level. Increases have occurred in all the four regional indices. Apart from perhaps the Pearl-bordered Fritillary, this species had shown the most severe decline in recent years of all species for which a collated index is produced. There is no evidence that the species might be returning to the many inland sites from which it has either disappeared, or there have been few records in recent years. Most of the increases were on chalk grassland sites in the south –east England and at some coastal sites. Interestingly numbers also increased appreciably at Rostherne Mere (Cheshire), and at Gait Barrow and Leighton Moss (Lancashire).

Scotch argus: there are reasonable populations at nine sites currently in the BMS, but annual indices could only be calculated for three of the sites. Numbers increased slightly at Smardale Gill (Cumbria) and Whitlaw Mosses (Borders), but dropped at Culvie Wood (Grampian).

Marbled white: the collated index remains high but dropped about 20% from the 1997 all-time high.

Grayling: there were more increases than decreases at the 14 sites for which comparisons could be made, but there was only a tiny increase in the collated index. The species mysteriously seems to have disappeared from Yarner Wood (Devon) though there have been no changes in the management of the site which could explain this.

Yarner Wood (Devon)

1976	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
34	18	46	46	25	57	41	38	30	5	12	16	4	23	33	27	30	10	17	15	0	0	0

Hedge brown: the second successive decline in the collated index with decreases at more than two-thirds of the sites for which comparisons are possible.

Meadow brown: a fairly small increase in the collated index this year with comparisons possible for 79 sites (10 fewer than in 1997), with 49 increases and 29 declines (1 no change) - with both categories represented throughout Britain.

Small heath: A substantial fall in the collated index after three successive years of gradual rises, with decreases at about 75% of sites.

Large heath: indices at only two of the six sites where this species is recorded regularly, and at only one site in both 1997 and 1998, however data are sufficient from five sites to indicate a decline in numbers at all these very widely dispersed sites. The species has been recorded at a further six sites currently contributing to the BMS, including, for the first time, on the current Pollymore transect on the north-west coast of Scotland (Highland).

Ringlet: there was a slight drop in the value of the collated index from 1997. The index for this species has remained high and relatively stable since 1982 after recovering from the severe population crash that followed the drought of 1976. There were relatively small declines in 1990 and 1995, both these years also followed long hot dry summers.

9 PUBLICATIONS IN 1998/1999

Pollard, E. & Greatorex-Davies, J.N. (1998). Increased abundance of the red Admiral butterfly Vanessa atalanta in Britain; the roles of immigration, overwintering and breeding within the country. *Ecology Letters*, **1,** 77-81.

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Moss, D. & Pollard, E. (1993). Calculation of collated indices of abundance of butterflies, based on monitored sites. *Ecological Entomology*, **18, 77-83.**

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APPENDIX I. GRAPHS SHOWING FLUCTUATIONS IN ALL SITES INDEXES FOR 34 SPECIES

Figures 6a-e. The graphs on the following pages show fluctuations in the national collated (all sites) index values for all species for which this figure is calculated. These collated indices are derived from the site annual indices (see footnote on page 6) using the method of Moss and Pollard (1993). For species for which two separate indices are produced, the second is shown here.

Species which produce annual indices from relatively few sites (generally less than 20, see Table 5 for 1998 figures) should be interpreted with caution. These include: grizzled skipper, common blue (northern, univoltine), chalkhill blue, white admiral, small pearl-bordered fritillary, pearl-bordered fritillary and grayling. The brown argus is now recorded on many transects and despite possible identification problems (especially confusion with brown common blue females), we consider that the collated index for this species has become increasingly reliable in recent years. All figures are of logged values and the same scale so that visual comparisons can be made.

In the cases of the holly blue and the painted lady, the fluctuations in the "all sites" indexes are somewhat greater than for other species. These are shown together on a separate figure (6e on page 34) so that they can be drawn at the same scale the rest.

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