BUTTERFLY MONITORING

SCHEME

Report to recorders 1997

INSTITUTE OF TERRESTRIAL ECOLOGY

(NATURAL ENVIRONMENT RESEARCH COUNCIL)

The Butterfly Monitoring Scheme

Report to Recorders

1997

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February 1998

CONTENTS

INTRODUCTION

Sites from which the BMS receives data

The Butterfly Monitoring Scheme (BMS) now has transect data for 22 years (1976-97). When the BMS started in 1976 there were just 36 sites in the scheme. In 1996 there were 115 sites in the BMS (110 in 1997; see below) spread throughout the United Kingdom.

Data are also received from a further 10 sites which are part of the Environmental Change Network (ECN), which 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. Although not officially part of the BMS we are able to use the data from some of the ECN sites along with the BMS data to calculate the annual national collated indexes. Two sites previously in the BMS are also now part of the network of ECN sites but they remain as part of the BMS.

Sites lost from the BMS in 1997

Five sites were lost to the BMS in 1997. These were Radipole Lake, an RSPB reserve at Weymouth in Dorset; St. Margaret's Bay, a coastal downland site in Kent; Wart Barrow in Cumbria, a farmland site; and two sites in Scotland; Tentsmuir Point in Fife, a coastal dune site; and nearby Morton Lochs inland. Recorders at these sites have had to give up recording the transects for various reasons. At some of these sites the loss may be only temporary as efforts are being made to find alternative recorders.

A few other sites were unable to provide sufficient data in 1997 for any annual site indexes to be calculated. These sites remain in the BMS for time being with the hope that problems in covering the recording can be resolved.

Possible new sites for the scheme

The loss of sites from the scheme will enable us to draw in a few extra sites into the BMS in 1998. There are in excess of 500 sites that are, or have been in the recent past, monitored for butterflies independently of the BMS but using the same methodology. Many of these sites are co-ordinated locally by Butterfly Conservation Branches, wildlife trusts, Forest Enterprise or other organizations. The priority for the BMS is to fill in some of the geographic "holes" in the distribution of sites. These occur mainly in the north. Despite the considerable bias of independently monitored sites to the south and east of England there are several suitable sites in the north which are currently being well monitored and where monitoring is likely to continue for the foreseeable future. Clearly these are prime candidates for inclusion in the BMS.

Ernie Pollard to take a much more reduced role in the BMS

The BMS was started by Dr Ernie Pollard, based at ITE Monks Wood, in 1976 and he has been closely involved with the scheme ever since. The BMS is currently jointly funded by the Joint Nature Conservation Committee and ITE. In 1987 Ernie took early retirement from ITE, but continued his close involvement with the scheme working from home as a consultant directly to JNCC. He has paid an annual visit to Monks Wood each November and early December to help with the initial analysis of data. During the rest of the year he has spent time on more detailed analyses of the data and writing scientific papers based on these analyses. Ernie has now decided that it is time for him take a much more reduced role in the BMS and during the past year he has been gradually spending less time on work to do with the scheme. He is not pulling out altogether, however, but plans to be on hand to give advice and guidance when required. The BMS at ITE wish Ernie well in his retirement and are very

grateful that he is not pulling out completely, but we shall inevitably miss his close involvement with the BMS which he initiated and has continued to work with for the past 22 years.

Developing the analysis and interpretation of BMS data

Plans are being made to automate the work Ernie did each year in estimating site annual indexes where recording weeks have been missed. This is a complex process that has relied very much on Ernie's expert knowledge of butterflies. However it does involve certain basic principles, and David Roy, a database expert and programmer based at Monks Wood, will be spending some time during the next few months, with advice from Ernie, automating this process. It is felt that the differences between the two processes are unlikely to be sufficient to make significant differences in the overall results achieved from the BMS and will have the benefit of making the process speedy and entirely consistent.

Our two resident statisticians at Monks Wood, Peter Rothery and Tim Sparks, have been taking a closer interest in the BMS database and have already been involved in the analysis and writing of some of the papers using BMS data that have been published. This involvement is likely to continue.

SUMMARY OF THE 1997 SEASON

Important features of the weather in 1997

Several features of the weather in 1997 are worth pointing out at the start of this section as they appear to have had a strong influence on the numbers and seasonality of butterflies in 1997. A continuing effect is also likely to be seen for some species in 1998. The following is a very brief overview, and is inevitably biased towards the south of Britain. February and March were unusually mild. January, March and April were generally dry months. April and May continued to be generally mild but June was exceptionally cool and wet. August was hot, dry and sunny with sunny weather continuing into September. A brief synopsis of the UK weather is given in Table 1.

Table 1. Shows a summary of UK weather 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.

1996	Daytime temp (^{0}C)	Rainfall (%)	Sunshine (%)	Brief description
September	+0.4	-60	+19	Mild, sunny and very dry
October	+0.7	+21	+5	Mild, wet in Scotland
November	-1.2	+37	+36	Cold, wet and sunny
December	-1.9	-28	+12	Dull and cold
1997				
January	-1.1	-70	-1	Dry and cloudy
February	+2.2	+74	+3	Very mild, wet and windy
March	+2.6	-31	+5	Very mild and mostly dry
April	+1.3	-41	-3	Mild and dry
May	+0.2	+25	+17	Sunny, cool in the north
June	-0.6	+65	-26	Cloudy, very wet in England
July	+1.2	-26	+17	Dry and quite warm
August	+2.8	-4	+16	Very hot
September	+0.8	-48	+24	Dry and very sunny

Early emergences due to the mild spring

Following the very mild weather during the early part of the year many of the spring butterflies were on the wing exceptionally early. Though not on BMS transects, some species were recorded earlier in Britain than ever before. The first grizzled skipper seen here at Monks Wood was on April 16th (not on the transect), however elsewhere in southern England, according to Butterfly Conservation's "Butterfly Line" (0891 884 505) it was recorded as early as April 1st at Brighton in Sussex. The earliest dates for grizzled skipper sightings in the UK given in Heath & Emmet (eds.)(1989) "*The moths & butterflies of Great Britain & Ireland*" Vol 7, is 7th April at Hereford and 9th April at Eynesford, Kent, both in 1893! Other early UK sightings included: green hairstreak in Suffolk on 27th March (more on April 1st); small copper on 5th April; Duke of Burgundy on 8th and 10th April in Hampshire; pearl-bordered fritillary in Devon on 11th April (apparently peaked in Devon in mid-April); dingy skipper on April 12th in Oxfordshire; brown argus in Suffolk on April 13th! The black

hairstreak was recorded on June 6th in Cambridgeshire and on the Monks Wood transect on June 9th. This species is not normally seen until about June 20th or later.

High spring indexes

Several spring species had very high indexes. The grizzled skipper did very well in 1997. The national collated indexes for this species have overall shown a steady decline since 1977. There was a big increase in the national index in 1996, and in 1997 it was back to its 1976 level, with only 1977 being higher. the index for the dingy skipper doubled and was the highest since 1990. The green hairstreak had the highest index since the scheme began and the small copper the highest spring index, and it remained high in the second generation. The brown argus also had the highest first generation index since the BMS began, but dropped in the second.

Cool wet June yet some very high summer indexes

The mild start to the season came to an abrupt end with an extended cool and wet period from the second week of June to the first part of July. It seemed inevitable that this sudden and prolonged change in the weather would have a severe effect on many summer butterflies. Surprisingly this was not generally the case. The weather improved markedly during the latter part of July, with August being particularly hot and dry. Several summer species had their highest collated annual indexes since the BMS began, these were small tortoiseshell, comma, dark green fritillary, silver-washed fritillary and marbled white. The last species seems to be making quite a come-back in some eastern counties of England where it is recolonising areas where it has not been present for decades though this is not yet reflected on BMS sites.

Small tortoiseshell

Based on past BMS data, the breeding success of the summer generation of the small tortoiseshell is greater when the early summer weather is wet (Pollard *et al* 1997), and the high index was therefore expected for this species. However it also appears that numbers were bolstered, at least in the east of England, by a big migration from the continent to the east in August. Large numbers were reported by some observers but not as part of the BMS. High numbers were however recorded at several eastern BMS sites. For example, at Wicken Fen 1623 were recorded on a single transect count on August 18th, most were feeding on the flowers of devil's-bit scabious (*Succisa pratensis*).

The whites

The three common whites also did well, recovering well from the generally low indexes of 1996, particularly in the second generation. The small white produced an exceptionally high index at Potton Wood in Bedfordshire with a second generation annual index of 4312. In weeks 20, 21 and 22; 1030, 1490,1298 were recorded respectively. In this case the close proximity of a field of very late flowering oil-seed rape (*Brassica napus*) (not mustard (*Brassica nigra)*) may have been responsible for the large numbers (Ian Woiwod *pers. comm.*).

Declines

In contrast, the wall brown produced its lowest index ever! The decline of the wall brown is discussed on page 17. The national indexes for the meadow brown and gatekeeper were appreciably down on the 1996 indexes, perhaps in response to the cool wet June. The brimstone was also well down in the summer / autumn flight. The cool wet June might also be expected to effect the second generation of some bivoltine species, certainly both brown argus and common blue declined in the second generation, but, as already mentioned, the small copper increased. The holly blue had the highest spring index since the BMS began, but dropped sharply in the second generation. However this may have been due as much to the build-up in numbers of its host specific parasite as to the effects of the

cool wet June. In more than one instance a very high level of parasitism was found in larvae collected in June.

Migrants

The two common migrants, the red admiral and the painted lady were well down on the previous year, though the national index for the red admiral was still above average. The painted lady produced its fifth lowest index in contrast to last years amazingly high figure.

Conclusions

In conclusion, the season was good for butterflies in general with most species doing better than in 1996. Most species that showed declines did not drop appreciably.

PERCENTAGE OF COUNTS COMPLETED

The overall percentage of counts completed at 112 sites was the same as in 1996 at 76%. It was particularly noticeable that northern sites had a difficult recording year with many missing weeks at some sites. The particularly difficult weeks over the whole country were week 6 (6 - 12 May) and week 13 (24 - 30 June).

Table 2. Percentage of sites at which counts were completed in each week in 1997

wk	1	2	3	4	5	6	7	8	9	10	11	12	13
%	67	72	65	50	84	36	87	74	92	85	71	63	44
wk	14	15	16	17	18	19	20	21	22	23	24	25	26
%	85	94	91	89	82	88	93	87	75	83	75	82	69

NUMBERS OF BUTTERFLIES RECORDED

The numbers of sightings of butterflies which were recorded most frequently on BMS transects in 1997 are listed in Table 3. The sites used in this analysis are those which provided data in 1996 & 1997 and estimates for missing counts are included. The numbers do not reflect accurately the relative abundance of species on transect routes because the chance of seeing an individual of a particular species depends partly on how conspicuous it is.

The most striking change from 1996 was, of course, the painted lady. Just 29 were recorded, compared with 11,342 in 1996! Many single counts in 1996 were higher than this year's national total.

As has always been the case to date, the meadow brown was by far the most frequently seen butterfly, although it declined substantially. The abundance of the chalkhill blue again reflects the large number of downland sites in the scheme; although restricted in range it undoubtedly occurs in very large populations at some sites. The small and green-veined whites entered the list together with the small tortoiseshell; the marbled white and peacock dropped out with the painted lady.

Table 3. Butterflies seen most frequently in 1997

order in 1997		sightings in 1997	order in 1996
1	meadow brown	41366	1
2	hedge brown	14691	2
3	ringlet	12656	7
4	chalkhill blue	11124	9
5	small white	10503	-
6	common blue	10096	3
7	green-veined white	9147	-
8	small heath	9119	8
9	small/Essex skipper	7618	5
10	small tortoiseshell	7267	-

SUMMARY OF CHANGES 1996-97

Table 4. All-sites indexes for 29 of the commoner butterflies in 1996 and 1997. The initial value in all cases was 100 in 1976, except for the clouded yellow, which is calculated on a different basis (see last year's report) and for which 10 was used in 1976. For species with two distinct flight-periods the second is used here. The number of sites is that used to calculate the 1997 index for each species. The 1996 indexes usually differ slightly from those given last year because of the retrospective inclusion of a few additional sites.

	1996	1997	sites
Small/Essex skipper	286	237	67
Large skipper	227	212	61
Dingy skipper	12	24	20
Grizzled skipper	53	100	17
Clouded yellow	1513	13	1 in 1997
Brimstone	149	83	57
Large white	69	147	74
Small white	80	168	67
Green-veined white	211	412	70
Orange tip	121	118	44
Green hairstreak	119	209	23
Small copper	129	150	66
Common blue (bivoltine)	165	115	67
Holly blue (bivoltine)	706	488	53
White admiral	56	27	21
Red admiral	225	80	74
Painted lady	16425	66	75
Small tortoiseshell	142	290	66
Peacock	400	324	81
Comma	222	316	57
Dark green fritillary	82	157	28
Speckled wood	144	203	62
Wall	15	12	40
Marbled white	296	380	38
Grayling	30	40	14
Hedge brown	163	111	75
Meadow brown	150	114	89
Small heath	40	48	51
Ringlet	310	462	60

Table 5. Changes in indexes of the rarer butterflies, comparing 1996 with 1997. Numbers of sites with increases, decreases or no change

	increase	decrease	no change	number of sites
Lulworth skipper	0	0	1	1
Silver-spotted skipper	5	0	0	5
Swallowtail	1	0	0	1
Wood white	2	2	1	5
Brown hairstreak	1	6	1	8
Purple hairstreak	8	11	2	21
Black hairstreak	1	2	0	3
White-letter hairstreak	3	5	0	8
Small blue	5	0	0	5
Silver-studded blue	0	1	0	1
Brown argus	14	25	0	39
Northern brown argus	3	0	0	3
Common blue (univoltine)	4	4	1	9
Chalkhill blue	5	10	0	15
Adonis blue	4	5	0	9
Holly blue (univoltine)	0	3	0	3
Duke of Burgundy	4	2	0	6
Purple emperor	3	2	0	5
Small pearl-bordered fritillary	7	5	0	12
Pearl-bordered fritillary	9	4	0	13
High brown fritillary	2	2	0	4
Silver-washed fritillary	14	10	0	24
Marsh fritillary	5	1	1	7
Heath fritillary	3	1	0	2
Glanville fritillary	1	0	0	1
Scotch argus	0	5	0	5
Large heath	3	0	0	3

There are similar numbers of increases and decreases (Table 6). One notable feature was the greatly reduced abundance of migrants, perhaps not surprising as 1996 was an exceptional year for immigration. Another notable feature was that the three whites (*Pieris* spp.) increased substantially in abundance, as did the dingy and grizzled skippers.

Table 6. Summary of changes in indexes 1996-97

decrease greater than 2-fold	decrease less than 2-fold	increase less than 2-fold	increase greater than 2-fold
clouded yellow	small skipper	grizzled skipper	dingy skipper
white admiral	large skipper	large white	small white
red admiral	brimstone	green-veined white	small tortoiseshell
painted lady	orange tip	green hairstreak	
	common blue	small copper	
	holly blue	comma	
	peacock	dark green fritillary	
	wall	speckled wood	
	hedge brown	marbled white	
	meadow brown	grayling	
		small heath	
		ringlet	

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

Small/Essex skipper: although some recorders separate these species, most do not and so the data are combined. Modest declines in all regions, but the collated index remains relatively high.

Lulworth skipper: no change in the current low numbers at Swanage (Ballad Down), (Dorset), the only BMS site for this species,.

Silver-spotted skipper: another good year for this rare butterfly, with increase at all sites. Lydden (Kent) provides an example of increasing abundance, presumably associated with good management for the butterfly

Lydden (Kent)

1990	91	92	93	94	95	96	97
91	264	181	149	94	281	436	829

Large skipper: a small decline, but remains at a high level. Another increase at Monks Wood (Cambridgeshire), assumed to be associated with the spread of coarse grasses there.

Monks Wood (Cambridgeshire)

74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
5	1	6	1	8	10	6	2	20	14	57	38	66	34	23	21	18	91	145	96	54	132	165	261

Dingy skipper: a good year for this species, reversing to a limited extent a steady decline over the last few years. However, no records on the transect at Kingley Vale (West Sussex), for the second year.

Kingley Vale (West Sussex)

76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
141	41	20	27	17	2	10	8	18	36	22	55	24	28	66	39	28	19	5	2	0	0

Grizzled skipper: the third successive increase in the collated index, taking it back to the 1976 level. Given the small number of sites we do not place great reliance on the index, but nevertheless the species has recently done relatively well at established sites.

Lullington Heath (East Sussex)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
35	16	3	6	9	14	19	18	9	11	16	27	*	16	41	25	22	40	72

Swallowtail: virtually no change in the index at the only current site, Bure Marshes (Norfolk).

Wood white: no indications of a general change from 1996-97 at our few sites, but after a period of scarcity has been increasing at Shabbington (Oxfordshire) and Oakley woods (Oxfordshire) over the last few years

Oakley Wood (Oxfordshire)

1985	86	87	88	89	90	91	92	93	94	95	96	97
7	1	0	0	0	3	0	2	4	6	7	18	18

Clouded yellow: a very poor year after the exceptional year of 1996. Records from only one site, Castle Hill (East Sussex).

Brimstone: reasonable numbers recorded in the spring, but 1997 seems to have been a poor breeding season. However, the collated index remains within the relatively narrow limits seen since 1976. In our last report we commented on the colonisation of Ynis Hir (Ceredigion) by the brimstone. We were a little embarrassed to discover that this was an authorised introduction, but at least we picked it up in the data!

Large white: a good year as with all the *Pieris* spp, with the collated index of *P. brassicae* more than double that of 1996. Some (E.P's.) brussels sprout plants did not recover and the sprouts were the size of marbles!

Small white: one of the highest collated indexes for this species, exceeded only in 1986 and 1995. Huge numbers were recorded at some sites in eastern England (index of 4312 at Potton Wood).

Green-veined white: the highest index apart from 1989. Although the second generation index is almost always larger than the first in the south, the opposite is usually true at some northern sites.

West Dean Woods (West Sussex)

	1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
Gen I	5	10	20	52	35	32	34	94	74	42	53	28	56	63	54	21	71	78	127
Gen II	7	22	21	101	32	64	102	120	77	99	130	130	55	201	59	122	180	95	296

Taynish (Strathclyde)

	1985	86	87	88	89	90	91	92	93	94	95	96	97
Gen I	83	7	122	299	116	132	188	154	79	92	177	145	43
Gen II	24	44	280	194	156	94	57	48	70	131	124	35	34

Orange tip: virtually no change, maintaining the remarkable consistency of indexes since the BMS began (range 84 to 188)

Green hairstreak: a good year, with the highest collated index that we have recorded.

Gibraltar Point (Lincolnshire)

1974	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
49	29	-	43	*	4	4	6	9	25	26	6	*	-	0	-	3	4	52	46	29	6	19	95

The other hairstreaks are not recorded adequately by the transect count method, as they usually fly high in the tree canopy. However in the long term the results for these species will be of value and recorders should continue to note them.

Small copper: a modest increase and the collated index remains at a relatively high level. In southern England the weekly counts suggest a second generation peaking in weeks 15-18 and a third in weeks 22-25. (Table 7).

Table 7. Mean weekly counts (m) of the small copper at sites in south & south-east England in 1997.

wk	1	2	3	4	5	6	7	8	9	10	11	12	13
m	0	0	0.6	0.6	1.6	4.8	1.7	1.2	0.9	0.6	0.3	0.3	0.4
wk	14	15	16	17	18	19	20	21	22	23	24	25	26
m	0.5	1.8	1.4	1.5	1.4	1.1	1.1	1.8	4.3	4.9	5.5	4.0	3.1

Small blue: increases at the five sites with data in 1996 and 1997, but indexes are generally small.

Martin Down (Wiltshire)

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

Silver-studded blue: only one comparison possible; a decline from the very large 1996 index at Studland Heath (Dorset).

Brown argus: see separate account

Northern brown argus: increases at the three sites.

Smardale Gill

1990	91	92	93	94	95	96	97
237	244	418	308	255	219	103	139

Common blue (bivoltine, southern): the first generation was relatively abundant, but the second was substantially smaller than in 1996. As usual, and in contrast to the small copper, there were just two generations in the south and south-east of England (Table 8)

Table 8. Mean weekly counts (m) of the common blue at sites in south & south-east England in 1997.

wk	1	2	3	4	5	6	7	8	9	10	11	12	13
m	0	0	0	0.1	0.1	0.2	4.2	14.7	25.3	18.9	9.2	5.1	0.8
wk	14	15	16	17	18	19	20	21	22	23	24	25	26
m	0.7	0.5	1.3	3.4	9.2	19.3	31.3	26.1	9.7	6.1	3.6	1.3	0.8

Common blue (univoltine, northern): no clear overall trend in the 1996-97 changes at our sites.

Murlough (Co. Down)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
164	250	445	281	182	36	*	62	264	757	2100	532	192	103	53	35	23	11	58

Chalkhill blue: decreases occurred at the majority of sites, but the changes were not generally large. There is now a huge population at Lydden (Kent) after seven successive increases since recording began in 1990. The recently established population at Wye also continues to increase.

Adonis blue: as with several bivoltine species, the spring generation was in good numbers, but the summer generation was generally smaller than in 1996.

Castle Hill (East Sussex)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
12	1	44	10	22	70	650	166	53	65	22	15	17	*	136	38	14	11	36	117
5	36	14	20	179	419	483	30	70	31	15	25	26	*	27	*	24	38	180	110

Holly blue (bivoltine, southern): this year appears to be the peak and start of the decline of a holly blue cycle. One of us (N.G-D.) found a high level of parasitism in larvae from the spring adults. There is still an element of doubt that these are true cycles rather than fluctuations which, by chance, look like cycles, but as the years go by the evidence becomes stronger.

Holly blue (univoltine, northern): these populations show no sign of the cycling which is so striking in the south.

Duke of Burgundy: the best year so far for Denge Wood, the BMS site with the highest indexes.

Denge Wood

1993	94	95	96	97
24	8	30	32	42

White admiral: generally a poor year for this species, with the collated index halved from 1996.

Picket Wood (Wiltshire)

1981	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
9	31	18	18	21	21	18	11	13	0	6	24	16	11	23	23	17

Purple emperor: occasional sightings except at West Dean Woods (West Sussex) where an index of 10 was recorded.

Red admiral: a decline from 1996, but a better than average year. Over 1000 sightings, compared with 29 for the painted lady. Increased at a few sites, including Culvie Wood in Grampian, which recorded its highest index

Culvie Wood (Grampian)

1991	92	93	94	95	96
30	0	12	80	6	85

Painted lady: one of the poorest years for this species, following the phenomenal numbers in 1996. There have been only four lower collated index values since 1976.

Small tortoiseshell: the index was more than double last year's and (just) the highest we have recorded. Our analyses suggest that it benefits from high early summer rainfall and this is supported by the results this year.

Camberwell beauty: the second record of this species; the first was in 1995 at Church Wood (Kent) and this year's was also in Kent, at Denge Wood.

Peacock: a modest decline in the collated index, but some increases especially at more northerly sites.

Comma: a good year and the highest collated index that we have recorded.

	1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
Ampfield Wood (Hampshire)	21	*	12	17	22	7	17	69	18	25	32	45	18	10	*	4	87	35	127
Wyre Forest (Worcestershire)	3	6	4	24	24	6	12	18	23	29	21	3	20	48	3	12	16	19	44

Small pearl bordered fritillary: no clear trend in the 1996-97 changes.

Pearl-bordered fritillary: more increases than decreases at the 13 sites, but numbers at most of the sites are very small and the changes of little consequence.

Gait Barrow (Lancashire)

1978	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
124	56	74	13	29	18	64	149	106	312	117	93	247	160	146	162	81	188	227	223

High brown fritillary: a good year at the two sites with large populations and the best so far at Leighton Moss (Lancashire).

Leighton Moss (Lancashire)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
57	42	27	53	45	94	45	25	40	35	29	27	35	55	39	86	67	115	230

Dark green fritillary: a very good year for this species, with large indexes at many sites, especially on the southern chalk. In spite of this, there were no records at Kingley Vale (West Sussex) where it was abundant when recording began in 1976.

Martin Down (Wiltshire)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
14	20	9	28	13	67	101	57	87	16	44	92	70	109	64	82	158	127	346

Sands of Forvie (Grampian)

1979	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
51	39	27	131	57	93	44	8	*	44	22	*	56	45	*	*	67	39	146

Silver-washed fritillary: little overall change in abundance, but the first transect records for several years at both Shabbington and Oakley Woods in Oxfordshire are encouraging. Good numbers at Bovey Valley (Devon) where there was a serious fire before the start of the season.

Marsh fritillary: as is typical of this species, some sites had a very good year and others a very poor one. The Taynish (Strathclyde) data typify the large fluctuations shown.

Taynish (Strathclyde)

1985	86	87	88	89	90	91	92	93	94	95	96	97
145	0	1	4	5	39	52	13	2	2	1	30	128

Heath fritillary: a good year at the sites in the Blean (Kent), but a decline at Luckett (Cornwall).

Glanville Fritillary: an increase at Mottistone Down (Isle of Wight), the only BMS site with this species, after two rather poor years.

Mottistone Down (Isle of Wight)

1989	90	91	92	93	94	95	96	97
6	22	129	45	43	39	18	17	48

Speckled Wood: a good year following the poor one in 1996. First transect records at Gibraltar Point (Lincolnshire) (recorded since 1974) and Culvie Wood (Grampian).

Wall: see separate account

Scotch argus: decreases at the five BMS sites with data for 1996 and 1997, but changes generally not large.

Loch Garten (Highland)

1977	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
111	77	50	158	152	223	92	147	217	172	233	303	137	104	122	281	*	186	132	223	177

Marbled white: an increase to the highest collated index in the series. Increases occurred on downland and woodland sites. The likely source of occasional individuals at Bevills Wood (Cambridgeshire) has been traced to a nearby railway cutting.

Grayling: an increase in the collated index after four successive declines. The first double-figure index at Lullington Heath (East Sussex), a transect which has been recorded since 1979.

Hedge brown: a moderate decline in the collated index. The consistency (synchrony) across the country is shown by the fact that it decreased at 58 of the 75 sites for which comparisons are possible. One of the increases was at Craig y Cilau (Powys) where the first records after many years of recording were in 1996.

Meadow brown: a moderate decline similar to that of the hedge brown. Comparisons possible for 89 sites, the most for any species.

Small heath: a small increase, making the third in successive years and a rise in the collated index from 25 to 48 over this period.

Large heath: increase at the three sites, but the BMS coverage of this northern species is poor.

Whixall Fen (Shropshire)

1993	94	95	96	97
37	46	43	60	80

Ringlet: the increase from 1996 to 1997 returns the collated index to the level it has maintained for much of the last 16 years.

DECLINE OF THE WALL BROWN BUTTERFLY

In 1997 the collated index for the second generation of the wall fell to 12, the lowest since we began recording in 1976. We also calculate regional indexes and that for the wall in the south and south-east was 2 (again compared with 100 in 1976). Clearly the wall is currently at a low ebb, at least in the south of England.

Since 1976, the wall has shown wide fluctuations in abundance (see Fig. 2d). The collated index fell from 100 to 22 from 1976 to 1977, but then increased steadily to a peak of 135 in 1983. There was a further crash in the mid 1980s, with a low of 17 in 1987. During this decline, the species apparently became extinct at some sites in the south (eg Alresford Farm (Table 9) and Gomm Valley), but at others that was a rapid recovery (eg Leigh Marshes) to give a further peak collated index of 120 in 1989. After this there was another decline which, at many sites, has continued to the present. The decline has been largely at southern sites, but not exclusively so. Northern sites showing recent declines include Wart Barrow at the edge of the Lake District and Murlough in Northern Ireland.

In sharp contrast, at other sites (eg Dyfi, Table 9) there is relatively little sign of decline and reasonable numbers have been maintained over the whole recording period. Many of these sites are coastal or close to the coast (Holkham, Dyfi, Saltfleetby, Gibraltar Point, Ynis Hir, Newborough Warren, Swanage) although including a range of biotopes. A few, such as Wye and Coombes Valley are well inland. Equally remarkable, the wall butterfly has actually expanded its range northwards in recent years, especially in the north-east (Ellis, 1994) and this expansion is assumed to be associated with warmer summers. The wall contracted in range in the second half of the 19th century when summer weather was often cool (Thomas & Lewington, 1991).

Table 9. Fluctuations in indexes of the wall butterfly at three sites. - no counts, or absent but insufficient counts for a zero index to be assumed, * present at the site, but insufficient counts for an index to be given.

	1976	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
Alresford Farm	-	-	-	6	15	*	12	14	5	1	0	0	0	0	0	0	0	0	0	0	0	0
	-	-	-	22	27	8	87	31	12	2	0	0	0	0	0	0	0	0	0	0	0	0
Leigh Marshes	0	1	3	5	19	14	-	38	4	1	0	0	0	0	21	3	0	0	0	-	0	0
	1	0	4	15	21	42	-	24	8	4	0	0	6	*	11	0	0	2	0	0	1	0
Dyfi	19	10	17	24	15	17	32	30	21	10	11	*	27	11	15	30	19	18	8	8	8	24
	32	21	20	26	21	23	33	11	11	16	30	29	12	*	76	75	30	*	15	12	18	35

Is the decline of the wall butterfly, especially in the south, a cause for concern. The answer is that we do not know because the cause of the fluctuations is not clear. Weather may have a role; our analyses suggest that is may be susceptible to drought, but the association is not strong. Indeed, given that the species is particularly associated with warm and dry situations, it would be surprising if it was highly vulnerable to drought. The larval food-plants include a range of grasses and a variety of biotopes are used, including woodland rides, grassland of various types and coastal dunes. Thomas & Lewington (1991) suggest that it has suffered from the loss of rich unimproved grassland. This is almost certainly true, but would not explain the very recent decline, nor its particular regional nature.

Answers to these questions can only come from more detailed research. A judgement must now be made as to whether the evidence, from the BMS and elsewhere, is sufficient to justify a programme of research on the requirements of this butterfly. Our feeling is that we should perhaps wait for another year or two, but procrastination .....

THE RECENT SPREAD OF THE BROWN ARGUS BUTTERFLY AND SOME LIKELY CAUSES

Introduction

The following is derived from a paper that one of us (NG-D) is currently drafting, with statistical help from Tim Sparks, hopefully for publication in a scientific journal later this year. The paper itself will be a fuller account with more analysis of data than is possible here.

The brown argus butterfly (*Aricia agestis*) was considered by Bourn and Thomas (1993) to be a declining butterfly in Britain. They state that about 40% of former British populations had disappeared by the late 1980s. The brown argus was also considered to be a relatively sedentary butterfly with many populations being closed and isolated. Most populations occurred on chalk and limestone downs where the main larval foodplant is common rockrose (*Helianthemum chamaecistus*) (Thomas & Lewington 1991). Populations occurred elsewhere on dunes, heaths and woodlands where the main foodplant was considered to be common storks-bill (*Erodium cicutarium*) and in some cases dove's-foot cranes-bill (*Geranium molle*). Since the work by Bourn and Thomas was published there has been a remarkable turn around in the fortunes of the brown argus. The butterfly has spread rapidly throughout the countryside in many parts of southern Britain to the extent that is now commonly seen in many situations including woodland, farmland, road-side verges and even suburban gardens. This increase was noted as early as 1989 but was most marked in the years 1994 to 1996.

A variety of possible reasons for the spread of the brown argus have been put forward. These include:

1) The influence of the run of warmer drier summers in recent years. Evidence from the BMS indicates that many butterfly species benefit from higher summer temperatures.

2) A transition to an alternative foodplant(s) previously not, or little, used by the brown argus.

3) The advent of set-aside (particularly non-rotational) which may provide additional breeding habitat for the butterfly due to its disturbed nature and the abundance of possible hostplants (notably *Geranium* species). Areas of set-aside land may act like stepping stones, aiding the spread of the butterfly across the countryside from traditional habitats.

4) An increase in foodplant availability/abundance, due to effect of climatic factors and/or the increase in suitable areas of habitat.

These factors are inevitably linked. This account examines the spread of the brown argus and discusses evidence pointing towards the above factors being, at least in part, responsible for this spread.

Records of the spread of the brown argus

In 1995 a new butterfly recording project called *Butterflies for the New Millennium*, was launched by the charity Butterfly Conservation, in association with the Biological Records Centre, (based at the Institute of Terrestrial Ecology, Monks Wood). The project includes an intensive five-year (1995-99) recording period to provide a detailed audit of the populations and distribution of butterfly species in Britain and Ireland. This will culminate in the production of a comprehensive atlas for the year 2000. To facilitate the collection and collation of butterfly records a UK-wide network of local co-ordinators called Butterfly*Net* has been set up (Asher 1996). An up-to-date list of local coordinators is contained in the recent issue of *Butterfly News* (1998, **No. 67,** pp 14-15). From discussions with local co-ordinators of the Butterfly*Net* it is clear that the recent spread of the brown argus has occurred throughout much of southern Britain (Table 10). This spread is particularly marked in Eastern England as far north as Grimsby in north Lincolnshire. The range of the brown argus has extended northwards into areas that have not been occupied by the butterfly for many years. Almost everywhere the brown argus has spread out into the wider countryside, often well away from its previously known habitats. It is now being recorded, sometimes in large numbers, in areas where there is neither common rockrose nor common storks-bill and where doves-foot cranes-bill does not grow in sufficient abundance to explain the numbers of brown argus being seen.

Many of these new records of brown argus are coming from habitats such as waste and disturbed ground (such as old railway land and old gravel workings), road-side verges (including land adjacent to dual carriageways and motorways) non-rotational set-aside, farmland, woodland (especially the rides) and gardens. Many of these records undoubtedly represent colonies, because in many places relatively large numbers of brown argus are being recorded, and in some cases egg laying has been observed, notably on *Geranium* species. In the case of woodland some records may represent colonies, but at other sites there are apparently no suitable foodplants. It may be that these butterflies are moving into the woodlands during hot summer weather to nectar and find shelter from a nearby colony on more open ground and there is some evidence that this is the case. In several instances where the brown argus has been found in woodland rides in numbers, they can also be found on adjacent disturbed ground where *Geranium* species are abundant.

In most counties in the east of England, the spread first became apparent in 1994, whereas in more western counties it was in 1995. Numbers continued to increase in 1996 and the brown argus was found on an increasing number of sites throughout its range. There was a marked drop in the numbers of brown argus seen in 1997, though it continued to be found on more new sites, particularly in counties in the north of the region, notably Lincolnshire, Nottinghamshire and Leicestershire. The exceptionally cool wet June of 1997 is thought to be largely responsible for the drop in numbers and BMS data seems to support this as there was a drop in the index from the spring to summer generations in 1997.

There is some indication from BMS data (and other records) that the brown argus was beginning to spread earlier than 1994, perhaps in response to the hot summers of 1989-91 (Table 11).

Table 10. A summary of the recent spread of the brown argus in England largely derived from discussions with local co-ordinators of the Butterfly*Net*. Counties are in alphabetical order except where they are grouped according to areas covered by individual local co-ordinators.

County	Summary of spread/status
Avon	Not declining, possibly increasing
Bedfordshire	Dramatic spread throughout the wider countryside since 1994 from traditional chalk habitats.
Berkshire, Buckinghamshire & Oxfordshire	Dramatic spread throughout since 1994. Fourfold increase in the proportion of tetrads in which it has been recorded between 1993 and 1997.
Cambridgeshire & Essex	Dramatic spread throughout since 1994. Not recorded in the vice-county of Huntingdonshire since1959 until 1991 onwards.
Cheshire	No records
Cornwall	No conclusive evidence of spread
Devon	Possibly spreading.
Dorset	Dramatic increase and spread since 1995 from former strongholds on the Downs into the wider countryside.
Gloucestershire	Spread from traditional calcareous grassland strongholds into the wider countryside.
Hampshire	Some indication that the butterfly may have spread into the wider countryside, but it is already widespread in Hampshire and additional records are difficult to separate from increased recorder effort.
Hertfordshire	Big increase in the number of sites on which it is being recorded. Particularly noticeable since 1995.
Kent & SE London	Previously widespread in Kent but has apparently spread into the wider countryside in last 2 years.
Leicestershire	In SE Leics since 1995 and apparently spreading. First records for about 50 years.
Lincolnshire & Humberside	Reinvasion and spread to north. Not previously recorded for 15 years until 1995. Now as far north as Grimsby
Norfolk	Marked spread into the eastern side of the county.
Northamptonshire	Become widespread since 1995. Not previously recorded since 1959 despite intensive butterfly survey 1979-81.
Nottinghamshire	Five sites in SE of the county in 1997. First records for about 40 years
Somerset	Spread off limestone into the wider countryside.
Suffolk	Formerly primarily restricted to NW of county & coast. Now widespread throughout (from 30 to 269 tetrads).
Surrey & South London	Marked spread into wider countryside from downland, especially since 1994.
Sussex	Spread off the Downs into the wider countryside
Warwickshire	Dramatic increase and spread across the county. 2-3 sites known in 1992/93. Now recorded from >100 sites in 85 tetrads
West Midlands	May be increasing in Worcestershire, but no records for Staffordshire or for Herefordshire since 1986, No new records for Shropshire.
Wiltshire	Spread off the Downs into the wider countryside.

Table 11. 17 BMS transects "colonised" and 6 "recolonised" by the brown argus since 1989 showing the annual indexes for both the spring and summer generations for the period 1989-1997.

. = No brown argus recorded
* = Brown argus recorded but too few weekly counts made to calculate an index.
? = No brown argus were recorded but too few weekly counts made during the flight period to indicate its absence.
In last column "1 in 2" (for example) means one specimen recorded in the second generation.

Site	County	Dominant habitat	Year transect came into scheme	1989	1990	1991	1992	1993	1994	1995	1996	1997	Earlier records on transect
West Dean Wood	Sussex	Woodland	1979	. 2	. 2	. 15	. 4	2 .	. 3	. 2	. 2	3 4	1 in 2 - 1983
Avon Gorge	Somerset	Woodland	1983	. 3	. .	. .	. .	. .	. .	. .	. 2	. 3	6 in 2 - 1983
Northward Hill	Middlesex	Woodland	1977	. 15	. 2	? .	. 30	. 2	? 14	. 3	. .	* *	
Waterperry Wood	Oxfordshire	Woodland	1976	. .	. 3	? .	. .	. .	. .	. 8	. 4	. 2	10 in 2 - 1976
Shabbington Wood	Oxfordshire	Woodland	1984	. .	. 2	. .	. .	. .	. .	. 1	. .	. 1	1 in 2 - 1984
Batch Farm	Gloucestershire	Farmland	1982	. .	. 1	. .	. .	. .	. .	. .	. 3	. .	
Whitecross Green Wd.	Oxfordshire	Woodland	1986	. .	. .	2 .	. .	. 2	. 3	. .	2 1	1 6	
Oakley Wood	Oxfordshire	Woodland	1985	. .	. .	. 1	. .	* .	. 6	. 2	. 5	. 3	
Barnack Hills & Holes	Cambridgeshire	Calcareous grs	1981	. .	. .	. .	. .	. .	2 7	4 90	19 155	* *	
Leigh Marshes	Essex	Wetland	1976	. .	. .	. .	. .	. .	. 5	? .	. 67	. 4	2 in 2 - 1978
Gomm Valley	Buckinghamshire	Downland	1976	. .	. .	. .	. .	. .	. 1	? 3	. *	* .	
Gibraltar Point	Lincolnshire	Dunes	1976	. .	. .	. .	. .	. .	. 2	11 12	5 116	* 101	
Somerford Common	Wiltshire	Woodland	1989	. .	. .	. .	. .	. .	. 2	. 12	. 14	. 3	
Woodwalton Farm	Cambridgeshire	Farmland	1974	. .	. .	. .	. .	. .	. .	. 1	. 26	. 7	
Bevill's Wood	Cambridgeshire	Woodland	1976	. .	. .	. .	. .	. .	. .	. 11	. 6	. 9	
Monks Wood	Cambridgeshire	Woodland	1974	. .	. .	. .	. .	. .	. .	. 32	. 2	1 5	
Potton Wood	Bedfordshire	Woodland	1974	. .	. .	. .	. .	. .	. .	. 210	. 117	1 35	
Castor Hanglands	Cambridgeshire	Woodland	1976	. .	. .	. .	. .	. .	. .	. .	7 37	* *	
Bure Marshes	Norfolk	Wetland	1976	. .	. .	. .	. .	. .	. .	. .	4 .	. .	2 in 1 - 1980
Stour Wood	Essex	Woodland	1983	. .	. .	. .	. .	. .	. .	. .	. 15	. 7	
Woodwalton Fen	Cambridgeshire	Wetland	1977	. .	. .	. .	. .	. .	. .	. .	. .	. 1	
Moor Farm	Lincolnshire	Farmland	1980	. .	. .	. .	. .	. .	. .	. .	. .	. 81	
St. Osyth	Essex	Landfill	1983	. .	. .	. .	. .	. .	. .	. .	. .	. 1	

Evidence of spread from the BMS

In the autumn of 1997 transect data was received from 118 BMS and ECN sites throughout the United Kingdom. Ninety-one of these sites fall within the current range of the brown argus. The butterfly has been recorded on 51 of these transects since they came into the scheme, and on 45 of them in 1997. At only one of the 51 transects has the brown argus not been recorded in the last 2 years. Since 1989 the brown argus has been recorded on 17 BMS transects on which it had not been previously recorded, at least since the sites came into the scheme. This figure only includes sites where there had been at least 5 years recording as part of the BMS prior to the appearance of brown argus on the transect. At a further six sites the brown argus has been recorded again after a gap of at least four years. Previous records at all these six sites were sporadic and probably did not indicate an established breeding population on these transects. However recent transect counts on at least three of these sites indicate that populations are now established. Table 12 shows the first year that the brown argus "colonised" or "recolonised" each of these 23 sites. At many of these sites the brown argus has continued to be recorded almost annually since the first date (Table 11).

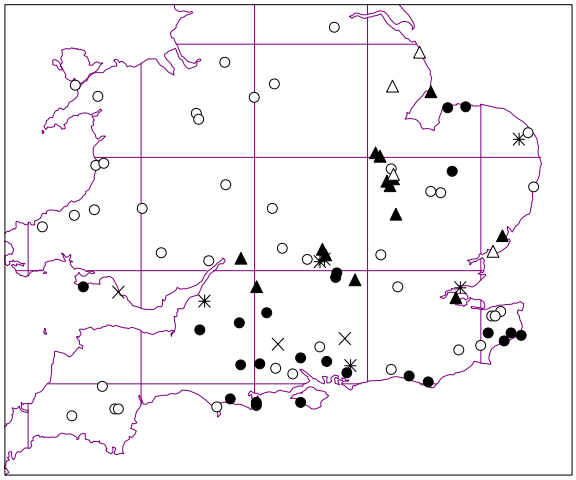

Figure 1. BMS/ECN sites in southern Britain showing where brown argus has, or has not been recorded on the transect: Solid triangles = "colonised" since 1989; Open triangles = first recorded in 1997; Solid circles = sites where already present; Open circles = not recorded; * ="recolonised"; x = recorded but site in scheme 5 years or less.

Table 12. The number of BMS sites "colonised" or "recolonised" in each year from 1989 to 1997 There were no sites in either of these categories before 1989.

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
"Colonisations"	1	1	2			4	4	2	3	17
"Recolonisations"	1					1	3	1		6

Table 13. Shows the predominant habitat type at BMS and ECN sites occupied by the brown argus; at sites within the current range of the brown argus; and at all sites in the scheme.

Predominant habitat	Brown argus already present	"Colonised" sites	"Recolonised" sites	Sites entered scheme in last 5 years with Brown	Total number of scheme sites with Brown argus	Number of Scheme sites in current range of Brown argus	Total number of sites in scheme
Calcareous grassland	15	2		1	18	18	19
Coastal dunes	3	1		1	5	8	13
Dry heathland	3				3	4	4
Wetland		1	2		3	10	13
Woodland	3	9	4	2	18	31	37
Farmland		3			3	8	8
Upland						2	7
Other categories		1			1	9	17
Totals	**24**	**17**	**6**	**4**	**51**	**90**	**118**

Effects of weather on the brown argus

Abundance of brown argus
Analysis of weather data (Central England mean monthly temperatures and the England and Wales monthly precipitation) and the log collated indexes for the brown argus from BMS data (1976-1997) show that the abundance of the brown argus is positively correlated with temperature but negatively correlated with rainfall. These correlations are evident with mean annual temperature and annual rainfall, however the correlation is strongest with the mean June-August temperatures ($r=0.75$, $p<0.001$).

Proportion (%) of BMS sites occupied by the brown argus
The proportion of sites on which the brown argus is recorded in any one year is also positively correlated with mean annual temperature and negatively correlated with annual rainfall. Again the strongest correlation is with mean June-August temperature ($r=0.74$, $p<0.001$)

In conclusion, warm dry summers appear to benefit the brown argus as both its abundance and the proportion of sites on which it is recorded increases.

Alternative foodplants ?

One of the features of the recent spread of the brown argus has the been the colonisation of areas where its traditionally recognised foodplants, common rockrose and common storks-bill do not grow and where dove's-foot cranes-bill does not appear to be sufficiently abundant to support the increase in numbers and range expansion of the species that has been observed. However, two other annual *Geranium* species are also widespread in the wider-countryside and often occur in abundance away from areas of semi-natural habitat. The most abundant of these is cut-leaved cranes-bill (*Geranium dissectum*). This is a common plant of disturbed wasteground, road-side verges, arable field edges and latterly non-rotational set-aside. In parts of the east of England small-flowered cranes-bill (*Geranium pusillum*) can also be abundant in similar situations.

During the last few years, brown argus females have been observed ovipositing and eggs have been found on cut-leaved cranes-bill in a variety of situations including old gravel workings, field boundaries, a river flood bank and on set-aside (Dickerson 1996, McNeill 1997, Roger Kemp, Tony Liebert & Richard Revels *pers. comm.*). Larvae have also been observed feeding on new seedlings and young plants of cut-leaved cranes-bill during August and September. Eggs have been found on other *Geranium* species including mountain cranes-bill (*Geranium pyrenaicum*) (Mike Slater *pers. comm.*) and meadow cranes-bill (*Geranium pratense*) (Tony Liebert & Richard Revels *pers. comm.*).

During the 1950's Jarvis (1958) fed brown argus larvae that had been initially reared on common rockrose on several alternative foodplants including several *Geranium* species; dove's-foot cranes-bill, small-flowered cranes-bill, round-leaved cranes-bill (*Geranium rotundifolium*) and herb robert (*Geranium robertianum*). The larvae fed freely on the first three of these, but only sparingly on Herb robert, deserting it in favour of dove's-foot cranes-bill when offered it as an alternative. In another test a female brown argus was placed in a cage with several *Geranium* species (dove's-foot, small-flowered and herb robert), commom rockrose and commom Storks-bill. Eggs were laid on all these plants, but higher numbers were laid on the three normally recognised foodplants. Larvae grew normally on all foodplants except the herb robert. These died within a few days after wandering ceaselessly over the leaves and only nibbling them at intervals.

In May 1997 two female brown argus were taken from a small non-rotational set-aside field in Cambridgehire where an apparently thriving colony had been found in 1996. Cut-leaved cranes-bill was abundant. The butterflies were subsequently confined over cut-leaved and small-flowered cranes-bill growing in pots. Eggs were laid profusely on both sets of plants. The resulting larvae were successfully reared, both outdoors on the potted plants, and also confined individually in plastic boxes with leaves of either cut-leaved, small-flowered or dove’s-foot cranes-bill. There was virtually no

mortality among the individually reared larvae. Resulting adult butterflies were normal size, or in some cases larger.

It is clear from the above that at least some small *Geranium* species, other than dove's-foot cranes-bill, are suitable as foodplants for the brown argus.

Has set-aside helped?

A voluntary set-aside scheme was launched in 1988 as part of the European Community's common Agricultural Policy (CAP) in order to encourage farmers to take some arable land out of crop production in exchange for payments. The only set-aside option in the scheme at the time was to take land out of agriculture for a period of five years, during which time the land had to be left fallow or sown as green cover (non-rotational set-aside). In 1992 the CAP was reformed. Under the revised scheme land could also be taken out of production for one year only (rotational set-aside). In addition there was no longer a five-year limit to non-rotational set-aside, and there was also the option of setting aside land into a separate 20-year Habitat Scheme.

Since 1992, rotational set-aside has generally been much more popular with farmers than non-rotational set-aside. The amount of non-rotational set-aside in different parts of England is somewhat variable. Norfolk, for example, had the highest amount in 1993/94 with between 10,000 and 25,000 ha of non-rotational set-aside. Within the range of the brown argus, Lincolnshire, Nottinghamshire, Suffolk, Essex, Kent, West Sussex, Dorset, Wiltshire and Gloucestershire had between 3,000 and 10,000ha whereas the remaining counties had less than 3,000 ha each (Firbank (ed.) 1996).

Cut-leaved cranes-bill is often an abundant plant on non-rotational set-aside as has frequently been observed. Anecdotal observations are supported by quantitative sampling. In January 1995 the Ministry of Agriculture Fisheries and Food sponsored an agronomic and environmental evaluation of set-aside (Firbank (ed.) 1998). As part of this survey work, approximately 100 randomly selected non-rotational set-aside sites (usually site = field) throughout England were surveyed. At each site grasses and dicotyledenous plants were identified from a series of botanical quadrats. Cut-leaved cranesbill (and to a lesser extent dove's-foot cranes-bill) was found in a high proportion (50% in 1997) of set-aside fields even though the samples covered only a very small area of each field.

Colonies of brown argus have been found associated with non-rotational set-aside where cut-leaved cranes-bill is common, (personal observations, Nick Bowles, Tony Liebert *pers. comm.*) and it is clear that they are able to breed on these areas. Cut-leaved cranes-bill, and to a lesser extent dove's-foot cranes-bill (and sometimes other annual species of *Geranium*) are an important feature of non-rotational set-aside. These areas could therefore be an important factor in the recent spread of this butterfly. Interestingly however, some of the counties where the brown argus has spread most are where there was relatively little non-rotational set-aside in 1993/94 (<3000ha/county).

Rotational set-aside is unlikely to benefit the brown argus as the time period is too short for the butterfly to make significant use of it, particularly as the vegetation is sprayed off or cut in June so there would be no opportunity for the second generation of this double-brooded (bivoltine) species. It is also unlikely that in one year there would be sufficient *Geranium* to provide much in the way of foodplant.

Has the weather helped the *Geranium*s?

The warm, dry summers of recent years may have acted in such a way as to benefit annual dicotyledonous plant species such as the annual *Geranium*s that the brown argus feeds on. In years with hot summers and low rainfall, many plants in grassy swards, especially on disturbed ground, die back or die completely leaving gaps which provide germination sites for new seedlings (Wells *et al.* 1993). Once rain comes in the late summer and early autumn and as the weather cools, seeds lying in the vacant spots germinate and because of the lack of competition become established. These plants,

often referred to as winter annuals, then establish themselves as rosette plants over the winter months, growing slowly in mild weather. In the spring they are ready to grow quickly to maturity and flower and seed. The timing of drought followed by cooler weather with rain is crucial both for good germination and for the brown argus. Second generation brown argus are on the wing from late July and into September. New plants would need to have germinated and be establishing in time for female butterflies to lay on them if they are to survive in habitats where they rely on annual herbs. It seems that if the brown argus is relying on annual *Geranium*s in many of its new habitats, populations are likely to fluctuate considerably from year to year and be much more vulnerable to extinction due to the ephemeral nature of the *Geranium*s and the unpredictability of the weather and germination success from year to year (Kemp *in prep.*). The current spread and abundance of the brown argus may be only short lived.

Conclusions

It is clear from the evidence presented here that the brown argus butterfly has greatly extended its range in parts of southern Britain during the past few years. In particular there has been a spread out from its traditional habitats on chalk and limestone downland and coastal grassland into the wider countryside, so much so that in some areas it can be encountered almost anywhere. This expansion of range has been particularly evident in the eastern counties of England where previously the butterfly was either scarce or in some cases absent. The brown argus has also moved north to reoccupy areas where it has not been recorded for several decades.

In the southern seaboard counties the expansion in range is less clear, though the general impression is that it has happened here too, though perhaps more so in some areas (Dorset and Sussex) than others (Hampshire and Kent). However any spread here is probably masked by the fact that the butterfly was formerly widespread in these counties where there are generally many suitable areas of its more traditional habitats. It is also difficult to unravel the increased numbers being recorded and the increase in the number of sites from which it is being recorded from increased recorder effort in recent years. In addition, since it became apparent that the brown argus was spreading, recorders are looking out for the butterfly more.

The picture is somewhat different further west. There is some evidence of spread in Somerset and Gloucestershire, but little evidence in either Devon or Cornwall. If it has occurred here then it has not happened to anything like the degree it has happened in the eastern counties, at least thus far. There is no evidence of spread in counties west and north of Gloucestershire, Worcestershire and Warwickshire.

It is also clear that the brown argus is using foodplants with which it has not normally been associated. Causes of biological phenomena are often multifactoral and inter-related and are often far more complex than at first appears. However two major factors appear to be high on the list of candidates for cause in the case of the spread of the brown argus. These are higher summer temperatures and the utilisation of previously largely unrecognised foodplants. There is a strong positive correlation between higher summer temperatures and both the abundance of brown argus and the proportion of sites it occupies in a given year when examining data from the BMS. The warmer summers of recent years have almost certainly played an important role in the spread of the brown argus.

From casual observations and from circumstantial evidence, it is also clear that the brown argus is utilising several annual *Geranium* species as foodplants in the areas it has colonised. These areas are often many miles away from its traditional strongholds where its “normal” foodplants grow. One of these *Geranium* species, dove’s-foot cranes-bill, was already recognised as a foodplant of the brown argus, though its importance seems to have been greatly underestimated. However until recently it was not appreciated that the brown argus might successfully breed on cut-leaved and small-flowered cranes-bills and probably other species as well. Annual cranes-bills can be extremely abundant on

disturbed ground such as wasteland, road-side verges and set-aside. cut-leaved cranes-bill is particularly so, as demonstrated in the study on set-aside. It also seems reasonable to suggest that warmer, dryer summers, together with mild winters, such as we have experienced more frequently in recent years, have benefited these annual *Geranium* species. However, we have no quantitative evidence to support this. In conjunction with other areas of disturbed ground, where annual *Geranium*s are abundant, it seems reasonable to suggest that set-aside has aided the spread of the brown argus, not only by providing additional suitable habitat, but also by acting like stepping-stones for what is, or was, thought to be a rather sedentary butterfly, to spread out rapidly across the countryside from its former, often very localised, breeding areas.

It remains to be seen whether these apparently newly established populations of the brown argus will remain viable in the long-term. We suspect that this will largely depend on weather factors, but also to some extent on the future of non-rotational set-aside and other disturbed areas of ground in the wider countryside.

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ACKNOWLEDEMENTS

We particularly wish to express our grateful thanks to all the recorders and site managers who contribute to the BMS, and especially to those whose long-standing and continued commitment to the scheme annually increases the value of this long-term dataset. We are again indebted to Val Burton, and this year to Bill Meek (a fellow entomologist), both of whom worked extremely hard and efficiently to process the 1997 data. We have been fortunate to have the continued support of Paul Harding (Head of the Biological Records Centre). We are also grateful to Henry Arnold for producing the brown argus map using Dr Alan Morton's DMAP programme. We would like to thank the local co-ordinators of the Butterflies for the New Millennium's Butterfly***Net*** for the information received in discussions relating to the status of the brown argus in their local area (Jim Asher, Charles Baker, Roger Bristow, Mike Fuller, Joyce Gay, Doug Goddard, Gail Jeffcoate, John Maddocks, Brian McIlwrath, Guy Meredith, Sarah Miles, John Murray, Andy Nichols, Maurice Paul, Val Perrin, Barry Shaw, Bill Shreeves, Adrian Spalding, Richard Stewart, Roger Sutton, John Taverner, Mark Tyszka, Michael Walker and Keith Warmington). In addition we would like to thank Andy Barker, Nick Bowles, Barry Dickerson, Howard Hillier, Roger Kemp, Tony Liebert, Richard Revels, Mike Slater and Ian Woiwod for additional information relating to the brown argus, and Tony Hughes of the Ministry of Agriculture Fisheries and Food for permission to use data gathered for the agronomic and environmental evaluation of set-aside study, and Nigel Critchley of the Agriculture Development Advisory Service in Newcastle and Les Firbank of ITE for information relating to this study. We would like to thank Tim Sparks for analysing weather and brown argus data for inclusion here. Finally we wish to express our thanks to the Joint Reprographic Services unit at the Natural Environment Research Council's headquarters in Swindon for once again producing this report for us. The Butterfly Monitoring Scheme is jointly funded by the Institute of Terrestrial Ecology and by the Joint Nature Conservation Committee acting on behalf of English Nature, Scottish Natural Heritage and the Countryside Council for Wales.

APPENDIX I

Figures 2a-e. The graphs on the following pages show fluctuations in the collated, "all sites", index values for all species for which this figure is calculated. In addition graphs of collated index values are included for a further six species for interest, however most of these species are recorded at relatively few sites in the scheme so the graphs should be interpreted with caution. These six species are: brown argus, small pearl-bordered fritillary, pearl-bordered fritillary, silver-washed fritillary, chalkhill blue and common blue (northern, univoltine). 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 to 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 (2e on page 34) so that they can be figured at the same scale the rest.

Please note that these figures are for information only and should not be quoted or used in any way without prior permission from ITE.

APPENDIX II

The tables in this Appendix list the sites, by country, which were in the Butterfly Monitoring Scheme (BMS) in 1996 and includes Environmental Change Network (ECN) sites. There were no new sites in 1997, though 5 sites were lost to the scheme (see introduction). (Fontmell Down and Shabbington Wood are included, as a substantial part of the old route in both cases is included in the revised routes of the new transects at these sites). Sites are ordered by county (according to the boundaries before the recent changes) and alphabetically within county. Information for each site is as follows: site name; county; ownership (see key below); date the site came into the BMS (or ECN); and the butterfly species recorded up to 1996 (there were a few additions in 1997, eg brown argus at 3 sites).on the transect since the site came into the scheme indicating the status of each species at the site (see key below). A map shows the distribution of sites in the UK.

Tables Ia-c. Butterfly species recorded at BMS sites in England.

Table II. Butterfly species recorded at BMS sites in Wales.

Table III. Butterfly species recorded at BMS sites in Scotland and Northern Ireland.

Table IV. Butterfly species recorded at ECN sites that are not part of the BMS. Two ECN sites, Rothamsted Farm and Upper Teesdale, were part of the BMS before the ECN was set up and so are not included in this table.

Key to ownership abbreviations:

ADAS	Agriculture Development Advisory Service
BBONT	Berkshire, Buckinghamshire & Oxfordshire Naturalist's Trust (now: The Wildlife Trust for Berkshire, Buckinghamshire & Oxfordshire)
Cn. WT	Cornwall Wildlife Trust
Cm. WT	Cumbria Wildlife Trust
ECC	Essex County Council
CCW	Countryside Council for Wales
DoENI	Department of the Environment, Northern Ireland (Environment & Heritage Service)
Dyf. WT	Dyfed Wildlife Trust
Dor. WT	Dorset Wildlife Trust
EDL	Eurotunnel Development Limited
EN	English Nature
FE	Forest Enterprise
FF	Fountain Forestry
IARC	Institute of Arable Crops Research
IGER	Institute of Grassland & Environmental Research
KWT	Kent Wildlife Trust
LT	Lincolnshire Trust (was LTNC: Lincolnshire Trust for Nature Conservation)
MLURI	Macaulay Land Use Research Institute
MoD	Ministry of Defence
NT	National Trust
NTS	National Trust for Scotland
NWT	Norfolk Wildlife Trust
Private	Non-institutional or society, usually owned by private individuals
RSPB	Royal Society for the Protection of Birds
Sc. WT	Scottish Wildlife Trust
SNH	Scottish Natural Heritage
Sx. WT	Sussex Wildlife Trust
UNIV	University owned
WT	Woodland Trust

Key to species symbols:

***** An average of >5 individuals recorded on the transect/year in the last 10 years (1987-96)

* An average of 5 or less individuals recorded on the transect/year in the last 10 years.

r Occasional sightings; not more than an average of one individual recorded per year on the transect in the last 10 years.

r More than a single individual recorded on only one occasion in the last 10 years.

< Not recorded on the transect for at least the last 5 years where the transect has been recorded for at least the last 10 years and where earlier recording indicated a local breeding population (does not include clouded yellow, red admiral or painted lady all of which are non-resident (with the possible exception of the red admiral) migrant species).

NB. The pearl-bordered fritillary has shown a marked decline in recent years at many of its BMS sites in southern Britain, and may have become extinct at several of these sites where it has not been recorded on the transect counts for 2-4 years, though this is not indicated in the table.

<< Not recorded on the transect for at least the last 10 years where the transect has been recorded for at least 15 years and where earlier recording indicated a local breeding population

o Not recorded on the transect for more than 10 years, but formerly recorded at least once.

> Recorded on the transect in only the last 5 years, with more than single individuals being recorded in at least one of 2 or more years, where the transect has been recorded for at least 5 years previous to the first transect record. Indicates possible colonisation.

> Recorded on the transect in only the last 5 years with more than one individual recorded on one occasion, or single individuals on two separate occasions only where the transect has been recorded at least 5 years previous to the first record.

Isolated earlier sightings have been discounted where it appears that the species has colonised more recently.

>> Recorded on the transect in only the last 10 years where the transect has been recorded for at least 5 years previous to the first transect record. Indicates possible colonisation.

N At least 2 specimens recorded for the first time on the transect in 1996.

n A single specimen recorded for the first time on the transect in 1996.

1 A single individual recorded in the last 10 years.

(1) A single individual recorded, but site in BMS 9 years or less.

+ Recorded, but transect recorded for too few years or data insufficiently complete to make an assessment.

N.B. The same criteria have been used for all species, but the symbols are less meaningful for migrant species (particularly the clouded yellow and the painted lady) and species which are not well monitored by the transect method, such as the canopy hairstreaks and the purple emperor.