The State of the UK's Butterflies 2015

Butterfly Conservation

Saving butterflies, moths and our environment

Executive summary

World-class citizen science projects provide a comprehensive and statistically robust evidence base to inform this assessment of the state of the UK's butterflies. Butterfly populations are monitored annually by volunteers at over 2,000 locations and tens of thousands of people have contributed almost 3 million butterfly distribution records over the past five years from all corners of the UK.

- New analyses confirm significant declines of UK butterflies since 1976. Multi-species indicators show that both habitat specialist butterflies and wider countryside species decreased significantly in abundance and occurrence. Indeed, a number of wider countryside species now rank among the most severely declining UK butterflies, which is a cause of grave concern.

- The UK Butterfly Monitoring Scheme results show that 57% of individual species had decreased in abundance since 1976, although not all of these trends are statistically significant. Among the 33 species with statistically significant long-term trends, 61% decreased over the period.

- Analysis of the Butterflies for the New Millennium recording scheme data reveals that 70% of species decreased in occurrence over the period 1976-2014.

- Overall, 76% of the UK's resident and regular migrant butterfly species declined in either abundance or occurrence (or both) over the past four decades. By comparison, 47% of species increased in one or both measures. The destruction and deterioration of habitats as a result of land-use change (e.g. intensification of agriculture, changing woodland management) are still considered the prime causes of long-term decline among habitat specialist butterflies in the UK. However, the factors responsible for the decreases of wider countryside species are not well understood.

- Wider countryside butterflies are generally faring better in Scotland than in England, mirroring trends reported in other species groups. This may be because detrimental land-use change is more prevalent in southern Britain or because climate change may be having a more beneficial impact in the north than in the south. Further research is needed to tease out these factors.

- The minority of UK butterflies that have fared well since the 1970s have increased their distributions, most likely as a response to climate change. However, we should no longer assume that southerly-distributed species will necessarily benefit from climate change. Species' responses are much more variable than previously realised and the increasing frequency of extreme climatic events, predicted in many climate change scenarios, may have serious implications for butterfly populations.

- In contrast to the long-term picture, UK butterfly trends over the past decade (2005-2014) provide some grounds for optimism. The declines of several threatened species appear to have been halted, and a range of habitat specialist and wider countryside species have become more abundant and widespread. Landscape-scale conservation projects targeting threatened butterflies, often implemented by accessing higher level agri-environment scheme grants, have achieved notable successes, but their overall contribution to the improving national trends of some species has yet to be quantified.

- Ten-year trends show that 52% of species decreased in abundance and 47% decreased in occurrence. While this indicates a generally improving situation, the declines of some threatened species show little signs of abating and, worryingly, populations of some common species have dwindled in recent years. Even for those species where declines have recently been halted, population levels and distributions are much smaller than they once were. The conservation of the UK's butterflies remains an enormous challenge.

- Butterflies are the best-studied UK insects by far, providing vital insights into the changing state of wider biodiversity and the ecosystem services that depend upon it, as well as an important opportunity for the general public to engage with conservation, citizen science and the natural world. Nevertheless, more research is needed, especially to understand and develop effective conservation responses to the declines of many wider countryside butterflies.

- UK recording and monitoring schemes for butterflies must be maintained and adequately resourced so that we can understand future changes, evaluate conservation strategies and adapt them accordingly.

- Further conservation measures are needed urgently to stem the decline of butterflies. Everyone can play a part, but favourable Government policies are essential. The recommendations listed at the end of this report (p.25) should be implemented fully to help achieve the targets agreed under the international Convention on Biological Diversity.

Cover photo: The Silver-studded Blue is one of several threatened UK butterflies that have shown signs of improvement in recent years. Neil Hulme

Introduction

This report, the fourth on the state of the UK's butterflies, comes at a time of particularly dramatic change. Agricultural intensification and other land-use changes have caused extensive wildlife declines in the UK[1], which show few signs of recovery despite the best efforts of conservation organisations and substantial government expenditure.

Now, in the age of austerity and with drastic cutbacks in government funding for the environment[2], the prospects of halting the decline of wildlife and achieving the Aichi Biodiversity Targets set by the global Convention on Biological Diversity for the year 2020 look poor[3].

In addition, new research findings suggest more significant negative impacts of climate change and pesticides on our wildlife than had previously been realised, threats to essential ecosystem services such as pollination as a result of biodiversity decline, and an increased awareness of the importance of nature for human health and well-being.

Set against this bleak backdrop are some significant changes for the good. Participation in long-term recording and monitoring of the UK's butterflies has never been stronger. In addition, new schemes such as the Wider Countryside Butterfly Survey and Big Butterfly Count have been successfully established, enhancing knowledge of the changing fortunes of our butterflies and involving tens of thousands of new recorders.

The UK Government and some devolved administrations have officially adopted biodiversity indicators based on butterfly population data. Modern technology has helped increase the quantity, quality and flow of butterfly data, new analysis techniques have produced more accurate and reliable trends, and the advent of social media has revolutionised the engagement of the general public in recording and conservation.

The landscape-scale approach to the conservation of threatened butterflies, pioneered by Butterfly Conservation, has proved its effectiveness, while strong scientific and public support has been demonstrated for the UK's protected areas.

Butterflies are known to respond rapidly to environmental change. They provide valuable insights into factors that will affect other wildlife and can be used to judge the effectiveness of conservation measures.

This new assessment of the state of UK's butterflies is thus both timely and important. It presents new analyses of long-term and recent trends in butterfly abundance and distribution, identifying areas of concern and glimmers of hope.

It also describes recent conservation initiatives to help save butterflies and gives recommendations for our future conservation strategy. These are relevant not just to the conservation of butterflies, but also to the whole of biodiversity and the future health of our environment.


Tom Brereton

Thousands of volunteer recorders contribute over 80,000 days of effort each year, representing an equivalent value of over £5 million and providing world-class evidence on the state of the UK's butterflies.

[1]Burns *et al.* 2013
[2]http://www.ifs.org.uk/tools_and_resources/fiscal_facts/public_spending_survey/cuts_to_public_spending
[3]Tittensor *et al.* 2014

Evidence base and analysis

This assessment of the changing state of UK butterflies has been made possible through the skill and dedication of thousands of volunteer recorders. Their contributions, channelled through long-term, citizen-science recording and monitoring schemes, ensure a statistically sound evidence base to underpin trends, conservation action and ecological research.

Population monitoring

The most accurate and sensitive means of assessing butterfly trends over time is through standardised counts of individual insects. Organised and analysed under the umbrella of the UK Butterfly Monitoring Scheme (UKBMS), weekly transect counts, Wider Countryside Butterfly Surveys, timed counts, and monitoring of egg numbers and larval nests all contribute to long-term trends in the relative abundance of butterflies. These annually updated trends have been widely adopted by governments at national, UK and European scales to measure the success of policy initiatives and progress towards the 2020 Aichi Biodiversity Targets of the global Convention on Biological Diversity[4].

Weekly fixed-transect monitoring of butterfly populations was devised by the Centre for Ecology & Hydrology and launched as a national scheme in 1976. Since then, volunteers have walked a total of 768,780km of butterfly transects in the UK, equivalent to a trip to the Moon and back, counting every butterfly spotted within a 5m strip along the fixed route. In all, more than 2,500 transect sites have contributed to the UKBMS. A record annual total of 1,223 butterfly transects were walked in 2014.

In addition, approximately 800 further locations are now monitored each year by the Wider Countryside Butterfly Survey (WCBS). Launched in 2009, the WCBS comprises a network of 1km x 1km grid squares, selected at random to be representative of habitats across the UK[5]. Given that traditional butterfly transects are biased towards semi-natural habitats rich in butterflies, the randomly chosen locations of the WCBS add value and rigour to the population trends derived from the UKBMS as a whole[6].

The WCBS employs a reduced effort transect method[7]. Within each square, recorders set up two 1km long survey lines and count butterflies using the same methodology and criteria applied to all UKBMS transects.

Two visits, spaced at least 10 days apart, are made over July and August, with optional recording at other times. Approximately 40% of the squares are also part of the Breeding Bird Survey[8].

This is the first time that WCBS data have been used in a State of the UK's Butterflies report. Some 2,000 volunteer recorders have participated in the WCBS, sampling over 1,500 squares, and the scheme provides good coverage for almost all wider countryside species[9].

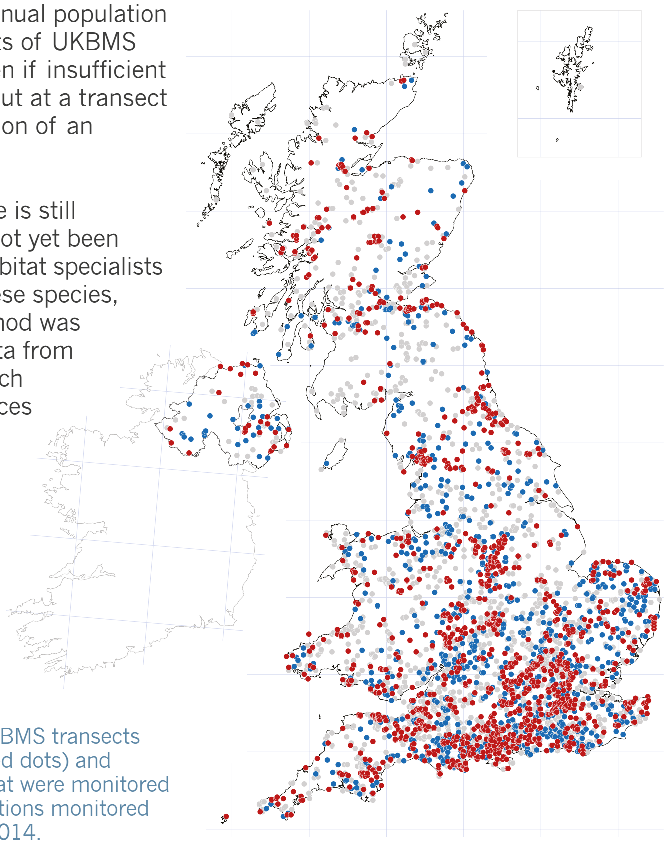
Counts from all UKBMS sampling schemes were combined and national and UK-wide indices estimated for wider countryside species using a new statistical model that accounts for differences in survey methods and patterns in sampling through the season and over years[10].

This represents a major advance for the UKBMS. Not only does it incorporate WCBS data, but it also utilises every transect count to derive annual population indices. None of the efforts of UKBMS volunteers are wasted, even if insufficient weekly walks are carried out at a transect site to enable the calculation of an annual site index.

The new analysis technique is still being developed and has not yet been used to report trends of habitat specialists or migrant species. For these species, the standard analysis method was used. In this, site index data from all sites were combined each year to derive collated indices using a statistical model that takes into account site and year effects[11].

For this report, long-term (mostly dating back to 1976) and 10-year (2005-2014) UK trends in relative abundance were calculated using linear regression for 56 species[12]. Improvements in both monitoring coverage and analysis have enabled population trends to be calculated for three species that were not covered in previous reports[13].

In addition, UKBMS data were combined to generate multi-species indicators to investigate patterns of change among groups of species (see p.8-9).
For example, we assess trends of habitat specialist butterflies and those of wider countryside species[14]. Multi-species (composite) indices of butterfly abundance were calculated using a generalised linear model accounting for species and year. Patterns of change in the butterfly indicators were identified based on smoothed indices and structural time series analysis[15].



Map showing locations of UKBMS transects that produced a site index (red dots) and WCBS squares (blue dots) that were monitored in 2014. Grey dots show locations monitored in previous years but not in 2014.

[4] Brereton *et al.* 2011a, Eaton *et al.* 2015
[5] Brereton *et al.* 2011b
[6] Roy *et al.* 2015
[7] Roy *et al.* 2007
[8] The Breeding Bird Survey is run by the British Trust for Ornithology, Joint Nature Conservation Committee and Royal Society for the Protection of Birds.
[9] Brereton *et al.* 2011b
[10] Dennis *et al.* 2013
[11] Rothery & Roy 2001
[12] All resident and regular migrant species apart from Chequered Skipper, Cryptic Wood White and Mountain Ringlet, for which there were insufficient data.
[13] Swallowtail, Black Hairstreak and Glanville Fritillary.
[14] Asher *et al.* 2001, species in each category are listed in Brereton *et al.* 2015 available at http://www.ukbms.org/reportsAndPublications.aspx
[15] Soldaat *et al.* 2007

Distribution recording

While the UKBMS generates the most up-to-date and responsive trends for UK butterflies, general distribution recording continues to provide the foundation for effective conservation action.

The Butterflies for the New Millennium (BNM) recording scheme comprises over 11 million butterfly occurrence records from 1690 to the present day. A comprehensive historical baseline exists from the 1970s, as a result of recording work organised by the Biological Records Centre.

Since 1995, the BNM has gathered butterfly sightings from thousands of participants through a network of expert 'County Recorder' verifiers, with the aim of achieving comprehensive national coverage in successive five-year survey periods. Sightings from the Big Butterfly Count and other schemes also contribute to the BNM after verification by County Recorders. The most recent survey (2010-2014) comprised 2.97 million UK butterfly records, the highest number yet collated during a five-year BNM recording period.

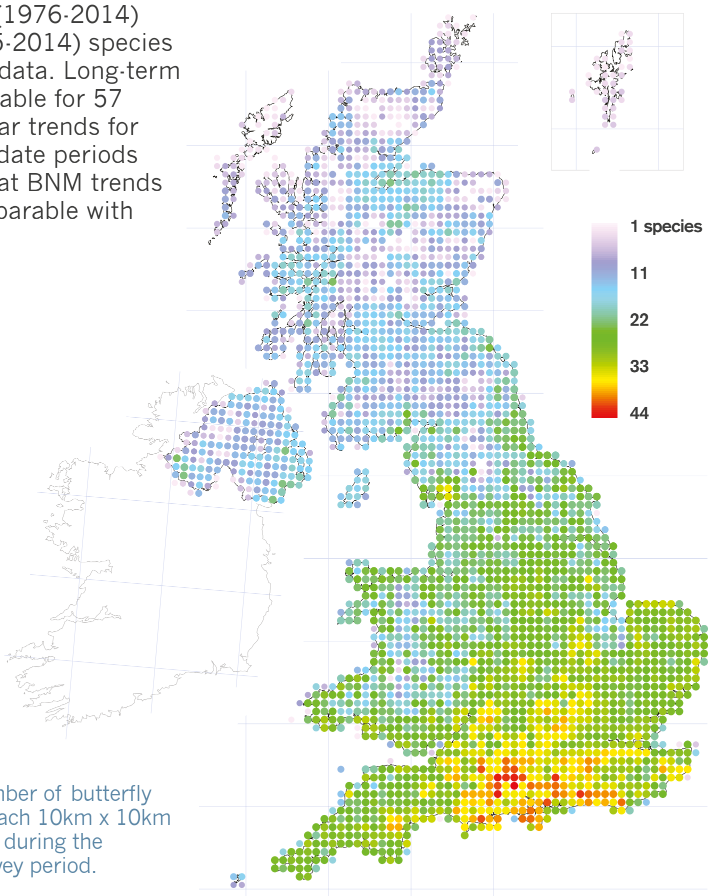
Distribution recording is usually done with no specific sampling method; people record wherever and whenever they choose and spend as much or as little time searching as they wish. This encourages participation but introduces biases that must be considered in any analysis of trends[16]. Many techniques have been developed to try to account for recording effort bias in such datasets and, currently, occupancy-detection models are considered to provide the most robust results[17]. Therefore, we used occupancy modelling to generate species trends from BNM data for this report[18]. Strictly speaking, these trends are changes in the frequency of occurrence, or commonness, of each species over time.

This approach differs substantially from previous analyses of UK butterfly distribution records and has enabled the production of more accurate butterfly trends from BNM data. Previous assessments used 100km^2 (10km x 10km National Grid squares) as the minimum unit of species distribution and combined records gathered over five or more years for comparison. Such coarse-scale trends tend to underestimate real change in butterfly populations[19]. However, the use of occupancy models, coupled with high-resolution data provided by BNM recorders (e.g. fine-scale grid references and exact dates) enables us, for the first time, to quantify the commonness of each species at 1km^2 scale across the UK for each year separately.

We used occupancy models to assess long-term (1976-2014) and 10-year (2005-2014) species trends from BNM data. Long-term trends were calculable for 57 species and 10-year trends for 58 species[20]. The date periods were chosen so that BNM trends were directly comparable with UKBMS trends.

Composite indicators were also created from the occupancy models to examine trends across all butterflies combined, habitat specialists and butterflies of the wider countryside. The annual values of the composite indicators were calculated as the mean (with confidence intervals) of the species' annual occupancy estimates.

Trends over time were considered significant if the indicator index value in the first year fell outside the confidence intervals of the index value in the final year. Interestingly, these new indicators suggest that 1976, the start of the UKBMS, was not a particularly abnormal year, as has sometimes been suggested (see p.9).



Map showing the number of butterfly species recorded in each 10km x 10km grid square in the UK during the 2010-2014 BNM survey period.

[16]Boakes *et al.* 2010, Isaac & Pocock 2015
[17]van Strien *et al.* 2013, Isaac *et al.* 2014, Eaton *et al.* 2015
[18]Occupancy-detection models estimated the proportion of 1km grid cells occupied by each species, each year, while simultaneously estimating and accounting for variation in detection probability. A Bayesian framework with 7,500 iterations was used to fit the models. The overall species trend was calculated as the mean percentage change in fitted occupancy between the first year (long-term trend = 1976, short-term trend = 2005) and 2014 across all model iterations. Confidence intervals of the means were generated to assess the statistical robustness of the overall trend.
[19]Thomas & Abery 1995, Cowley *et al.* 1999
[20]There were insufficient BNM data to generate any occurrence trends for the Large Blue or to assess a long-term trend for the Cryptic Wood White.

Trends of UK butterflies

Species	Scientific name	10km squares (BNM 2010-14)	1km squares (BNM 2010-14)	UKBMS sites (1976-2014)	1976-2014 % Occurrence change (BNM)	1976-2014 % Abundance change (UKBMS)	2005-2014 % Occurrence change (BNM)	2005-2014 % Abundance change (UKBMS)
Swallowtail (resident)	*Papilio machaon britannicus*	6	78	11	**-56**	88*	-13	30
Swallowtail (migrant)	*Papilio machaon gorganus*	65	78	5	-	-	-	-
Dingy Skipper	*Erynnis tages*	643	3052	305	**-61**	-19	**21**	69
Grizzled Skipper	*Pyrgus malvae*	340	1441	203	**-53**	-37*	7	0
Chequered Skipper	*Carterocephalus palaemon*	40	239	23	**-44**	-	18	-
Essex Skipper	*Thymelicus lineola*	725	4228	555	**104**	-88***	3	-66
Small Skipper	*Thymelicus sylvestris*	1483	13062	1183	**-7**	-75***	-1	27
Lulworth Skipper	*Thymelicus acteon*	14	68	16	**-78**	-76**	23	39
Silver-spotted Skipper	*Hesperia comma*	42	233	39	10	943***	7	12
Large Skipper	*Ochlodes sylvanus*	1553	15484	1185	**-12**	-17	**12**	23
Wood White	*Leptidea sinapis*	48	184	45	**-89**	-88***	**-25**	-18
Cryptic Wood White	*Leptidea juvernica*	35	86	13	-	-	**-23**	-
Orange-tip	*Anthocharis cardamines*	2240	24280	1123	**8**	10	**-4**	59
Large White	*Pieris brassicae*	2239	35459	1697	**-3**	-30	**2**	-28
Small White	*Pieris rapae*	2153	38701	1769	**-8**	-25	**7**	9
Green-veined White	*Pieris napi*	2697	38624	1682	**5**	-7	-1	72
Clouded Yellow	*Colias croceus*	996	4432	450	**84**	734	**-19**	-57
Brimstone	*Gonepteryx rhamni*	1346	19169	1056	**20**	1	**14**	-1
Wall	*Lasiommata megera*	1089	6024	500	**-77**	-87***	**-36**	-25
Speckled Wood	*Pararge aegeria*	2085	32136	1616	**71**	84**	**3**	4
Large Heath	*Coenonympha tullia*	338	810	8	**-58**	261**	-5	-49
Small Heath	*Coenonympha pamphilus*	2102	12556	942	**-57**	-54***	**-7**	18
Mountain Ringlet	*Erebia epiphron*	39	231	4	**-63**	-	-19	-
Scotch Argus	*Erebia aethiops*	378	1803	31	**-17**	170**	**-18**	24
Ringlet	*Aphantopus hyperantus*	2262	25902	1584	**63**	381***	**21**	72*
Meadow Brown	*Maniola jurtina*	2525	38282	1884	**-3**	1	**-2**	-15
Gatekeeper	*Pyronia tithonus*	1458	29070	1554	**15**	-41*	**1**	-44*
Marbled White	*Melanargia galathea*	798	7967	757	**29**	50*	**26**	25
Grayling	*Hipparchia semele*	542	2007	161	**-62**	-58***	**-18**	10
Pearl-bordered Fritillary	*Boloria euphrosyne*	190	604	135	**-95**	-71***	3	45
Small Pearl-bordered Fritillary	*Boloria selene*	769	2502	116	**-76**	-58***	**-25**	3
Silver-washed Fritillary	*Argynnis paphia*	775	4526	393	**56**	141***	**55**	6
Dark Green Fritillary	*Argynnis aglaja*	1223	4110	359	**-33**	186***	**44**	18
High Brown Fritillary	*Argynnis adippe*	21	88	62	**-96**	-62*	-16	0
White Admiral	*Limenitis camilla*	427	1958	206	**-25**	-59**	**-14**	-45
Purple Emperor	*Apatura iris*	213	754	65	**-47**	69	**135**	-35
Red Admiral	*Vanessa atalanta*	2436	33760	806	**25**	257**	1	-40
Painted Lady	*Vanessa cardui*	1886	11528	553	**14**	133	**-16**	-84
Peacock	*Aglais io*	2490	39716	1682	**16**	17	**3**	21
Small Tortoiseshell	*Aglais urticae*	2607	41149	1752	**-15**	-73***	**13**	146
Comma	*Polygonia c-album*	1718	24447	1265	**57**	150***	**11**	-28
Marsh Fritillary	*Euphydryas aurinia*	246	954	94	**-79**	-10	**-22**	-64
Glanville Fritillary	*Melitaea cinxia*	17	81	8	**-66**	-42	10	-88
Heath Fritillary	*Melitaea athalia*	13	65	33	**-68**	-87***	-12	-79**
Duke of Burgundy	*Hamearis lucina*	84	334	86	**-84**	-42**	3	67
Small Copper	*Lycaena phlaeas*	2081	16321	1074	**-16**	-37	**5**	-19
Brown Hairstreak	*Thecla betulae*	155	1297	48	**-49**	-15	8	-58
Purple Hairstreak	*Favonius quercus*	934	3819	324	**-30**	-54*	**-15**	-10
Green Hairstreak	*Callophrys rubi*	1107	3880	307	**-30**	-41**	**-14**	-34
White-letter Hairstreak	*Satyrium w-album*	641	1642	163	**-45**	-96***	**-41**	-77**
Black Hairstreak	*Satyrium pruni*	25	93	10	**-61**	-54	-11	-87
Small Blue	*Cupido minimus*	279	1116	335	**-44**	9	0	-27
Holly Blue	*Celastrina argiolus*	1431	14051	800	**39**	37	**-12**	-61*
Large Blue	*Maculinea arion*	6	28	29	-	1440***	-	-20
Silver-studded Blue	*Plebejus argus*	105	590	68	**-64**	19	**19**	-9
Brown Argus	*Aricia agestis*	860	5361	601	**115**	-25	2	-11
Northern Brown Argus	*Aricia artaxerxes*	122	352	36	**-27**	-52*	**-36**	6
Common Blue	*Polyommatus icarus*	2291	21906	1327	**-17**	-17	1	1
Adonis Blue	*Polyommatus bellargus*	125	721	89	-6	175**	**-12**	-43
Chalk Hill Blue	*Polyommatus coridon*	249	1122	175	**-50**	20	8	55

Occurrence trends (derived from 1km square resolution occupancy modelling of BNM data) shown in bold are statistically robust.
Statistical significance of UKBMS trends * p<0.05, ** p <0.01, *** p <0.001.

Long-term trends

The long-term UKBMS population trends, which run from 1976-2014 for most species, show that 57% of the 56 species decreased in abundance and 43% of species increased. Of the 32 species that declined in numbers over the period, 20 showed statistically significant trends, while of the 24 butterflies that increased, 13 showed significant trends. Thus, of 33 species with statistically significant UKBMS trends, 61% decreased and 39% increased.

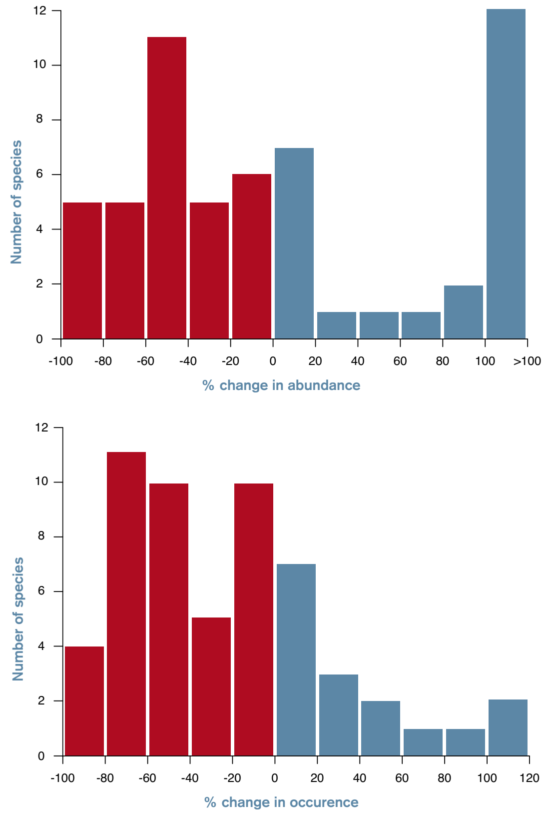
The occupancy model analysis of the BNM distribution data presents an even more clear-cut picture. Overall, 70% of species (40 in total) had decreased and 30% (17 species) increased in occurrence over the period 1976-2014. All but two of these trends are statistically robust.

Taken together, these two separate lines of evidence demonstrate that 76% (44 out of the 58 species for which at least one type of trend was calculated) of the UK's resident and regular migrant butterfly species declined in either population or occurrence (or both) over the past four decades. By comparison, 47% of species (27 out of 58) increased in one or both measures.

Some species show mixed results, although these often matched our expectations based on reports from recorders in the field. Fourteen species showed a decreasing trend in one of the analyses, increasing in the other. Of these, 10 species had increased in abundance, while decreasing in occurrence, and the other four species showed the opposite pattern (increasing in occurrence at the same time as decreasing in abundance). Such patterns likely result from the differing impacts of environmental change and/or conservation management in different parts of a species' distribution.

The overall pattern of long-term change differs little from the previous analysis carried out a decade ago, which showed that 54% of species had decreased in abundance and 76% had decreased in distribution in Great Britain[21].

The long-term trends in abundance (top) and occurrence (bottom) of UK butterfly species (1976-2014).



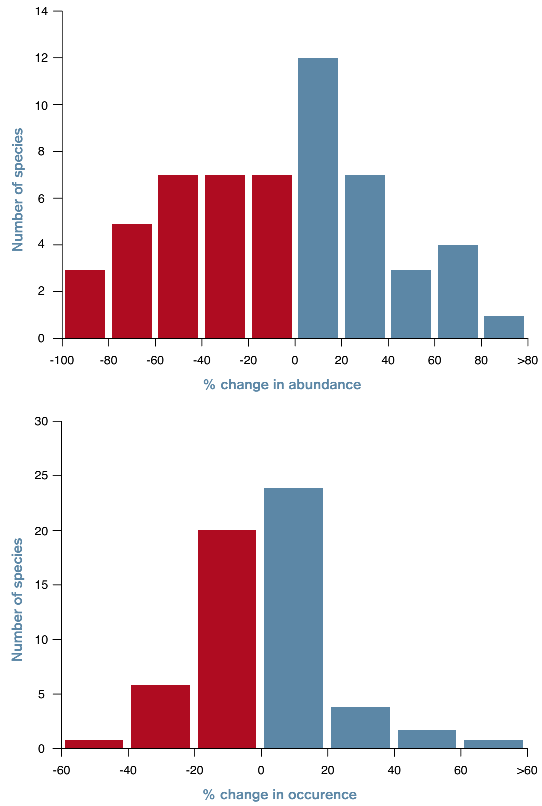
Short-term trends

In contrast to the long-term pattern, trends from both data sources show a more favourable situation for UK butterflies over the last decade. According to UKBMS trends, 29 species (52%) decreased and 25 species (45%) increased in abundance over the 10-year period (2005-2014), with two species showing no change. Very few of the trends attained statistical significance, due to the short time period over which trends were assessed and the high natural variability of butterfly populations from one year to the next.

BNM occurrence trends show 10-year decreases for 27 species (47%), increases for 30 species (52%) and no change at all for one. The occupancy models for 36 out of the 58 species were considered to be statistically robust over the 10-year period.

These results appear to show some overall improvement in the state of butterflies over the previous 10-year assessment, which found that 72% of UK butterfly species had declined in abundance and 54% in distribution[22]. In particular, there are signs of recovery among several threatened habitat specialists in the last 10 years (see p.14). The net result still shows that 40 butterflies (68% of UK species) showed a decrease in either abundance or distribution over the 10-year period 2005-2014, but that 39 species showed an increase in one or other measure over the same period.

The 10-year trends in abundance (top) and occurrence (bottom) of UK butterfly species (2005-2014).



[21]Fox *et al.* 2007
[22]Fox *et al.* 2011

Butterfly indicators

Biodiversity indicators are now widely used to monitor the state of the environment and to assess and communicate progress towards national and international targets[23].

Multi-species butterfly indicators have been developed using UKBMS data to report on the overall status of butterfly populations at UK level and within the separate UK countries[24]. Some have been adopted as official measures by the relevant governments.

Indicators have been constructed that reflect different groups of butterflies (e.g. habitat specialists and wider countryside species), different habitats, different land management strategies (e.g. agri-environment schemes) and the responses of butterflies to environmental drivers such as climate change[25]. Butterfly data can be combined with population data for other species to produce multi-taxa indicators, such as that recently developed for UK Priority Species[26].

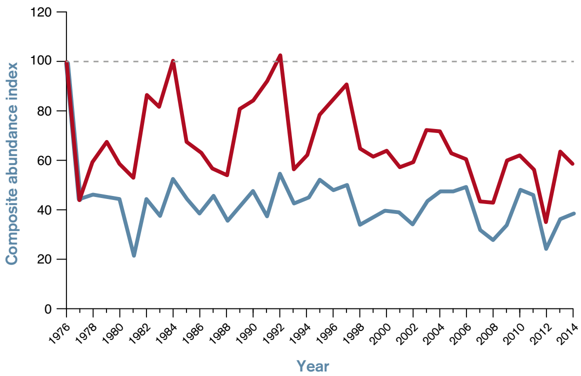
Indicators provide clear, quantitative assessments of biodiversity change and can be used to evaluate the effectiveness of policies and to understand ecological responses to environmental change. The range of indicators is limited by the data, so not all combinations of country and indicator type are available at present. Nevertheless, the indicators demonstrate some important results. For example, population indicators of habitat specialist butterflies, those species that require semi-natural habitats, show an unequivocal picture of long-term decline across the UK, while those for wider countryside species show substantial country-level differences (see box opposite).

UKBMS Indicator	Smoothed trend	Trend class	Statistically significant	Date period
Long-term trends				
UK habitat specialists†	-45%	Moderate decline	Yes	1976-2014
UK wider countryside species†	-25%	Moderate decline	Yes	1976-2014
England habitat specialists	-26%	Moderate decline	Yes	1976-2014
England wider countryside species	-30%	Moderate decline	Yes	1976-2014
England all butterflies in woodland	-55%	Moderate decline	Yes	1990-2014
England all butterflies on farmland	-57%	Moderate decline	Yes	1990-2014
Scotland habitat specialists†	-28%	Moderate decline	Yes	1979-2014
Scotland wider countryside species†	27%	Stable	n/a	1979-2014
Wales habitat specialists	-49%	Moderate decline	Yes	1990-2014
Wales wider countryside species	1%	Stable	n/a	1990-2014
10-year trends (2005-2014)				
UK habitat specialists†	-12%	Stable	n/a	2005-2014
UK wider countryside species†	-16%	Stable	n/a	2005-2014
England habitat specialists	-12%	Moderate decline	Yes	2005-2014
England wider countryside species	-18%	Uncertain	No	2005-2014
England all butterflies in woodland	-27%	Moderate decline	Yes	2005-2014
England all butterflies on farmland	-37%	Moderate decline	Yes	2005-2014
Scotland habitat specialists†	-9%	Moderate decline	Yes	2005-2014
Scotland wider countryside species†	6%	Stable	n/a	2005-2014
Wales habitat specialists	52%	Uncertain	No	2005-2014
Wales wider countryside species	0%	Stable	n/a	2005-2014

†Official government indicator

The habitat indicators for butterfly populations at woodland and farmland sites in England show significant decreases in overall abundance both in the long-term (since 1990) and over the past 10 years (see plot below right).

Woodland and farmland birds have also decreased in abundance in the UK and the majority of other species associated with these habitats have also declined[27]. The trends are thought to be linked to deterioration in the quality of habitats, driven principally by changing management[28], rather than to the wholesale loss of habitat.



UK butterfly population indicators for habitat specialists (blue line) and wider countryside species (red line).

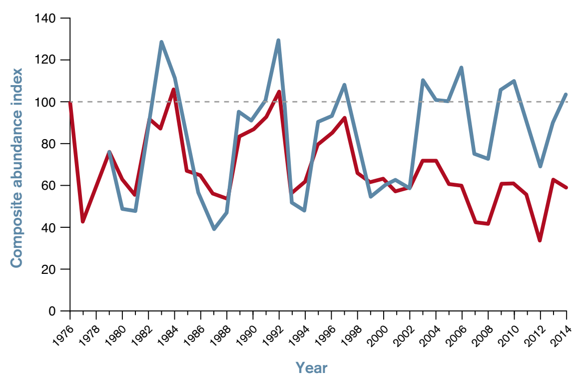
England butterfly population indicators for woodland sites (green line) and farmland sites (brown line).

[23]Butchart *et al.* 2010, Defra 2014, Eaton *et al.* 2015
[24]Brereton *et al.* 2011a
[25]Devictor *et al.* 2012
[26]Eaton *et al.* 2015
[27]Burns *et al.* 2013
[28]Thomas *et al.* 2015

North–South divide

Butterfly population indicators for the wider countryside species reveal strongly contrasting long-term trends for England (a statistically significant 30% decrease) and Scotland (a 27% increase categorised as a stable trend). Analogous results have been found in the abundance of common moth species (40% decrease over 40 years in southern Britain versus no significant change in northern Britain[29]) and in occurrence trends for widespread moths[30], as well as in woodland bird communities[31] and a range of individual bird species[32], suggesting that this result may be widely applicable to British biodiversity.

The wider countryside butterfly trends in England and Scotland diverge from 2003 onwards suggesting either that environmental factors have deteriorated more rapidly in England since then or the impact of climate change is having different effects in the two countries (or both). Interestingly, the indicator trend for wider countryside butterflies in Wales also shows no decrease, possible evidence of an East-West divide too, although this is for a shorter time period and, therefore, not directly comparable.



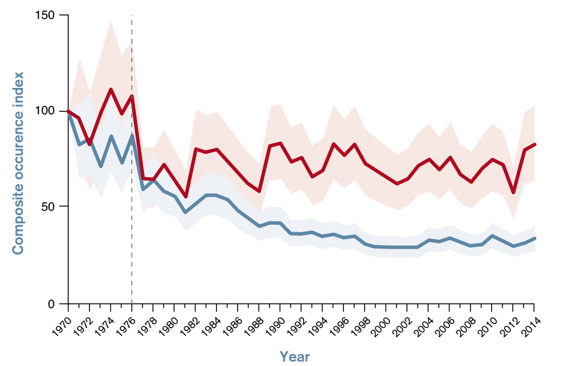
UKBMS wider countryside butterfly population indicators for England (red line) and Scotland (blue line).

New directions

The development of butterfly indicators continues. For instance, butterfly population data from transect monitoring schemes in different countries can be combined to produce international indicators. The first example is a European Grassland Butterfly Indicator, based on 17 species (including Orange-tip, Marsh Fritillary, Meadow Brown and Small Blue) monitored in 19 countries[33]. The indicator shows a decrease of almost 50% over the period 1990-2011, indicative of general biodiversity loss in grasslands across the continent due largely to agricultural intensification and abandonment. Advances in analysis methodology will facilitate increased use of butterfly population data at international scales in the future[34].

Another new area of indicator development has been in the use of occurrence data from distribution recording schemes. One such indicator, which measures change in the frequency of occurrence of 179 insect species (mostly moths, bees and wasps) of conservation priority, has been officially adopted by the UK Government[35]. The new occupancy model analysis of UK butterfly distribution data carried out for this report can be used to develop similar indicators. Trends in BNM occurrence indicators for all species, habitat specialist butterflies and wider countryside species are shown in the table right (also see box below).

BNM occurrence indicator	Trend	Statistically significant
Long-term trends (1976-2014)		
UK all species	-43%	Yes
UK habitat specialists	-62%	Yes
UK wider countryside species	-24%	Yes
10-year trends (2005-2014)		
UK all species	13%	No
UK habitat specialists	5%	No
UK wider countryside species	18%	No



The combined indices of occurrence (with confidence intervals) for habitat specialists (blue line) and wider countryside species (red line) derived from BNM distribution records show two notable features. First, there has been a clear long-term decrease for both groups in the UK from 1976 onwards with little sign of recovery to earlier levels.

Second, the occurrence values for the first five years (1970-1975) show that overall butterfly occurrence was similar to that in 1976. This demonstrates that 1976 was not an atypical year for butterflies and, therefore, is an appropriate start point for trends from the UKBMS.

[29] Fox *et al.* 2013
[30] Fox *et al.* 2014
[31] Massimino *et al.* 2015
[32] Fuller *et al.* 2013
[33] van Swaay *et al.* 2013
[34] Schmucki *et al.* 2015
[35] http://jncc.defra.gov.uk/page-6850

The state of the UK's butterflies

Change since the 1970s

In keeping with previous assessments, the new analyses undertaken for this report, together with the UK butterfly population indicators, present a clear picture of long-term decline in the abundance and distribution of the UK's butterflies.

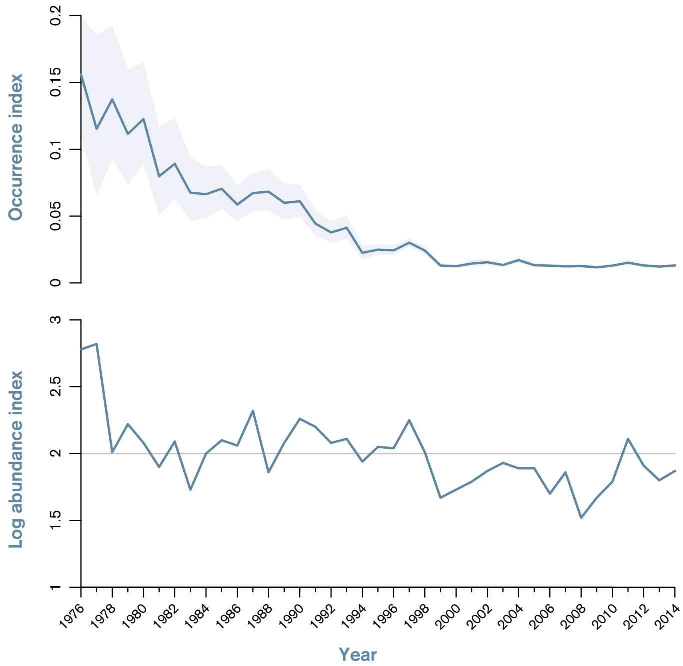
Many of the most substantial declines over the past four decades represent the continuation of trends that started much earlier. Thus, species such as the High Brown Fritillary, Pearl-bordered Fritillary (see plots and map below), Wood White, Duke of Burgundy, Marsh Fritillary and Heath Fritillary, which have some of the worst trends in the current analyses, had already suffered major (but unquantified) contractions of range when the first atlas of butterflies in Britain and Ireland was published in 1984[36]. These species now occupy only a small fraction of their former distributions and, for the past 15 years or so, have been the focal points of conservation action to halt the declines and so prevent their extinction in the UK.

The long-term UKBMS indicator trends for habitat specialist butterflies show significant decreases in abundance at the UK level and separately in England, Scotland and Wales (see p.8). This is supported by the BNM occurrence indicator for habitat specialists, which has decreased by 62% since 1976 (see p.9).

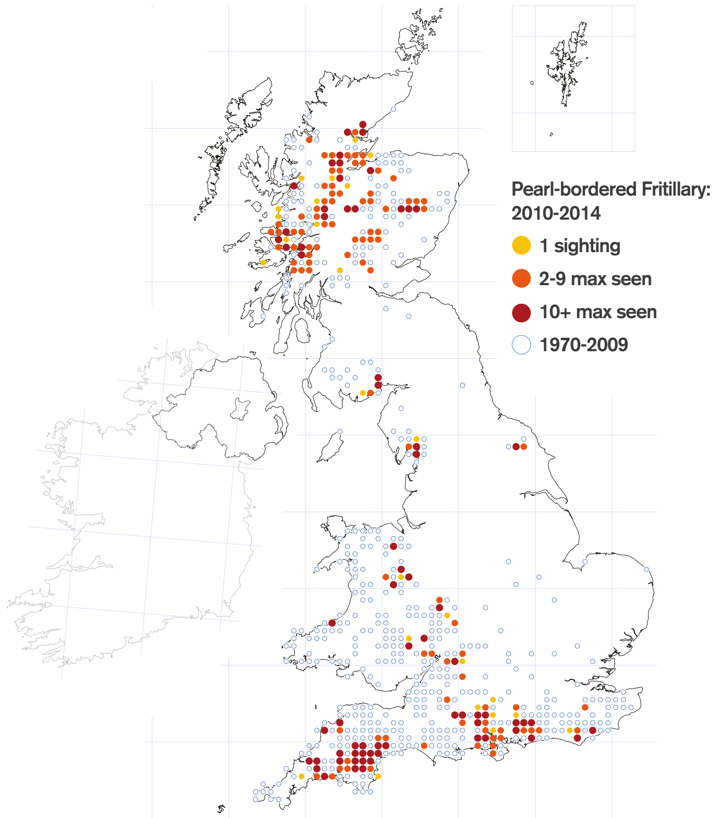
The long-term trends remain a particular concern for those few UK species adapted to cooler climatic conditions and restricted to northern Britain. The new BNM 1km square occupancy analysis shows declines of more than a quarter for Northern Brown Argus and more than a half for Mountain Ringlet and Large Heath. The long-term UKBMS trend for Northern Brown Argus also shows a significant decrease in abundance, though conversely the trend for Large Heath is a large, statistically significant increase, albeit based on a small number of monitored sites.

Scotch Argus, the only other northern species in the UK, is of less concern, with a modest decrease in occurrence and a significant increase in abundance. A new research project led by the University of York has just commenced, which will improve further our understanding of distribution and population changes in these northern species.

Another group of species of increasing conservation concern includes relatively widespread butterflies that have undergone major declines since the 1970s. Previous analyses of the BNM distribution data, carried out at a coarse 10km square resolution, almost certainly under-estimated the true scale of decline among these species. Notable examples include the White-letter Hairstreak, Small Pearl-bordered Fritillary, Wall and Small Heath, all of which have suffered very substantial decreases in both abundance and occurrence over the past four decades (see boxes opposite).



Long-term BNM occurrence index (with confidence intervals) and UKBMS abundance index for the Pearl-bordered Fritillary. This species has had only one year (2011) this century when its UKBMS abundance was above the average (shown by the grey line) for the whole series!



[36]Heath *et al.* 1984

The total abundance of wider countryside butterflies (species not restricted to special semi-natural habitats) has declined significantly since 1976, despite substantial increases by some species in response to climate warming (see p.12). UK and England indicators that combine populations of wider countryside butterflies show significant decreases of 25% and 30% respectively (although the equivalent indicators in Scotland and Wales have not declined).

Half of the 10 butterflies that have suffered the most severe long-term UKBMS declines are wider countryside species (White-letter Hairstreak, Essex Skipper, Wall, Small Skipper and Small Tortoiseshell). The occurrence indicator for wider countryside species derived from the BNM distribution data decreased by 24% over the same period.

Wall

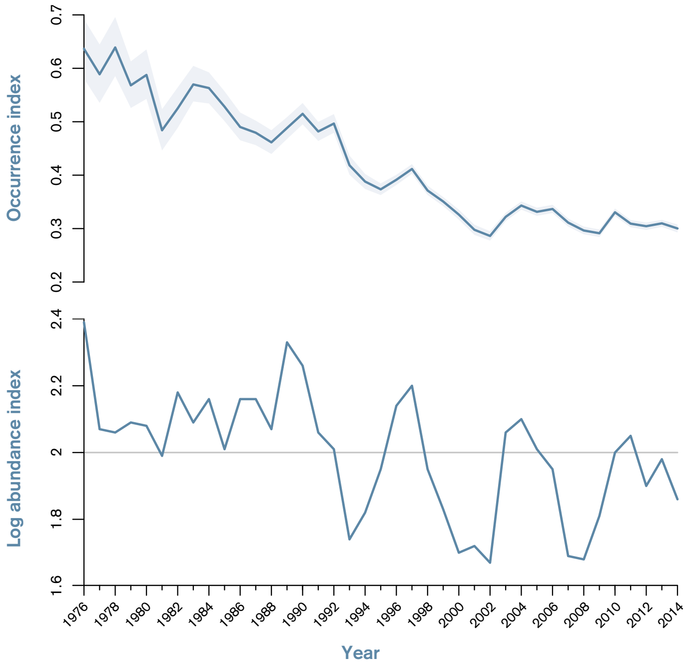
The precipitous decline of the Wall, once a common farmland butterfly, is well-known but little understood. The local extinction of colonies across a huge tract of southern Britain is reflected in a 77% decrease in occurrence and an 87% decrease in abundance since 1976. Only six other butterfly species show a greater long-term decrease in occurrence and only three have more severe population declines in the UK. The Wall is declining in other countries too and shows a significant decline in abundance in the European Grassland Butterfly Indicator[37]. Recent evidence suggests that climate change may be driving the Wall's decline[38], perhaps through a shift towards a third generation in the autumn that produces few offspring[39], although there may also be other factors involved (e.g. nitrogen pollution[40]).

Neil Hulme

Dan Lombard

Small Heath

The new fine-scale assessment of distribution data shows that the Small Heath has decreased by 57% since 1976, while its abundance on monitored sites has also more than halved over the same period. To put this into context, the Small Heath has fared worse than the Grizzled Skipper, Small Blue, Northern Brown Argus or White Admiral, despite being much more widespread than any of them (Small Heath is the 11th most widespread UK species based on occupied 10km squares in the 2010-2014 BNM survey). Research is urgently needed to investigate the causes of this dramatic and continued decline.



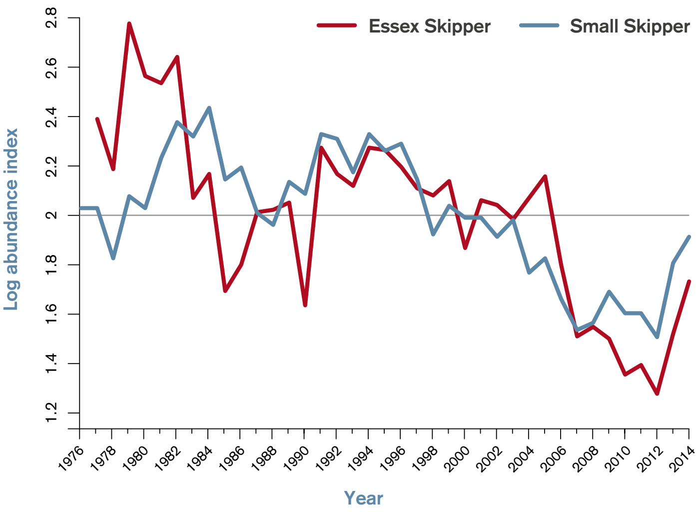
Long-term BNM occurrence index (with confidence intervals) and UKBMS abundance index for the Small Heath.

[37]van Swaay *et al.* 2013
[38]Palmer *et al.* 2015
[39]Van Dyck *et al.* 2015
[40]Klop *et al.* 2015

While the overall picture is one of long-term decline, some UK butterflies have bucked the trend and done well since the 1970s. These include a few species that had become scarce (e.g. Silver-spotted Skipper, Adonis Blue), the reintroduced Large Blue and the three regular migrants (Clouded Yellow, Red Admiral and Painted Lady) (see p.22). However, most of the species faring well over recent decades are wider countryside butterflies capable of breeding in modern agricultural and urban landscapes.These have expanded their distributions (see mapped examples right), most likely in response to climate change and, in many cases, their population levels have also increased significantly.

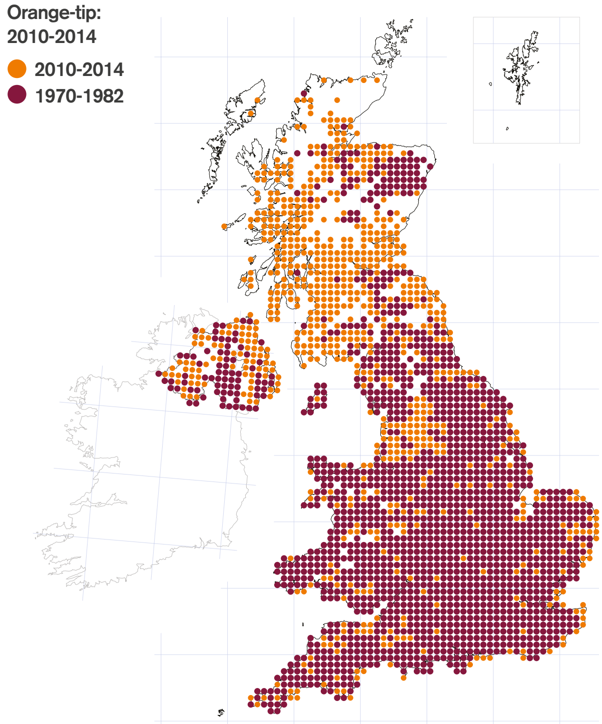
However, long-term change is not always so clear cut. Both Small and Essex Skipper, for example, have shown substantial increases in their British range since the 1970s; through northern England and into southern Scotland in the case of the Small Skipper and across central southern England and the Midlands into South Wales and the West Country in the case of Essex Skipper.

Despite these continuing range expansions, both species have undergone significant decreases in their UKBMS population trends (75% for Small Skipper and 88% for Essex Skipper) (see plot below). Thus their populations appear to be thinning in their core range while they expand at the margins. These population declines started in the mid-1990s, although both species showed some encouraging signs of recovery in 2013 and 2014. The Small Skipper's UKBMS population index has been below the long-term average (shown by the grey line) in every year this century, while the Essex Skipper recorded its seven worst years from 2007-2013.

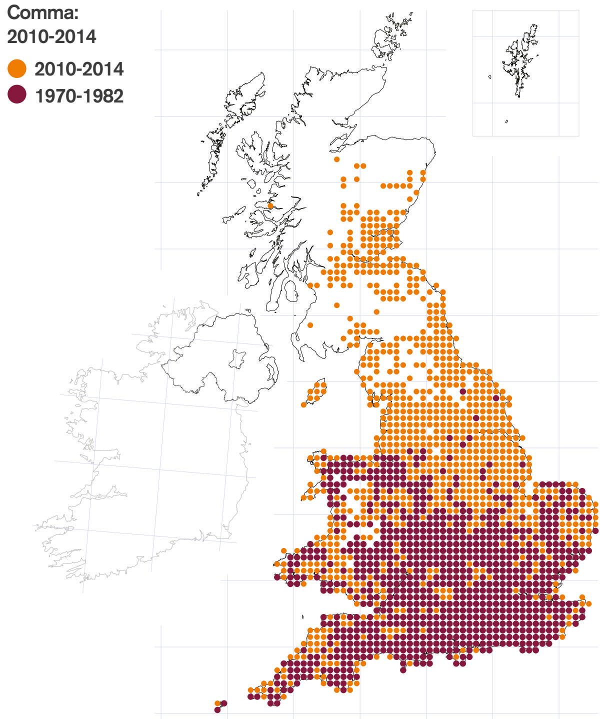


UKBMS abundance index for Small Skipper and Essex Skipper.

Orange-tip:
2010-2014



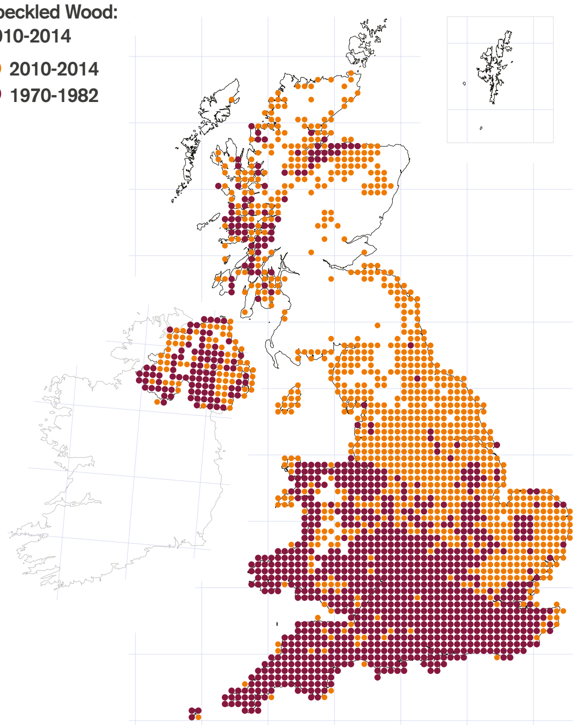
Comma:
2010-2014



Maps showing the expansions in UK distribution recorded for six wider countryside species; the original distributions recorded in 1970-1982 are shown as well as additional 10km x 10km grid squares occupied in 2010-2014.

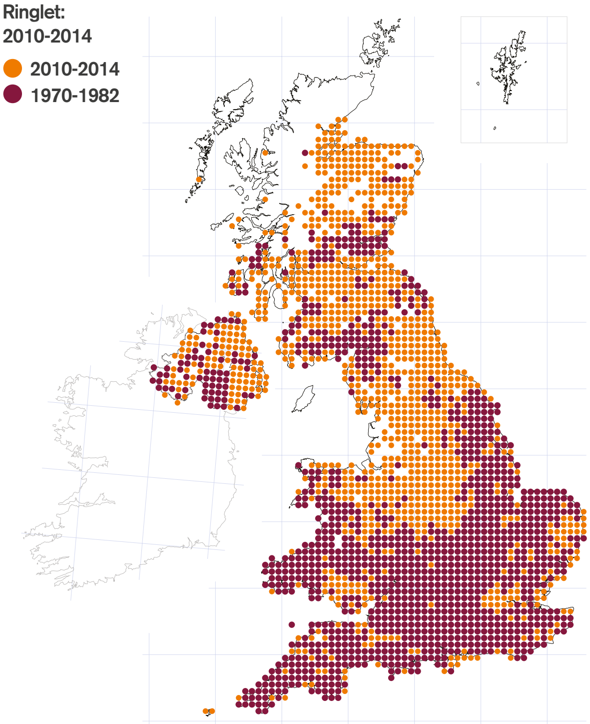
Speckled Wood:
2010-2014

- 2010-2014
- 1970-1982



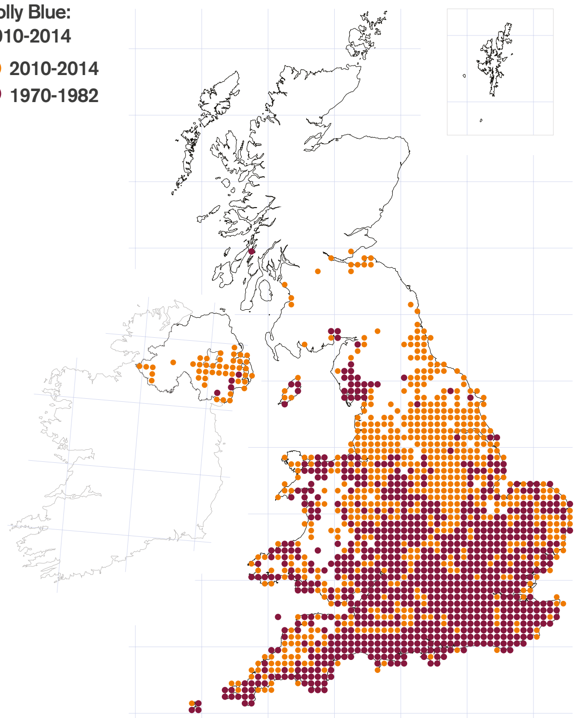
Ringlet:
2010-2014

- 2010-2014
- 1970-1982



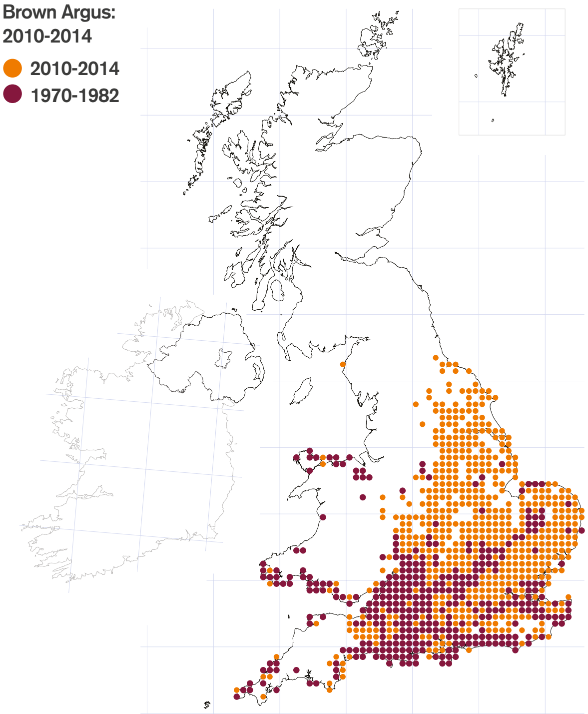
Holly Blue:
2010-2014

- 2010-2014
- 1970-1982



Brown Argus:
2010-2014

- 2010-2014
- 1970-1982



Change over the past decade

The overall assessment of the state of butterflies in the UK over the past 10 years (2005-2014) provides some grounds for optimism, even more so than in the previous report[41], although major challenges remain.

The most welcome news relates to several threatened species that have undergone long-term declines. Population levels of the Duke of Burgundy increased by 67% over the decade and its occurrence trend (3%) suggests that the long-term distribution decline has been halted. Landscape-scale conservation projects focussed on the Duke of Burgundy in the North York Moors, Morecambe Bay Limestones and south-east England have contributed to this upturn in fortune[42], and the species may also have benefitted from climate change[43]. The Pearl-bordered Fritillary shows a similar pattern, with abundance up by 45% and occurrence by 3%. Trends for the Dingy Skipper are even more positive, with a 69% increase in abundance and 21% increase in occurrence, while the Silver-studded Blue shows a 19% increase in occurrence.

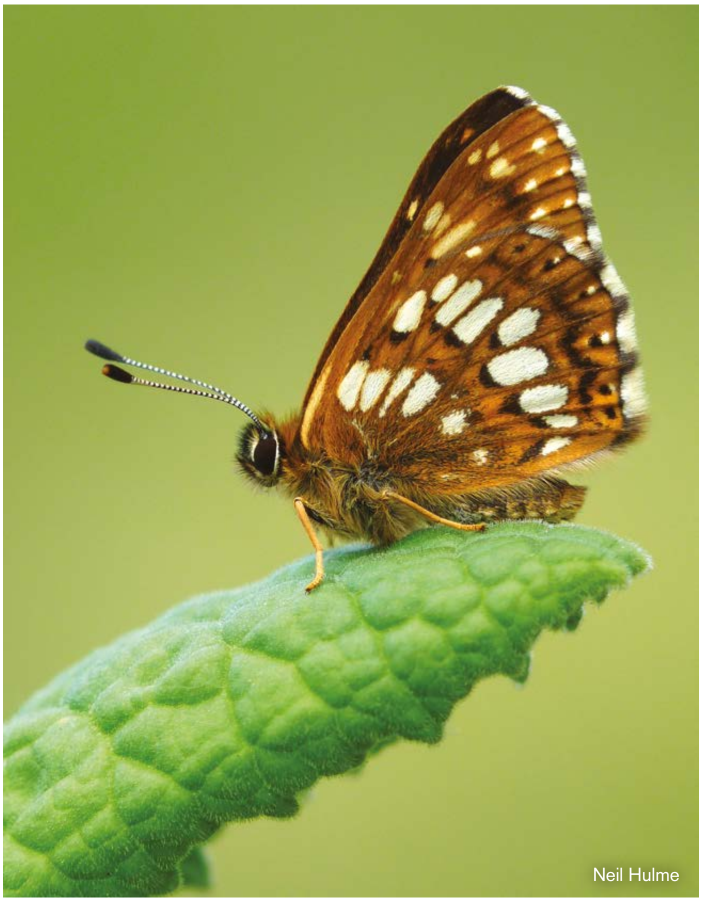
Other habitat specialist species showing some positive signs over the past decade include Chalk Hill Blue, Dark Green Fritillary, Silver-washed Fritillary (see box opposite), Chequered Skipper, Brown Hairstreak and Purple Emperor, although the increases in occurrence of the latter three species may be due, in part, to successful targeted recording. Even the High Brown Fritillary, the UK's most endangered butterfly, is showing some positive signs in response to intensive conservation efforts in south-west England (see p.17) and at the only remaining colony in South Wales.

However, all of these species were once considerably more widespread than they are today and the recent upturns in their fortunes, while rightly celebrated, are very modest in the context of long-term trends.

The past decade has been a tumultuous period for the Small Tortoiseshell, one of our most familiar garden butterflies. It suffered a run of eight consecutive poor years between 2005 and 2012, producing the eight lowest indices of abundance for the species in the UKBMS series since 1976, but then recovered spectacularly in 2013 and 2014. Thus, while the long-term abundance trend for Small Tortoiseshell remains a significant major decrease (-73%), the past decade shows a strong (but not statistically significant) increase of 146%.

The composite indicators show stable 10-year abundance and occurrence trends for both habitat specialists and wider countryside species at the UK level (although ongoing declines in abundance are seen in some country-level indicators).

These signs of stabilization and recovery are all the more impressive given that this period has not been particularly good for UK butterflies in general. In particular, a run of six consecutive summers (2007-2012) provided poor weather for butterflies. A ranking of all years since 1976, based on UKBMS counts for all species combined, shows that seven of the past 10 years were below average (including the two worst years in the whole series, 2012 and 2008) and only three were above average.



Neil Hulme

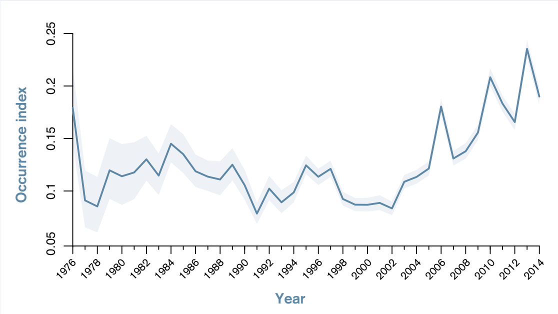
The endangered Duke of Burgundy butterfly has fared much better over the past decade. The loss of colonies seems to have been stemmed by concerted conservation effort and, in 2011, the species reached its highest UKBMS population index since 1992.

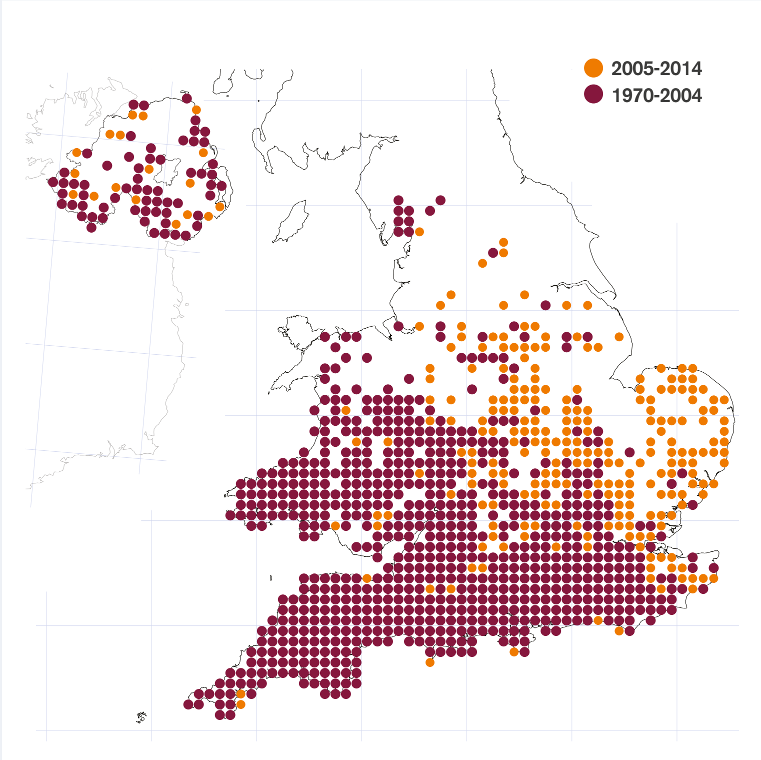
[41]Fox *et al.* 2011
[42]Ellis *et al.* 2012
[43]Palmer *et al.* 2015

Silver-washed Fritillary

The distribution of the Silver-washed Fritillary has waxed and waned over the past 200 years, but in the last decade it has expanded rapidly (55% increase in occurrence), colonising many woodlands across East Anglia and the Midlands.


Neil Hulme





The 10-year trends do not, however, provide encouraging news across the board for UK butterflies. The long-term decreases of some of our rarest and most rapidly-declining species show little sign of abating. White-letter Hairstreak, Wood White, White Admiral, Marsh Fritillary, Glanville Fritillary, Heath Fritillary and Wall all show short-term declines in abundance and all except Glanville Fritillary and Heath Fritillary also show statistically robust decreases in occurrence. The population indicators for habitat specialist butterflies reveal significant decreases in the abundance of this group in both England (12% decrease) and Scotland (9% decrease) over the past decade.

Also of note is the 10-year occurrence trend for the Cryptic Wood White. This is the only butterfly species found in Northern Ireland but nowhere else in the UK and its true identity was only established in 2011[44]. Although there are too few UKBMS data to calculate abundance trends for the Cryptic Wood White, the new analysis of BNM distribution records, indicates a 23% decrease in occurrence (2005-2014). The causes of this decline require further investigation.

Among the wider countryside species, one that seems to be faring particularly badly at present is the Gatekeeper. The distribution of this butterfly expanded northwards rapidly during the 1980s and 1990s through the East Midlands, Cheshire, Lancashire and Yorkshire, but since the millennium this advance has petered out. Its abundance showed no overall change during the years of range expansion but, over the past decade, numbers have fallen dramatically, contributing to statistically significant 10-year and long-term declines of 44% and 41% respectively. The butterfly is also declining in many other European countries[45].


Gatekeeper Neil Hulme

[44] Dincă *et al.* 2011
[45] van Swaay *et al.* 2010

Reversing declines of threatened butterflies through landscape-scale conservation

Since the start of the current century, Butterfly Conservation has shifted the majority of its conservation effort for threatened butterflies from a focus on single sites to targeting networks of sites across landscapes.

This approach is required because many butterflies persist in the landscape as metapopulations, where local populations occupy 'islands' of suitable semi-natural habitat (e.g. chalk grassland) amongst a 'sea' of more intensively managed, and hence unsuitable, land. Such local populations are connected due to dispersal by individual butterflies, so that if extinction occurs there is potential for recolonisation from a nearby population[46]. However, if the landscape becomes more fragmented, with butterflies occupying smaller, more isolated sites, then the likelihood of extinction increases and the chances of recolonisation are reduced[47]. When local extinctions exceed colonisations, extinction across the whole landscape becomes increasingly likely[48].

The objective of landscape-scale conservation is therefore to ensure the metapopulation remains at or is returned to equilibrium, balancing any local extinctions with an equal or greater number of colonisations. The approach is to maximise habitat quality within individual sites by targeted management, while also taking account of the spatial context of those sites[49]. For example, sites at the centre of a network may be given higher priority than small, isolated sites at the network's periphery.

Firstly, habitat management is targeted at sites that are currently occupied by the butterfly to maintain and increase populations, which will potentially provide a source of dispersing individuals. Secondly, the habitat of former and potential sites is improved, focussing on larger and less isolated sites that are most likely to be colonised. Thirdly, where possible, barriers to butterfly dispersal (such as patches of scrub or blocks of coniferous woodland) between sites are removed to increase chances of colonisation.

Butterfly Conservation has applied this approach in over 70 landscape-scale projects across the UK, targeting important areas for threatened species. These provide some of the best evidence that landscape-scale conservation can be effective and identify some key elements of success[50]:

- Careful targeting of management both across the network and on individual sites is essential and needs to be co-ordinated by a skilled project officer, able to link up a partnership of landowners, land managers, volunteers, statutory and non-statutory organisations with a shared vision for the landscape.
- Landscape-scale projects must be evidence based and underpinned by an understanding of the species' habitat requirements, high quality distribution data and a suitable monitoring system to assess their effectiveness.
- Short-term direct funding is invaluable for restoration phases of landscape-scale projects, but well-designed agri-environment and woodland grant schemes are often vital both to delivery of the initial project aims and to sustaining these benefits in the long term.
- Maintaining existing high quality habitat is more cost effective in the long run than restoration management.

Our case studies also demonstrate that extinctions on small, isolated sites are not inevitable if properly managed and that the principles of landscape-scale conservation of butterflies can be applied at relatively small spatial scales. Butterflies can respond very rapidly to landscape-scale conservation and projects targeting one species often benefit a suite of others, thus contributing to conserving biodiversity as a whole[51].

In a rapidly changing climate, landscape-scale conservation must adapt to altered habitat associations of target butterflies[52], novel vegetation responses to traditional habitat management techniques[51] and, potentially, extensive geographical shifts in species range[53]. Maintaining landscapes with large and diverse areas of habitat, with corresponding microclimatic variability, will be important both to buffer species against negative impacts of climate change[54] and to enable climate-driven range shifts[55].

While Butterfly Conservation's landscape-scale projects continue to yield some notable successes for threatened species, the ongoing decline of many butterflies underlines the need for wider application and greater resourcing of such action to meet government policy commitments and to reverse decades of loss[56].

Volunteers improving Wood White habitat by widening a woodland ride.

Sharon Hearle

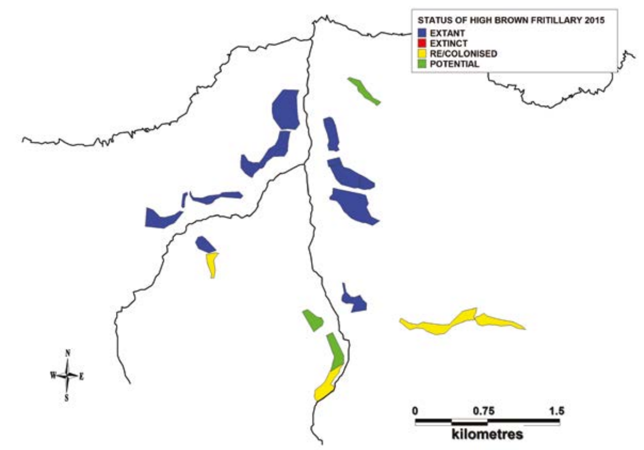
[46]Hanski 1999
[47]Hanski 1999, Wilson *et al.* 2009
[48]Bulman *et al.* 2007
[49]Thomas *et al.* 2001, Ellis *et al.* 2012, Bourn *et al.* 2013
[50]Ellis *et al.* 2012
[51]Ellis *et al.* 2012
[52]Roy & Thomas 2003, Davies *et al.* 2006
[53]Settele *et al.* 2008
[54]Oliver *et al.* 2010, 2013, Suggitt *et al.* 2015
[55]Bennie *et al.* 2013
[56]Lawton *et al.* 2010

High Brown Fritillary on Exmoor

Britain's most endangered butterfly, the High Brown Fritillary, has responded positively to landscape-scale targeted management in the Heddon Valley, Exmoor since 2005[57].

In partnership with landowners and organisations, habitat management advice was provided for all 16 sites in this network. A total of nearly 16ha of invasive scrub and trees was removed across 14 sites, Bracken control undertaken on 12 sites and fencing erected to facilitate low-intensity grazing by cattle or ponies on three sites. Much of the management was funded through agri-environment or woodland grant schemes, but volunteer work parties also played an important role.

Abundance of the Heddon Valley populations increased significantly by 235% between 2002 and 2014, compared to a moderate but statistically significant 44% decline across the whole of the UK over the same period. Population increases on core Heddon Valley sites enabled the butterfly to disperse and colonise four peripheral sites in the network. There were no extinctions in the same period, suggesting this metapopulation is well on the way to being stabilised.



Map showing changes in site occupancy by High Brown Fritillary in the Heddon Valley, Exmoor 2002-2015. Four colonisations at the network's periphery followed intensive targeted management intervention on both occupied and potential sites.

Wood White in Northamptonshire

The Yardley-Whittlewood Ridge landscape in Northamptonshire is a national stronghold for the Wood White.

Here, the butterfly breeds in grassy vegetation at the edges of open, sunny woodland rides and glades, but numbers have declined over the last few decades as the habitat became more shaded. Between 2012 and 2015, 25 rides were widened (over 11km of ride in total) and five glades created in seven woods across the landscape (six with existing small colonies and one unoccupied), improving the condition of 23ha of habitat and increasing connectivity within the woodlands.

The Wood White responded positively to this habitat management. Populations increased in eight of the 13 rides that were occupied at the outset, enabling the butterfly to colonise 10 newly widened rides and all of the new glades. Only two widened rides remained unoccupied and these were both in the wood that had no Wood White butterflies at the start of the project. Continuing follow-up work by the Forestry Commission should maintain this revival and enable the seventh wood to be recolonised in the future.

[57] Ellis *et al.* 2015

Agri-environment schemes

Farming is vital to maintain habitats for many scarce and common butterflies in the UK and yet agricultural intensification is also a principal cause of their long-term decline.

Agri-environment schemes (AES) provide funding for biodiversity conservation and environmental protection on agricultural land. These schemes are essential to create farmed landscapes for the future that support healthy populations of butterflies and other wildlife.

AES have become a vital tool for conservation delivery across Europe and are an integral part of the Common Agricultural Policy designed to support the non-market benefits from farming. This shift in subsidy for agriculture was initiated in the UK from the early 1990s, and is now deeply embedded both in commercial farming and as a significant source of funding for the conservation management of wildlife-rich, semi-natural habitats.

However, while there is some limited evidence that past AES have benefitted butterflies[58] and other wildlife[59], they have great potential to be far more effective[60]. For example, management prescriptions should be evidence based[61]. In order to improve conditions for threatened butterflies, AES need to be more precisely targeted and flexible, while expert advice is essential to fine-tune habitat management[62]. Improved assessment of the impacts of AES on target species and habitats is also important to ensure that public money is used efficiently.

Within the UK, each devolved government administers its own AES, which are split between general schemes open to all landowners and more targeted schemes for priority species and areas of high ecological value. Butterfly Conservation currently focusses its involvement on the latter schemes across the UK, providing species data to target schemes, helping to develop management options, giving advice on the ground and monitoring the outcomes.

Butterflies have successfully been incorporated as specific targets in the Glastir AES in Wales, the forthcoming Northern Ireland Environmental Farming Scheme and in Scotland's new scheme (the Agri-environment and Climate Scheme). Changes under the latter should make management of Marsh Fritillary colonies on hill ground more viable, thereby benefiting the butterfly in crucial parts of its range, such as on Islay.

Increasingly, butterfly (and moth) data collected by our volunteers and staff are being used both to set overall priorities for AES and to ensure that agreements are fully tailored to meet species' needs at individual sites.

The Farmland Butterfly and Moth Initiative, run by Butterfly Conservation and Natural England, has been critical in developing bespoke guidance for 11 priority butterflies and 15 moths within the new English AES, Countryside Stewardship. The focus is on three factors required by a range of butterfly species: structural variety in ground vegetation, summer nectar and patches of scrub.

Providing direct advice to farmers, and training to government agency farm advisers, is vital to the success of all the targeted AES schemes in the UK. In Scotland, Butterfly Conservation staff have given detailed advice at over 200 farms with Marsh Fritillary colonies or habitat over the past five years, while, in England, the Farmland Butterfly and Moth Initiative has helped to tailor over 170 Higher Level Stewardship agreements.

Ongoing refinement of AES is essential. Limited funding, competition for agreements, insufficient payment rates for the required management and onerous reporting all present limitations on what might be achieved. Feedback is provided through direct dialogue with governments and by monitoring the outcomes of AES, as Butterfly Conservation is doing for the Glastir scheme on behalf of the Welsh Assembly, for example.

In Scotland, over five years, Butterfly Conservation has provided specialist advice to farmers and land managers at more than 200 sites that already support or have the potential to support Marsh Fritillary colonies. Thanks to the experience and enthusiasm of our staff and volunteers, 114 of these sites are now receiving appropriate management to benefit Marsh Fritillary and other threatened butterflies.

Helen Bibby

[58]Davies *et al.* 2005, Brereton *et al.* 2007, 2011a
[59]Kleijn *et al.* 2006
[60]Batáry *et al.* 2015
[61]Pywell *et al.* 2012
[62]Bourn *et al.* 2013

Wider benefits of AES

While targeted, higher-tier AES agreements are an essential part of the conservation of threatened UK butterflies, there are also great opportunities to use other agricultural subsidies to create a healthier countryside.

Farmed land accounts for 75% of the UK land area and the diversity of this landscape is key to supporting healthy populations of butterflies and other wildlife, and reversing some of the declines of widespread species.

Restoring some of the lost biodiversity in the wider countryside is likely to deliver significant benefits for society via ecosystem services such as pollination, flood protection and improvements in soil health[63], while moving towards more sustainable methods of food production. Such improvements need not involve a reduction in crop yield and could actually enhance it[64].

The recent policy focus delivering benefits to pollinators through AES (see box below) may benefit common bees[65], but is only part of the solution to conserving butterflies and other insects on farmland. Measures must take account of the whole insect life cycle, providing resources for the immature stages (including caterpillar foodplants) and year-round suitable management.

Butterfly Conservation is committed to raising awareness about farmland butterflies across the UK, furthering our understanding of the key issues through research collaborations, promoting the needs for butterflies and moths on farmland, working closely with farmers and retailers and, importantly, feeding back to the devolved administrations on the effectiveness of the new schemes. Butterfly data will continue to be a key source of evidence in gauging the success of AES in delivering species and habitat conservation targets, as well as improving ecosystem services such as pollination.

Pollinators

Since the publication of the first clear signs of widespread declines of UK butterflies[66], increasing evidence has pointed to similar decreases among other groups of pollinating insects such as bees and moths[67].

Concern about the ecological[68] and economic[69] implications of these declines, and controversy about the possible role of neonicotinoid pesticides in causing the declines[70], have pushed the plight of pollinators up the political agenda.

As a result, pollinator strategies have been published or are being developed in each of the four UK countries. These strategies focus mainly on raising public and landowner awareness of ways to help pollinators, improving the evidence base and, in some cases, the development of specific AES options to support pollinators.

Within the Countryside Stewardship AES in England, for example, the Wild Pollinator and Farm Wildlife Package has been created. A participating farmer would dedicate 3-5% of agricultural land to pollinator and wildlife-friendly options in a mid-tier agreement or 5-10% in the higher-tier scheme.

Though the national strategies are a welcome start and provide opportune recognition of the importance of pollinating insects such as butterflies, far more comprehensive and better resourced measures are needed if we are to reverse the decline of pollinators[71].

Comma and a bee share a scabious flower. Andrew Dejardin

[63] Laliberté *et al.* 2010
[64] Pywell *et al.* 2015
[65] Dicks *et al.* 2015
[66] Warren *et al.* 2001
[67] Conrad *et al.* 2006, Potts *et al.* 2010, Carvalheiro *et al.* 2013, Vanbergen *et al.* 2013, Fox *et al.* 2014, Goulson *et al.* 2015
[68] Biesmeijer *et al.* 2006
[69] Klein *et al.* 2007, Garibaldi *et al.* 2011
[70] Godfray *et al.* 2015. Increased research into the impacts of neonicotinoid pesticides on non-target insects such as butterflies is urgently needed, particularly as Gilburn *et al.* (2015) recently found a strong correlation between use of neonicotinoids and population declines of widespread butterflies. This does not constitute proof that pesticides are causing butterfly declines but it certainly merits further investigation.
[71] Senapathi *et al.* 2015

Role of protected areas

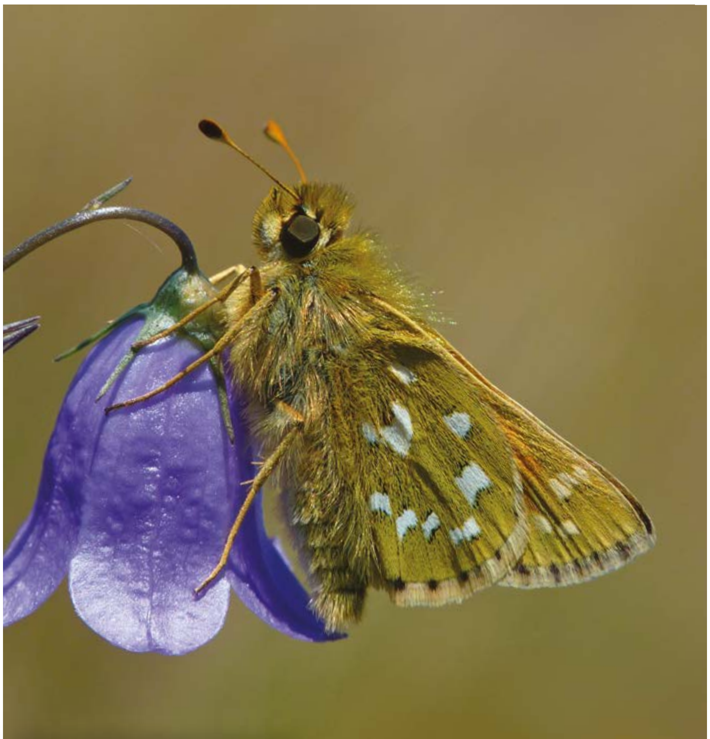
Protected areas have long been the cornerstone of biodiversity conservation in the UK. Covering many of the best examples of semi-natural habitat, rare species and rich wildlife communities, the thousands of protected areas in the UK today represent a sanctuary for biodiversity and offer wonderful opportunities for people to engage with the natural world.

Protected areas have proved invaluable for the conservation of threatened butterflies such as the Swallowtail, Heath Fritillary and Large Blue. However, protected areas face many challenges, both within their boundaries (e.g. in maintaining their wildlife interest) and from surrounding, competing land uses such as intensive agriculture and urban development. Isolation is another problem and it is now widely recognised that protected areas must be managed in the context of the wider landscape, if they are to retain species of conservation concern (see p.16-17).

Climate change poses an additional and significant new challenge; species are shifting their distributions and wildlife communities are being reshuffled in response to the changing climate (see p.21). Protected areas, however, are static, designated to conserve particular species and habitats at a location in perpetuity. It is inevitable that some of these features will be lost from nature reserves in the environmental turmoil of climate change. While this is clearly a cause for concern, recent research using British butterflies and other wildlife groups, suggests that protected areas may also accrue species due to climate change and remain a vital element of UK biodiversity conservation in the future.

Most British butterfly and dragonfly species have greater abundance within Sites of Special Scientific Interest (SSSI) than in the surrounding landscape because these statutory protected areas contain high-quality habitats[72]. This effect is evident both in the historical core distribution of species as well as in areas that have been recently colonised in response to climate change[72]. Detailed examination of the range expansions of several habitat specialist butterfly and bird species in Britain, such as the Silver-spotted Skipper, Adonis Blue, Bittern and Dartford Warbler, found that they had preferentially colonised SSSIs[73]. The same pattern was found in an analysis of over 250 invertebrate species in Britain. In recently colonised areas, almost all of the species (98%) were recorded more frequently from SSSIs than expected, after taking account of the proportion of protected land in the landscape and any recording effort bias. Habitat specialist butterflies were significantly more likely to colonise SSSIs than nearby undesignated land, whereas there was no such relationship for wider countryside butterfly species[73].

Thus, although these protected areas were not designated to benefit the species that have subsequently colonised, they have played a disproportionately important role in facilitating the movement of a wide range of species in response to climate change. It is likely that protected areas will have the same beneficial effect for butterfly species colonising the UK from overseas in due course, as has been found for wetland birds[74].



Silver-spotted Skipper Neil Hulme

For a species to expand or shift its distribution successfully it must not only colonise new climatically-suitable sites but these new populations must endure. In studies of the Silver-spotted Skipper in southern England, SSSIs that were being actively managed were not only three times more likely to be colonised by this scarce butterfly than suitable habitat that was not being protected or managed, but also increased the survival of existing populations[75]. The protection itself is important to ensure that semi-natural habitats are retained, but the proactive land management that often accompanies protected status is even more crucial for butterflies.

Another important potential role for protected areas lies in safeguarding species most at risk from the negative impacts of climate change. To date, the evidence for this is more limited. A study of butterflies and birds with northern distributions in Britain suggested a positive effect of protected areas on the persistence of populations at low altitude and latitude[76], but more research is required to understand the strength and wider applicability of this effect.

It is clear, however, that the importance of protected areas to UK biodiversity conservation is likely to be enhanced rather than diminished by climate change.

[72]Gillingham *et al.* 2015a
[73]Thomas *et al.* 2012
[74]Hiley *et al.* 2013
[75]Lawson *et al.* 2014
[76]Gillingham *et al.* 2015b

Climate change

The rich body of evidence accumulated from studies based on UK butterfly distribution and abundance data has had a major impact on international assessments of the biological impacts of climate change[77]. The latest findings suggest much more varied, subtle and worrying impacts on butterflies than had previously been realised.

Globally and in the UK, climate change appears to be causing the distributions of a wide range of animal and plant species to shift uphill and towards the poles[78]. In Britain, the rate at which southern butterflies (and moths) have spread northwards has accelerated significantly over time[79]. However, the responses of individual species are more complex and idiosyncratic[80], and appear to depend upon the population trend of the species, as well as habitat availability. Generally, if a butterfly species is declining in abundance, it is unlikely to be able to expand its distribution northwards in response to climate change[81].

Previous research into the likely impacts of climate change on UK butterflies had suggested that southern and lowland species should generally benefit from warmer conditions and become more numerous and widespread[82]. Concern about negative responses to climate change was limited, in the UK at least, to specialist northern species such as Mountain Ringlet and Scotch Argus, which are adapted to cooler, damper conditions[83].

However, climate change is complex and the latest studies suggest that it may pose more of a threat to UK butterflies than had been realised. In one such study, researchers predicted butterfly (and moth) abundance trends over the past 40 years in Britain based solely on the climate, using correlations between weather variables and annual population growth of each species[84]. One-third of the 24 butterflies studied (and half of the 131 moths) were predicted to have decreased in abundance in response to the climate, even though all were lowland species that reach a northern limit to their range within Britain. These included the White Admiral, High Brown Fritillary, Grizzled Skipper and Wall. Conversely, species such as Orange-tip, Ringlet, Comma and Speckled Wood were predicted to have increased strongly.

The predicted abundance changes closely matched the real trends of the species measured by long-running monitoring schemes, suggesting that the climate has had a hitherto unrecognised negative impact on some butterflies, in addition to the well-known positive influence on others[84]. Another area of concern is the effect of extreme climatic events. These are often predicted to become more frequent with climate change, but their impact on butterflies is poorly understood. A recent study examined the effect of an extreme drought in Britain in 1995 on butterfly abundance and identified six particularly drought-sensitive species, including Large White, Ringlet, Green-veined White and Large Skipper[85]. Over the course of this century, climate change models suggest that extreme droughts will become more common, occurring every few years, such that UK populations of the sensitive species will not have sufficient time to recover in between and will decline substantially[85].

Green-veined White Dan Lombard

Dan Lombard

Brown Argus and climate change

As species distributions shift, new communities are formed, ecological interactions between species change, and rapid evolution can take place[86]. For example, the warming British climate has enabled the Brown Argus to breed successfully on widespread caterpillar foodplants (particularly Dove's-foot Crane's-bill) that it rarely used in the past under cooler conditions. As a result, the butterfly's distribution has expanded substantially[87]. This change is not merely ecological; Brown Argus butterflies have evolved during this relatively short period of range expansion. Female butterflies in the newly colonised parts of Britain have become specialised on the new caterpillar foodplants and, in doing so, have lost their ability to use their ancestral foodplant, Common Rock-rose[88].

It is not only the butterfly's relationship with its foodplants that has changed. Its rapid range expansion has enabled the Brown Argus to escape partially (and probably only temporarily) from some of its natural enemies. Brown Argus caterpillars suffered significantly lower mortality from parasitoid wasps and flies in populations in newly colonised parts of Britain compared with long-established populations, even though parasitoid species were present throughout the range[89].

[77]IPCC 2014
[78]Chen *et al.* 2011, Mason *et al.* 2015
[79]Mason *et al.* 2015
[80]Mair *et al.* 2012
[81]Mair *et al.* 2014
[82]Warren *et al.* 2001
[83]Franco *et al.* 2006
[84]Palmer *et al.* 2015
[85]Oliver *et al.* 2015
[86]Parmesan 2006, Hill *et al.* 2011
[87]Pateman *et al.* 2012
[88]Buckley & Bridle 2014
[89]Menéndez *et al.* 2008

Migration

Recent years have seen some dramatic events among the butterflies that visit the UK from overseas, either as regular, obligate migrants or as opportunistic vagrants.

Traditionally, three butterfly species were considered to recolonise the UK each year from southern Europe or North Africa: the Clouded Yellow, Red Admiral and Painted Lady. However, nowadays the Red Admiral is commonly present here during winter, blurring the distinction between resident and visiting species[90]. There are also continuing indications that Clouded Yellow larvae and pupae may be overwintering in warm, sheltered spots. Irrespective of such overwintering, all three species show substantial decreases in UK abundance over the past 10 years. The Clouded Yellow and Painted Lady also show decreases in distribution over the same period. Such is the magnitude of annual fluctuations in these species, driven by the number of immigrant individuals that arrive here, that these short-term declines are not a cause for conservation concern. Indeed, the long-term trends show (often substantial) increases in abundance and occurrence for all three species.

While the factors that determine the number of migratory butterflies arriving in the UK each year remain unknown and constitute an area for future research, considerable advances have been made in understanding Painted Lady migration. During a peak Painted Lady year in 2009, over 60,000 citizen science sightings from the UK, continental Europe and North Africa, as well as data from Rothamsted Research's entomological radar[91], were used to piece together its incredible migratory cycle. In a very good year, such as 2009, the Painted Lady undertakes an annual round-trip of up to 9,000 miles between sub-Saharan Africa and the Arctic Circle, almost double the distance of the famous Monarch butterfly migration in North America[92]. The journey is a series of steps, each leg undertaken by one of up to six successive generations during the year.

Much of the Painted Lady's migration takes place at high altitude, unobserved by human recorders. Extrapolations from the radar data suggested that some 11 million flew in over southern England in May-June 2009 and some 26 million were on the move in August-October. Most were over 350m above ground level, with some over 1km high. Painted Ladies select favourable winds at particular altitudes to achieve average speeds of c.30mph, more than twice their capability under their own steam[92].

In addition to regular migrant butterflies that come to the UK to breed each year, a larger number of species turn up here sporadically and are perhaps best thought of as opportunistic pioneers. In recent years, two such butterfly species in particular, the Long-tailed Blue and Scarce Tortoiseshell (see boxes right), have arrived in the UK in unprecedented numbers. There also appears to have been an increase in sightings of the continental *gorganus* race of the Swallowtail. It is not yet clear whether these rare events, together with the long-term increases of the regular migrant species, represent a fundamental shift in immigration patterns, associated with climate change.

Long-tailed Blue

Southern Britain appears to lie at the northern edge of the current European range of the Long-tailed Blue and there are usually a small number of sightings of this highly-mobile species here each year. In addition to genuine immigrants, small numbers arrive as caterpillar stowaways in vegetables imported from warmer climes.

In August 2013, there was a substantial influx of this species, with around 30 individual butterflies recorded, predominantly from south and east coast counties of England[93]. In several cases, eggs or larvae were discovered at the same locations and, subsequently, an autumn 'home-grown' generation of Long-tailed Blues emerged across southern England, generating sightings of at least 80 individual butterflies spread across eight counties[93]. Although the occurrence of Long-tailed Blue in the UK in 2013 was unprecedented in abundance and distribution, the species is not able to survive our winters and so permanent colonisation is impossible at present. Amazingly, another almost identical influx of Long-tailed Blue occurred in the summer of 2015, again with substantial local breeding and the emergence of a new generation.

Scarce Tortoiseshell

The 2014 influx of Scarce Tortoiseshell (also known as Yellow-legged Tortoiseshell) into Britain was extraordinary. This eastern European species had occurred here only a few times previously.

However, in July 2014, a massive movement of Scarce Tortoiseshells spread south-westerly from Scandinavia across Denmark and the Netherlands, just reaching into eastern England[94]. Identification of this species is not straightforward, but there were 19 confirmed sightings of Scarce Tortoiseshell across eight English counties in 2014, and a further seven records (in five counties) in spring 2015 of butterflies that had successfully overwintered in Britain[94]. It seems that none of the latter was able to find a mate and breed in Britain as there were no further records during 2015.

[90] Fox & Dennis 2010
[91] Chapman *et al.* 2011
[92] Stefanescu *et al.* 2013
[93] Fox 2014
[94] Fox *et al.* 2015

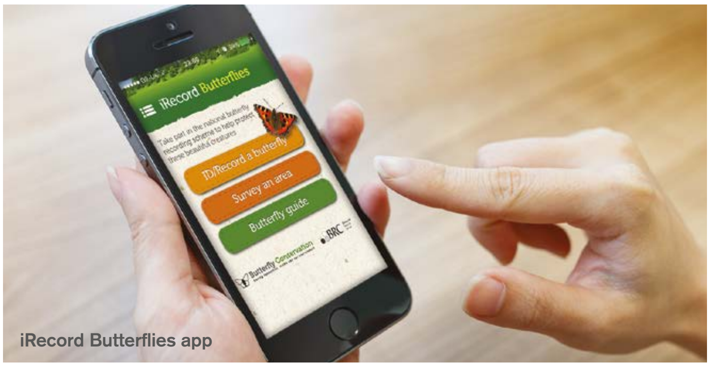
New recorders and new technology

While observations made by amateur naturalists have been the mainstay of UK butterfly recording and monitoring for decades, a renewed research interest in 'citizen science' and the opportunities afforded by modern technology have had a dramatic impact in recent years[95].

The internet and 'smart' mobile devices provide a relatively cheap and efficient means to engage far wider audiences with butterfly recording. Butterfly Conservation has developed a series of simple, online, citizen science projects aimed at the general public (although many existing butterfly recorders also take part). These projects aim to educate and raise awareness but also, crucially, to encourage people to do something – to take that first step of making and submitting a butterfly sighting. For some that may be the limit of their involvement, but for others it will serve as a springboard into a greater engagement with butterflies, biological recording, nature conservation and the great outdoors.

The high media profile of these easily accessible schemes generates high levels of participation. In the first six years of Butterfly Conservation's Big Butterfly Count (2010-2015) 158,000 people have undertaken 15-minute counts of widespread summer butterfly species, making the project comfortably the largest of its kind in the world. Engagement is maintained through a free monthly email newsletter (sent to almost 100,000 subscribers) and massive coverage on social media such as Facebook and Twitter. Among this huge new audience will be some of the transect walkers and active conservation volunteers of the future.

These citizen science projects generate useful data too. All Big Butterfly Count sightings are passed to the network of county experts who compile and verify the records for the BNM scheme. Sightings from another Butterfly Conservation project, Migrant Watch, a simple online survey of the Painted Lady and Humming-bird Hawk-moth, contributed substantially to an improved scientific understanding of the butterfly's annual migratory cycle in Europe and Africa[96].



iRecord Butterflies app

New technology is being utilised as part of Butterfly Conservation's core suite of recording and monitoring schemes too. Online data entry for UKBMS transects has been introduced and, by 2014, counts from 81% of transects were submitted in this way. The system improves efficiency, reduces errors and provides participants with real-time feedback. The WCBS has used online submission since the outset and 89% of visits in 2014 were logged through the website.

The BNM scheme is making use of smartphone technology to encourage and facilitate butterfly distribution recording. A free app, iRecord Butterflies, was developed recently and 70,000 records were submitted by over 3,000 users in the 14 months since it was launched. With the app, recorders can log and submit sightings as a single process and also make use of the GPS device built into their smartphone to automatically generate high-resolution grid references for their records. The app also acts as a simple identification guide to help new recorders and steers them through the process of submitting a record.

However, new technology can pose challenges too. There are the obvious additional costs of website and app development and ongoing maintenance, but it also heralds a more fundamental evolution of recording. The proliferation of local and national online submission systems and the related, almost exponential increase in the number of people recording butterflies represent a sea change for the BNM project. The local expert volunteers (such as County Recorders) who form the backbone of the BNM face a rapid increase in workload in order to maintain accurate verification of records and effective communication with recorders.

Volunteer recorders are the lifeblood of butterfly recording and monitoring in the UK and without them we would know little about the current state of our butterflies. Whether submitting sightings online or via pen and paper, long-standing recorders and new recruits alike play a vital role and we are extremely grateful to each and every one.

Citizen science projects such as Big Butterfly Count are introducing new audiences to butterflies and butterfly recording. Over 158,000 people have taken part in Big Butterfly Count over the last six years, showing how popular butterflies are amongst the UK public.

[95]Dickinson *et al.* 2010, Pocock *et al.* 2015
[96]Stefanescu *et al.* 2013

Valuable butterflies

Why does the continued decline of UK butterflies matter? Butterflies have roles in ecosystems, as pollinators and as herbivores and prey in food chains. But they are also important to humans.

Many people believe that butterflies have an intrinsic value, a right to exist that is not dependent on their value to other species (including humans), and that we have a moral or religious responsibility to prevent their extinction. But butterflies can also play important roles for humans.

One particularly valuable role for butterflies is in providing a window into the largely hidden world of invertebrate biodiversity. There are over 25,000 insect species in the UK, most of which are unknown and unloved by the public and politicians, and we know little about how many of them are faring in our countryside. UK butterflies, by contrast, are charismatic, popular, relatively easy to identify and observe, and, as a result, are extremely well studied. Butterflies can be used as indicators, both of the wider state of insect species and as a sensitive gauge for the impacts of subtle habitat or climatic change on biodiversity and ecosystem services[97].

The patterns of change initially revealed by studies of UK butterflies[98] have subsequently been echoed among other insect taxa[99], as well as being shown to be comparable with those of birds and flowering plants[100]. This role, and the scientific reliability of butterfly data, has been officially recognised with the adoption of butterfly population trends as Government biodiversity indicators in the UK, England and Scotland (see p.8-9). Such indicators contribute towards the development and assessment of government policy responses to the deteriorating state of nature in the UK and to international obligations, e.g. under the Convention on Biological Diversity.

But the value of butterflies as indicators goes well beyond that of providing policy-relevant evidence to civil servants. The scientific understanding gained from butterfly studies contributes substantially to wildlife conservation in the UK and around the world, both in practical terms on the ground and in raising public awareness and support for insect conservation.

The impact of butterflies as indicators and flagships for conservation empowers people. Through the mass-participation citizen science schemes run to record and monitor UK butterflies, as well as practical conservation tasks to improve butterfly habitats, tens of thousands of members of the public, of all ages and walks of life, are able to respond positively to the seemingly overwhelming challenges of habitat destruction and climate change. These activities also provide an opportunity for exercise and recreation in the open air.

Butterflies are culturally important too, as demonstrated by their frequent appearances in art and literature through the ages. Their beauty and graceful movement are pleasing to the human eye and their metamorphosis, from caterpillar to butterfly, is widely used as a cultural symbol of spiritual growth, progress and making a new start.

Butterflies, such as this Purple Emperor, have an amazing capacity to bring joy to people.

These strong cultural associations may make butterflies particularly important in attempts to understand and tackle the increasing disconnect between UK citizens and the natural world (sometimes called nature deficit).

A wealth of studies now positively link exposure to natural places with human health and well-being, although the mechanisms involved are unclear. Contact with nature can reduce stress and anger, improve mood and self-esteem, and increase concentration[101]. Little is known about which characteristics of natural places convey these benefits to humans, but there is some evidence that when people think they are in an area rich in butterflies or other wildlife, their general well-being increases[102]. Similarly, the well-being benefits derived from watching garden birds increase with species richness[103]. Conversely, a loss of culturally-valued biodiversity might be detrimental to human health[104].

Restoring butterfly populations across the UK, in gardens, urban green spaces and the countryside, is likely to bring substantial benefits to innumerable other species but also to the health and well-being of the human population.

[97]Parmesan 2003, Thomas 2005
[98]Roy & Sparks 2000, Warren *et al.* 2001
[99]Conrad *et al.* 2006, Hickling *et al.* 2006, Hassall *et al.* 2007, Potts *et al.* 2010, Burns *et al.* 2013, Carvalheiro *et al.* 2013, Vanbergen *et al.* 2013, Fox *et al.* 2014
[100]Thomas *et al.* 2004
[101]Keniger *et al.* 2013
[102]Dallimer *et al.* 2012
[103]Cox & Gaston 2015
[104]Clark *et al.* 2014

Conclusions

- The new results presented in this report provide further evidence of the serious, long-term and ongoing decline of UK butterflies, with 70% of species declining in occurrence and 57% declining in population since 1976. This is of great concern not just for butterflies but for other wildlife species and the overall state of the environment.
- Some threatened species seem to be responding to landscape scale conservation, with declines having been halted or turned around in some regions. However, many species remain vulnerable. More research and far greater effort on the ground are required to secure their recovery.
- The effectiveness of landscape-scale conservation partnership projects developed by Butterfly Conservation provides a template for future action: targeted effort, strong partnership working and payments for positive habitat management (e.g. through agri-environment schemes). This approach should be expanded to benefit more species.
- Perhaps the most worrying finding of the report is the decline of widespread butterflies, several of which are now amongst our most rapidly declining species. This suggests that environmental conditions are deteriorating for the majority of species and is likely to reflect a decline of other widespread insects, knock-on impacts for animals further up food chains and implications for the resilience of ecosystems. The causes of these declines are unclear and further investigation is urgently required.
- The impacts of climate change on UK butterflies are more complex and nuanced than previously realised. New research suggests that climate change is having a substantial negative influence on the populations of some butterflies and effects are predicted to intensify in the future.
- There is growing evidence that nature is an important factor in human health and well-being. Butterflies are an iconic part of wildlife and have a role to play in enhancing the human experience, but they are also key indicators of the health of the environment and efforts to conserve it. The importance of robust, long-running data gathered through the citizen science schemes presented here has, thus, never been more important.
- Despite the recent upturns of some threatened species, the recovery of butterflies in the UK is severely limited by a lack of resources. This situation is likely to get worse in an era of reduced Government funding for the environment[105]. Unless more funds are made available, and more urgent action taken, it seems unlikely that the UK will meet the Aichi targets agreed in the international Convention on Biological Diversity, at least as far as butterflies are concerned. Concerted action by Government bodies working in partnership with the farming industry is desperately needed to halt biodiversity declines and create a healthier environment. This will require further improvements to agri-environment policy with more money going to management that directly benefits biodiversity and the wider environment.

Recommendations

- To stem the decline of butterflies, conservation measures are needed urgently at a variety of scales, from small patches of resources for butterflies in gardens and verges through to extensive landscapes of semi-natural habitat. Individual actions by members of the public can play an important part, but favourable Government policies are essential. Pressure on land use (e.g. for food production and house building) is likely to intensify so it is vital that Government policies continue to protect all important semi-natural habitats and designated sites, which provide breeding areas for specialist butterflies. But, with declines among wider countryside butterflies increasingly evident, better policies are needed to improve the rural and urban environment for biodiversity, through planning regulations, agri-environment schemes and other incentives.
- Climate change is likely to have a growing impact on butterfly populations and conservation and land-use policies need to adapt. Sites managed for butterflies and other wildlife need to be as large and diverse as possible, covering a range of aspects, microclimates and vegetation types. Climate change adaptation should be incorporated into plans for all threatened species.
- The data presented in this report highlight the enormous and increasing value of butterfly recording and monitoring schemes, not just to assess the state of butterflies, but also to help gauge the state of the environment as a whole. These schemes must be maintained and adequately resourced so that we can understand future changes, evaluate land-use policies and conservation strategies and adapt them accordingly.
- The recommendations made in our last State of Butterflies report remain valid and their implementation is now more urgent than ever:

1. Maintain and restore high quality, resilient habitats through landscape-scale projects.
2. Restore the species-focussed approach that has proved effective in reversing the decline of threatened species. While an integrated 'ecosystem services' view of biodiversity is important, it alone will not save threatened butterflies.
3. Enhance funding for agri-environment and woodland management schemes targeted at species and habitats of conservation priority.
4. Restore the wider landscape for biodiversity in both rural and urban areas, to strengthen ecosystems and benefit the economy and human welfare.
5. Encourage public engagement through citizen science schemes such as the BNM, UKBMS and Big Butterfly Count.
6. Increase the use (and monitoring) of landscape-scale projects for threatened wildlife and ensure that funding mechanisms are in place to support them (e.g. landfill tax credits).

[105] http://www.ifs.org.uk/tools_and_resources/fiscal_facts/public_spending_survey/cuts_to_public_spending

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Numbers of the Small Skipper have decreased by 75% since 1976. The decline of this species and other wider countryside butterflies is a cause of grave concern.

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