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The European Grassland Butterfly Indicator: 1990–2011

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EEA project manager
Katarzyna Biała

Photo: Marsh Fritillary (*Euphydryas aurinia*), Örsegg, Hungary, 22 May 2011 © Chris van Swaay

Summary

- This report presents the European Grassland Butterfly Indicator, based on national Butterfly Monitoring Schemes (BMS) in 19 countries across Europe, most of them in the European Union.
- The indicator shows that since 1990 till 2011 butterfly populations have declined by almost 50 %, indicating a dramatic loss of grassland biodiversity. This also means the situation has not improved since the first version of the indicator published in 2005.
- Of the 17 species, 8 have declined in Europe, 2 have remained stable and 1 increased. For six species the trend is uncertain.
- The main driver behind the decline of grassland butterflies is the change in rural land use: agricultural intensification where the land is relatively flat and easy to cultivate, and abandonment in mountains and wet areas, mainly in eastern and southern Europe.
- Agricultural intensification leads to uniform, almost sterile grasslands for biodiversity. Grassland butterflies thus mainly survive in traditionally farmed low-input systems (High Nature Value (HNV) Farmland) as well as nature reserves, and on marginal land such as road verges and amenity areas.

Photo: Chalkhill Blue (*Polyommatus coridon*), Eifel, Germany, 26 July 2008 © Chris van Swaay

- Abandonment is caused by socio-economic factors. When farming on low-productivity land brings only small incomes and there is little or no support from the Common Agricultural Policy (CAP), farmers give up their enterprises and the land is left unmanaged. The grassland quickly becomes tall and rank and is soon replaced by scrub and woodland.

- The EU Biodiversity Strategy recognises the poor conservation status of grasslands and of their characteristic butterflies. The actions set out in this Strategy need urgent implementation. Appropriate management is vital both for grasslands designated as Natura 2000 areas and on HNV farmland outside these areas. Financial support for biodiversity-friendly actions and programmes should also be further enhanced through the Common Agricultural Policy measures.

- Butterflies offer the possibility to be used as a structural headline indicator, not only for grasslands but also for other habitats, and to track other pressures such as climate change.

Photo: Abandoned grassland get overgrown by shrubs and trees leaving no habitat for grassland butterflies © Chris van Swaay

1 Introduction

The European Grassland Butterfly Indicator is one of the status indicators on biodiversity in Europe. It is based on the population trends of 17 butterfly species in 19 countries. This report presents the fourth update of this indicator now covering 22 years.

After the new EU Biodiversity Strategy was adopted by the European Commission in May 2011, the Convention on Biological Diversity (CBD) meeting in Nagoya (Japan) adopted the Strategic Plan for Biodiversity 2011–2020 proposing 5 goals and 20 so-called Aichi targets. This provided a framework for the EU to meet its own biodiversity objectives and its global commitments as a party to the CBD. One of the main targets is to halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020 and restore them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss.

The strategy includes the development of a coherent framework for monitoring, assessing and reporting on progress in implementing actions. Such a framework is needed to link existing biodiversity data and knowledge systems with the strategy, and to streamline EU and global monitoring, reporting and review obligations.

Some indicators provide specific measurements and trends on genetic, species and ecosystem/landscape diversity, but many have a more indirect link to biodiversity. Very few were established specifically to assess biodiversity. The status indicators on species only cover birds and butterflies, since these are the only taxa/species groups for which harmonised European monitoring data are available (EEA, 2012).

For the European Grassland Butterfly Indicator, the trends of 17 butterflies in 19 countries in Europe

Photo: Large Skipper (*Ochlodes sylvanus*), Moerputten, Netherlands, 23 June 2009 © Chris van Swaay

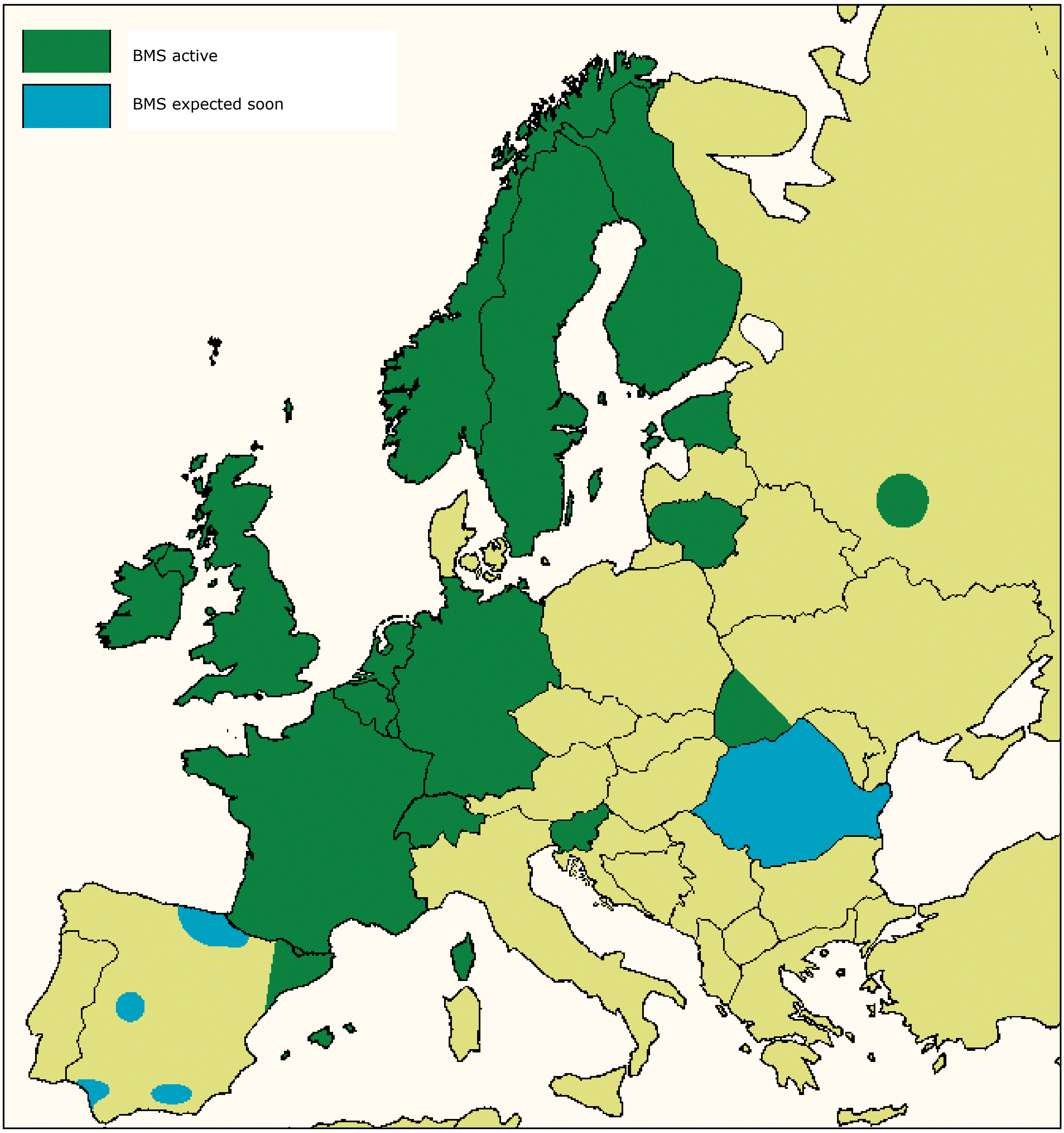
(17 of them in the European Union) were assessed. This report gives an overview of the results and presents the indicator.

Butterfly monitoring enjoys growing popularity in Europe. Map 1.1 shows the current BMS and the countries where they are soon expected to be implemented. Although BMS are present in a growing number of countries and new ones are being initiated in many places, long-time series are only available for a limited number of countries. For this new indicator, data were used from 19 countries: Andorra, Belgium, Estonia, Finland, France, Germany, Ireland, Jersey, Lithuania, Luxembourg, the Netherlands, Portugal, Russia (Bryansk area), Slovenia, Spain, Sweden, Switzerland, Ukraine and the United Kingdom. The Norwegian scheme is still in the start-up phase and the results could not yet be used for the indicator.

In this report we update the European Grassland Butterfly Indicator, first published by van Swaay and van Strien in 2005. The method closely follows the one for the bird indicators (Gregory et al., 2005). The updated indicator not only has a longer time series, with data from the 2005–2011 field seasons now included, but the method of calculating the indicator has been improved on and enhanced. Furthermore, new countries have been added. This leads to differences with the previous version of the indicator, because the species population indices at national and supranational levels are recalculated each year again for the full time series. When index values change, the multispecies indicator values also change. These changes are, however, small and of minor importance because the interpretation of indicator values should focus on long-term trends.

Photo: Mazarine Blue (*Cyaniris semiargus*), Eifel, Germany, 12 June 2009 © Chris van Swaay

Map 1.1 Countries contributing their data to the European Grassland Butterfly Indicator



Note: Andorra (part of the Catalan scheme): since 2004; Belgium (Flanders): since 1991; Estonia: since 2004; Finland: since 1999; France: since 2005 (Doubs area 2001–2004); Germany: since 2005 (Nordrhein-Westfalen since 2001, Pfalz region for Phengaris nausithous since 1989); Ireland: since 2007; Jersey: 2004–2009; Lithuania: since 2009; Luxembourg: since 2010; the Netherlands: since 1990; Portugal: 1998–2006; Russia (Bryansk area): since 2009; Slovenia: since 2007; Spain (Catalonia): since 1994; Sweden: since 2010; Switzerland: since 2003 (Aargau since 1998); Ukraine (Transcarpathia): since 1990; United Kingdom: since 1976.

Countries or regions not used in the indicator:
Norway: since 2009 (starting up, not used in indicator); Romania: starting up; Spain (Andalusia, Extremadura and Basque country starting up).

In 2011 approximately 3 500 transects were counted.

2 Building the European Grassland Butterfly Indicator

The European Grassland Butterfly Indicator shows the population trend of butterflies that are characteristic of grasslands in Europe.

Fieldwork

The Butterfly Indicator is based on the fieldwork of thousands of trained professional and volunteer recorders, counting butterflies on approximately 3 500 transects scattered widely across Europe (see Map 1.1). These counts are made under standardised conditions. National coordinators collect the data and perform the first quality control. More details can be found in Annex 1.

Photo: Most of butterfly counts are done by volunteers who are vital to the butterfly monitoring schemes and to the production of the indicator © Martin Warren

Grassland butterflies

European butterfly experts selected species they considered to be characteristic of European grasslands and which were found in a large part of Europe, covered by the majority of the BMS and having grasslands as their main habitat (van Swaay et al., 2006). The species are listed in Figure 2.1.

Population trend

National population trends from the BMS (Map 1.1), calculated by the programme TRIM (Pannekoek and van Strien, 2003), are combined to form supranational species trends (Chapter 3). These trends per butterfly species are then combined into an indicator: a unified measure of biodiversity following the bird indicators as described by Gregory et al. (2005), by averaging indices of species rather than abundances in order to give each species an equal weight in the resulting indicators. When positive and negative changes of indices are in balance, then we would expect their mean to remain stable. If more species decline than increase, the mean should go down and vice versa. Thus, the index mean is considered a measure of biodiversity change. More details on the method can be found in the previous indicator report (van Swaay and van Strien, 2008; van Swaay et al., 2010b). Although the BMS are very similar, there are differences in choice of location, number of counts and other aspects. These are summarised in Annex 1.

Figure 2.1 Seventeen butterflies were used to build the European Grassland Butterfly Indicator, comprising 7 widespread and 10 specialist species

Widespread grassland butterflies

Widespread species: *Ochlodes sylvanus, Coenonympha pamphilus, Maniola jurtina, Lasiommata megera, Polyommatus icarus, Lycaena phlaeas and Anthocharis cardamines*

Specialist grassland butterflies

Specialist species: *Euphydryas aurinia, Polyommatus coridon, Cyaniris semiargus, Thymelicus acteon, Polyommatus bellargus, Phengaris nausithous, Phengaris arion, Cupido minimus, Spialia sertorius and Erynnis tages*

3 Species trends

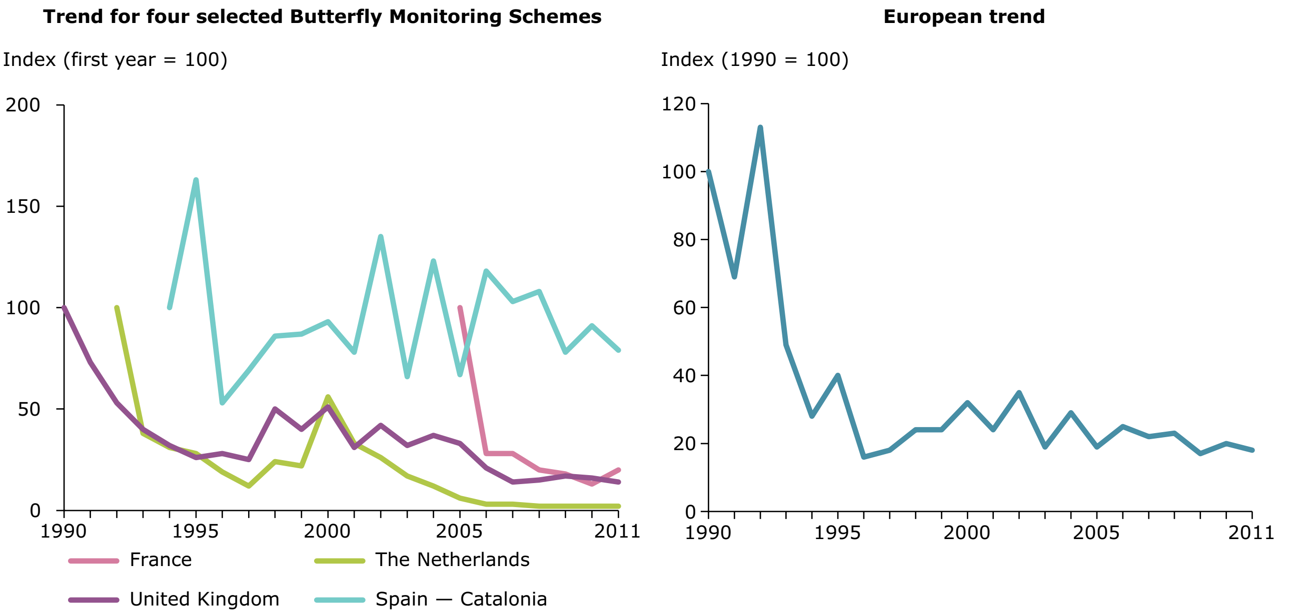
The European Grassland Butterfly Indicator is built from European species trends. In this chapter, we give an overview of the trends of grassland butterflies in Europe and the EU.

First, we calculate the trend in each country and for each species separately. Figure 3.1 shows four of the national trends for the Wall Brown (*Lasiommata megera*). The European trend is calculated for this species by combining all the national trends. In Annex 2, the method is described in greater detail. The results show that this butterfly declined, especially in the early 1990s, and was more or less stable on a low level after that. In the EU, eight species show a decline and five are stable. Two species show an increase and for two species the trend is uncertain (Table 3.1). In Europe, eight species are declining and two are stable. One species shows an increase and the trend for the remaining species is uncertain (Table 3.2).

When interpreting the species trends it is important to take account of various points.

- The coverage of the species' populations and thus the representativeness of the data may be lower at the beginning of the time series (see also the note for Map 1.1). As more countries join in, the indices improve in accuracy each year.
- Large year-to-year fluctuations or a low number of transects can cause large standard errors, leading to uncertain European or EU trends.
- In almost half of the EU Member States, and even more non-EU countries, there is no BMS yet. The trends shown only represent the countries in Map 1.1. However, because they are based on a wide geographic range of countries, we believe that they are reasonably representative of the EU as a whole.

Figure 3.1 National and European trends for the Wall Brown (*Lasiommata megera*)



Note: Note that the starting year for the left graph (see also Map 1.1) for each scheme is different. All indexes are set to 100 for the first year of a scheme.

Table 3.1 Supranational EU trends of the 17 butterfly species of the European Grassland Butterfly Indicator

Trend in EU	Species	Trend classification
Decline: 8 species	*Coenonympha pamphilus*	Moderate decline ($p < 0.01$)
	Lasiommata megera	Moderate decline ($p < 0.01$)
	Lycaena phlaeas	Moderate decline ($p < 0.01$)
	Phengaris nausithous^{N2000}	Moderate decline ($p < 0.01$)
	Maniola jurtina	Moderate decline ($p < 0.01$)
	Polyommatus icarus	Moderate decline ($p < 0.01$)
	Euphydryas aurinia ^{N2000}	Moderate decline ($p < 0.01$)
	Ochlodes sylvanus	Moderate decline ($p < 0.01$)
Stable: 5 species	*Erynnis tages*	Stable
	Anthocharis cardamines	Stable
	Polyommatus bellargus	Stable
	Cupido minimus	Stable
	Polyommatus coridon	Stable
Increase: 2 species	*Cyaniris semiargus*	Moderate increase ($p < 0.01$)
	Spialia sertorius	Moderate increase ($p < 0.01$)
Uncertain: 2 species	*Thymelicus acteon*	Uncertain
	Phengaris arion ^{N2000}	Uncertain

Note: For the trend classification see Annex 2.
^{N2000}: Species listed on the annexes of the Habitats Directive.

Photo: Wall Brown (*Lasiommata megera*), Skärhamn, Sweden, 13 June 2012 © Chris van Swaay

Table 3.2 Supranational European trends of the 17 butterfly species of the European Grassland Butterfly Indicator

Trend	Species	Trend classification
Decline: 8 species	*Phengaris arion* N2000	Steep decline ($p < 0.01$)
	Coenonympha pamphilus	Moderate decline ($p < 0.01$)
	Lasiommata megera	Moderate decline ($p < 0.01$)
	Lycaena phlaeas	Moderate decline ($p < 0.01$)
	Phengaris nausithous N2000	Moderate decline ($p < 0.01$)
	Maniola jurtina	Moderate decline ($p < 0.01$)
	Polyommatus icarus	Moderate decline ($p < 0.01$)
	Erynnis tages	Moderate decline ($p < 0.05$)
Stable: 2 species	*Anthocharis cardamines*	Stable
	Polyommatus bellargus	Stable
Increase: 1 species	*Spialia sertorius*	Moderate increase ($p < 0.01$)
Uncertain: 6 species	*Euphydryas aurinia* N2000	Uncertain
	Ochlodes sylvanus	Uncertain
	Cyaniris semiargus	Uncertain
	Cupido minimus	Uncertain
	Polyommatus coridon	Uncertain
	Thymelicus acteon	Uncertain

Note: For the trend classification see Annex 2.
N2000: Species listed on the annexes of the Habitats Directive.

- Apart from the EU Member States, the European trend is determined by Switzerland, the western part of Ukraine and the Bryansk area in western Russia. In the near future this will probably be extended to Norway. However, large parts of Russia and the Ukraine as well as parts of the Balkans and the Mediterranean are still not covered.

Figure 3.2 shows some examples of European butterfly trends:

- the Common Blue (*Polyommatus icarus*), a widespread and in many countries common and abundant butterfly, occurring on all kinds of grasslands;
- the Orangetip (*Anthocharis cardamines*), a typical spring butterfly;
- the Lulworth Skipper (*Thymelicus acteon*), a specialist species of dry calcareous grasslands.

Figure 3.2 European indices (blue lines) and trends (black line = decline, green line = stable) of three butterflies in Europe

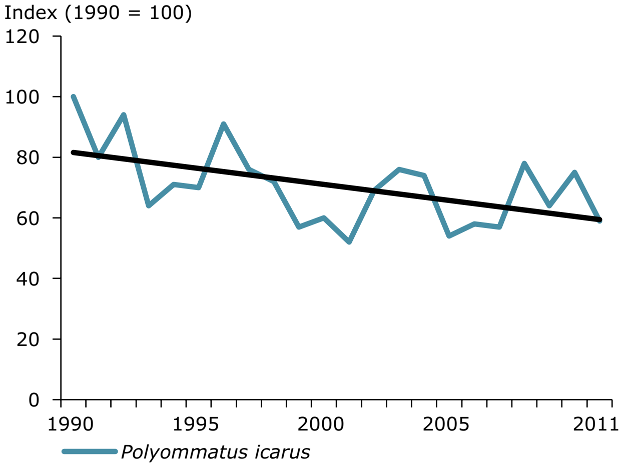


Photo: Common Blue (*Polyommatus icarus*), Wageningen, Netherlands, 1 August 2008 © Chris van Swaay

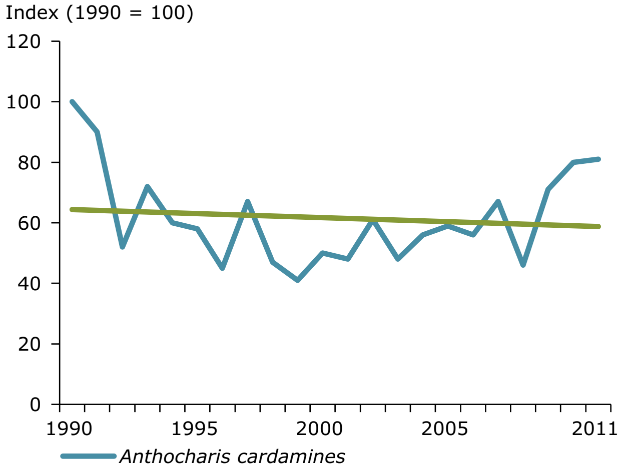


Photo: Orangetip (*Anthocharis cardamines*), Lettele, Netherlands, 11 April 2011 © Chris van Swaay

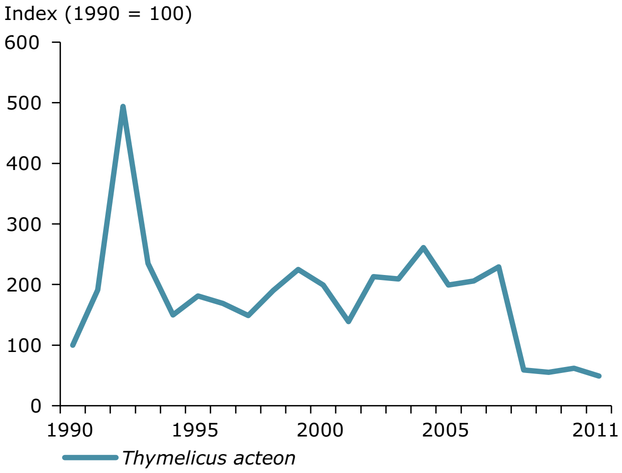


Photo: Lulworth Skipper (*Thymelicus acteon*), Eifel, Germany, 27 July 2008 © Chris van Swaay

Note: Top: The Common Blue (*Polyommatus icarus*) shows a significant decline, in spite of year-to-year fluctuations.
Middle: The Orangetip (*Anthocharis cardamines*) is considered stable, in spite of higher indices in the beginning and at the end of the research period.
Bottom: Large fluctuations make the trend of the Lulworth Skipper (*Thymelicus acteon*) uncertain, so it is not possible to add a trend.

4 The indicator

The European Grassland Butterfly Indicator has been updated both for Europe and the EU. In this chapter both indicators are presented.

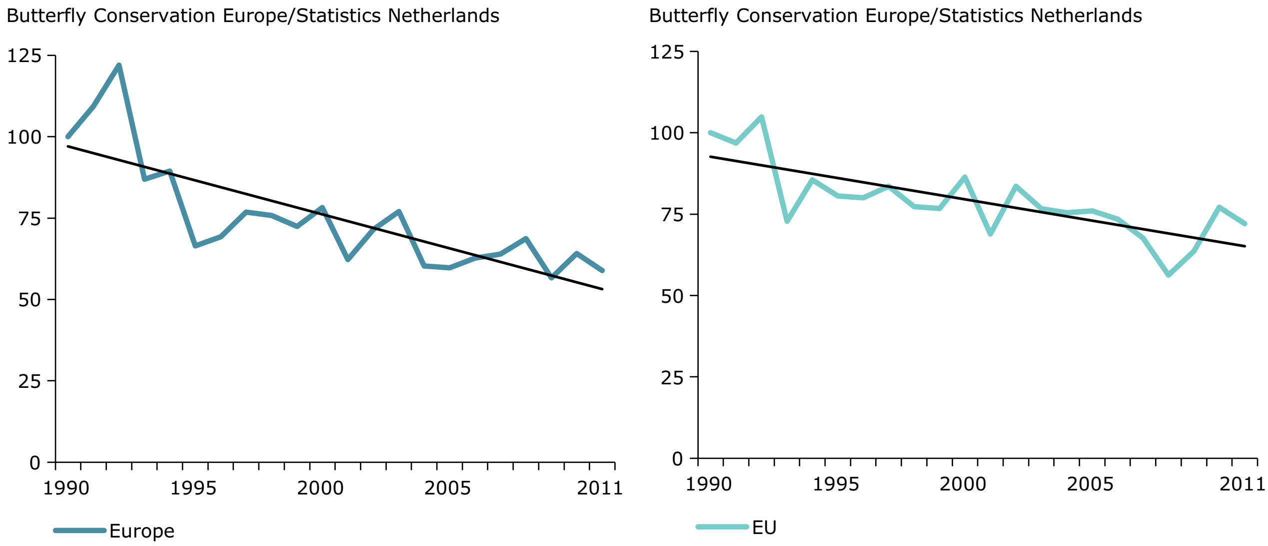
Figure 4.1 shows the European Grassland Butterfly Indicator, as well as the indicator for the Member States of the EU alone. The indicator is based on the supranational species trends as presented in Chapter 3. As in previous versions, both indicators showed a marked decline between 1990 and 2011. Compared to 1990, the European populations of the 17 indicator species have declined by, on average, almost 50 %. The decline seems to have slowed a little in the last few years. The negative trend in the EU Member States alone is a little less than in Europe as a whole, with a decline of almost 30 % over the period.

When interpreting these graphs it should be remembered that a large decline of butterflies in north-western Europe (countries all already in the EU for a long time) happened before 1990.

So far, 2008 and 2009 were the worst years for these butterflies, both on a European and EU scale, but 2010 and 2011 showed a slight recovery, especially in western Europe. These good years might be attributed to weather conditions, but they do not compensate for the steady loss in previous years.

Photo: Flower-rich semi-natural grasslands are the home of many butterflies © Chris van Swaay

Figure 4.1 The Grassland Butterfly Indicators for Europe (left) and the EU (right)



Note: The indicators (blue lines) are based on the countries in Map 1.1 and characteristic grassland butterfly species in Figure 2.1 (the black line represents the significant trend). Both indicators show a marked decline.

5 Implications

The European Grassland Butterfly Indicator shows that butterfly numbers on grasslands have decreased by almost 50 %. What does this mean for Europe's biodiversity?

The European Grassland Butterfly Indicator shows a clear negative trend (see Figure 4.1). **The indicator shows that since 1990 butterfly populations have declined by almost 50 %.** Although in 2010 and 2011 some populations showed a slight recovery, the declining trend identified in the first versions of this indicator in 2005, 2008 and 2010 has continued (van Swaay and van Strien, 2005 and 2008; van Swaay et al., 2010b). This shows that butterflies are still disappearing from Europe's grasslands.

This huge decline has important implications for the conservation of biodiversity because butterflies are considered to be representative indicators of trends observed for most other terrestrial insects, which together form around two thirds of the world's species (Thomas, 2005). Butterflies are therefore useful biodiversity indicators — for example, in evaluating progress towards achieving the EU target of halting biodiversity loss (EEA, 2012).

Butterflies appeal both to the general public and decision-makers (Kühn et al., 2008). They are also fairly easy to recognise and therefore data on butterflies have been collected for many years and by thousands of voluntary observers. The method for monitoring butterflies is well described, extensively tested and scientifically sound (Pollard, 1977; Pollard and Yates, 1993; van Swaay et al., 2008a). As a result, butterflies are the only invertebrate taxon for which it is currently possible to estimate rates of decline among terrestrial insects (de Heer et al., 2005; Thomas, 2005).

Photo: Common Blue (*Polyommatus icarus*) gathering in the evening sun © Chris van Swaay

6 Intensification and abandonment

Grassland butterflies have undergone a huge overall decrease in numbers. Their populations declined by almost 50 % from 1990 to 2011. Although the causes for the decline are different for each species and country, the two main drivers are agricultural intensification and abandonment of grasslands.

Large parts of Europe are used for agricultural purposes, and grasslands are a major land-cover type within these areas. For centuries, grasslands have formed an important part of the European landscape. Sustainably managed semi-natural grassland harbours a high biodiversity, especially of plants, butterflies and many other insect groups.

Grasslands are the main habitat for many European butterflies. Out of 436 butterfly species in Europe for which information on habitat type is available, 382 (88 %) are on grasslands in at least one country in Europe, and for more than half of the species (280 species, 57 %) grassland is their main habitat.

Thomas (2005) argued that butterflies are good indicators of insects, which comprise the most species-rich group of animals in Europe. The trend in grassland butterflies is thus an indicator for the health of grassland ecosystems and their component biodiversity. Insects play a crucial role in pollination services and the health of the ecosystems on which they depend is important for Europe's future economic and social well-being.

Intensification

Until a few decades ago, semi-natural grasslands were widespread and common all over the continent. Since the 1950s, grassland management has undergone huge changes. In western Europe, farming has intensified rapidly and over the last 50 years semi-natural grasslands have become greatly reduced in area. In some countries they are more or less confined to nature reserves or protected areas. In eastern and southern Europe, semi-natural grasslands remained a part of the farming system until more recently. However, in the last few decades these are also being lost and there has been a clear shift towards intensification, especially in relatively flat and nutrient-rich places.

Intensification comprises a wide range of activities, including the conversion of unimproved grasslands to arable crops, and permanent grasslands into temporary grasslands, heavy use of fertilisers, drainage, the use of herbicides, insecticides and pesticides, enlargement of fields, removal of landscape features and field margins and the use of heavy machines. In its most extreme form, the remaining agricultural land is virtually sterile with almost no butterflies. In such situations, butterflies can survive only on road verges, in

Photo: Black-veined White (*Aporia crataegi*), Eifel, Germany, 11 June 2011 © Chris van Swaay

Photo: Intensively farmed grassland, Wageningen, Netherlands, 10 September 2008 © Chris van Swaay

remaining nature reserves and urban areas. Even then butterflies are not safe, as wind-drifted insecticides kill many larvae on road verges next to sprayed fields and nitrogen deposition fertilises nutrient-poor meadows. This speeds up succession and leads to the paradox of micro-climatic cooling in combination with climate warming (Wallis De Vries and van Swaay, 2006).

As a consequence, the biggest loss of butterflies in the intensified grasslands of western Europe occurred **before the 1990s and therefore does not show up in the indicator**. As a result, butterfly populations in these areas are already at a low level and are vulnerable to further losses of sustainably managed grassland and habitat fragmentation. As the western European BMS dominate the indicator in the 1990s and the first years of the 21st century, intensification will be the main driver for the indicator trend in that period.

Abandonment

In most of Europe, grasslands are not the climax vegetation. Without any form of management, they would gradually change into scrub and forest. This means that grasslands and their butterflies are highly dependent on activities such as grazing or mowing. Traditional forms of farming management, such as extensive livestock grazing and hay-making where fertiliser and pesticide use are minimal, provide an ideal environment for these butterflies.

In recent decades, large areas of grassland have become abandoned, especially in areas that are too wet, steep, rocky or otherwise unsuitable for intensive farming. Furthermore, many villages in the European countryside have become abandoned for social and economic reasons, often leading to young people moving to cities and only old people remaining. Following abandonment, some butterfly species flourish for a few years because of the lack of management, but thereafter scrub and trees invade and the grassland disappears, including its rich flora and butterfly fauna. Eventually, the vegetation reverts to scrubland and forest, eliminating grassland butterflies.

Additional threats

In addition to these two main drivers, there are other threats to grassland butterflies in Europe, including fragmentation, the targeting of pesticides and climate change. The intensification and abandonment of grassland leads to the fragmentation and isolation of the remaining patches. This not only reduces the chances of survival of local populations, it also makes it more difficult for butterflies to re-colonise if they become locally extinct. Other factors which negatively influence butterfly populations are urbanisation, soil sealing and afforestation of grasslands.

Climate change is also expected to have a serious effect on the distribution and population sizes of grassland butterflies in the future as grasslands face extreme weather events, such as droughts or fire, or change their composition. In montane habitats, as temperatures rise, sensitive butterfly species may not be able to move to higher altitudes as there may be no further land to colonise or no suitable grassland habitat there.

7 Reversing the trend

The European Grassland Butterfly Indicator shows a clear decline, and the main drivers behind this are identified as intensification and abandonment. This chapter describes what can be done to reverse this trend.

As the majority of grasslands in Europe require active management by humans or sustainable grazing by livestock, butterflies also depend on the continuation of these activities. The main driver behind the decline of grassland butterflies is thought to be changes in rural land use. In some regions, grassland habitats have deteriorated due to agricultural intensification, while in other regions (such as more remote mountain areas) the main problem is land abandonment or afforestation. In both cases, the situation for butterflies is the same as their habitats become less suitable for breeding. When land use is intensified, host plants often disappear or the management becomes unsuitable for larval survival. In the case of abandonment, the grassland quickly becomes tall and rank, and is soon replaced by scrub and eventually woodland.

Natura 2000 network

In the intensively farmed parts of the European Union, the **Natura 2000 network**, as part of the **Habitats Directive (92/43/EEC) and the**

Photo: Örsegg, Hungary, 21 May 2011 © Chris van Swaay

Photo: Small Blue (*Cupido minimus*), Eifel, Germany, 31 May 2008 © Chris van Swaay

Bird Directive (79/409/EEC), is one of the most important tools to prevent further loss of grassland biodiversity. The network should give a positive lead on conservation of the butterfly fauna of grasslands. Of the species listed in the annexes of the Habitats Directive, three species were included as specialist species in the European Grassland Butterfly Indicator. One of them (*Phengaris nausithous,* formerly *Maculinea nausithous*) shows a decline, both in the EU and across Europe. *Phengaris (Maculinea) arion* is declining in Europe, but the trend is uncertain in the EU. For *Euphydryas aurinia* it is uncertain in Europe and declining in the EU. Although there are signs that directed conservation effort can in some circumstances reverse a negative trend for these species (e.g. Wynhoff, 2001; Thomas et al., 2009), it is also clear that small patches supporting specialised species that are not part of a wider metapopulation are very vulnerable to local extinctions. If such sites are isolated from nearby grasslands supporting healthy butterfly populations, there is little chance of re-colonisation from surrounding or nearby patches. This is often the case in an intensified or abandoned landscape. Although the Natura 2000 network is vital to the survival of many species, management must guard against losses due to intensification and abandonment, and this instrument must be seen in the context of the wider landscape.

High Nature Value farmland

Baldock et al. (1993) and Beaufoy et al. (1994) described the general characteristics of low-input farming systems in terms of biodiversity and management practices, and introduced the term **High Nature Value (HNV) farmland.** A first overview of the distribution of HNV farmland in Europe has been produced by Paracchini et al. (2008). Examples of HNV farmland areas are alpine meadows and pasture, steppic areas in eastern and southern Europe, and dehesas and montados in Spain and Portugal. Such areas are vital for the survival of grassland butterflies across Europe and their maintenance provides the best long-term and sustainable solution. This will require the support of small farmers and their traditional way of life over relatively large areas so they do not have to resort to intensification or abandonment as their only options.

The EU Biodiversity Strategy recognises the poor conservation status of grasslands and of their characteristic butterflies. The actions set out in this EU Strategy need urgent implementation. Appropriate management (through sustainable grazing or mowing) is vital both for grasslands designated as Natura 2000 areas and on HNV farmland outside these areas.

A redistribution of the Common Agricultural Policy (CAP) support in favour of HNV farming could be pursued in a number of ways (EEA, 2009). Better targeting towards HNV systems would mean a much stronger reallocation of payments towards low-intensity farming, with a goal of reducing the abandonment of active meadow management. Further discussion of the issues and case studies can be found in Opperman et al. (2012).

Without these changes to the CAP, rural communities that depend on low-intensity farming will continue to decline, cultural landscapes will be lost, and butterflies and other pollinators will disappear. Butterflies belong to the few species groups for which European-wide monitoring is possible. Therefore, butterfly monitoring and the building of indicators on a regular basis should be supported by the EU and its Member States.

Other measures

In some regions of north-western Europe, where intensification is the main driver, grassland butterflies are now almost restricted to (rail)road verges, rocky or wet places, urban areas and nature reserves. For the common and widespread species, verges can be an important habitat, certainly if the management of these areas consists of traditional mowing and hay-making.

Although the management of nature reserves is mostly targeted at achieving a high biodiversity, butterflies still suffer from fragmentation of habitat. When a species disappears from a locality, even if this is due to natural causes, the site often cannot be re-colonised as the nearest population is too far away. There are many examples of such isolated grassland habitats where species have disappeared one by one, leaving an impoverished fauna.

It is clear that, on its own, the Natura 2000 network will not be sufficient to halt the loss of grassland butterflies. Additional measures are needed urgently to encourage butterfly-friendly grassland management across the EU. Abandonment is mostly caused by socio-economic factors, leading to farmers giving up marginal livestock farming and young people moving to cities and other urbanised areas. Often, only older people remain in the villages and, one by one, grasslands become abandoned. In other cases, the landscape does not allow for intensive farming and as farmers feel they cannot make a proper living, they leave the area, abandoning the grasslands. The conservation of grassland butterflies relies on the existence of a viable European countryside, which can provide sustainable livelihoods from grassland farming and maintain rural social fabric, while respecting long-established farming traditions, as prescribed by the geography and landscape. To stop abandonment, farmers in marginal areas need enhanced support and increased public support for agriculture's role in the provision of public goods.

Photo: Small Copper (*Lycaena phlaeas*), Wageningen, Netherlands, 17 April 2011 © Chris van Swaay

8 Developing butterfly monitoring and improving indicator production across Europe

Butterflies are among the few species groups where large-scale, continent-wide monitoring is feasible. We urge the European countries and the EU and its institutions to stimulate butterfly monitoring and secure butterfly indicators.

In this fourth version of the European Grassland Butterfly Indicator, new countries have joined in and thus the geographical scope of the indicator is improving rapidly, especially in the EU (see Map 1.1). This makes butterflies, after birds, the second group for which European trends can be established and used for the evaluation of biodiversity. The bird and butterfly indicators are now used in the indicator 'abundance and diversity of groups of species' (EEA, 2012). This is in fact one of the few 'direct' core biodiversity indicators, as most of the others represent pressures on biodiversity or social responses to biodiversity loss (Levrel et al., 2010).

Although the national and regional BMS are often well founded in the national administration and monitoring results are used for many purposes, this is certainly not the case for all countries as well as for many EU Member States. The basis for butterfly monitoring in countries like Lithuania and Slovenia depends completely on voluntary work without financial or personnel support from their governments. In most other countries in eastern and southern Europe there is no standardised butterfly monitoring at all, despite their richness in butterflies. Information on how to establish a BMS is now available (van Swaay et al., 2012) and it is urgent that schemes are established in these countries, supported by national and regional governments.

This indicator shows that there are huge changes in butterfly diversity on European grasslands. It is therefore recommended that butterflies are incorporated into EU policy and monitored through changes with this indicator. The indicator gives a deeper insight into the well-being of not only butterflies, but also other insects and small animals.

Given the evidence of declines, it is crucial to act swiftly to integrate biodiversity concerns into sectoral policies and invest more in habitat protection, restoration and recreation, where feasible. If existing trends in land management continue, there will inevitably be further declines in butterfly numbers, which in time will be catastrophic for the whole food chain that depends on invertebrates. EU heads of government recently committed themselves to avoiding such consequences and stressed the need to integrate biodiversity concerns into all EU and national sectoral policies, in order to reverse the continuing trends of biodiversity loss and ecosystem degradation.

The European Grassland Butterfly Indicator is currently produced on an ad-hoc basis, which hampers further improvements in indicator quality. However, in every updated version of the European Grassland Butterfly Indicator, new countries join in and more 'old' data become available. Furthermore, the time series that can be used become longer, resulting in more robust trends and smaller standard errors. The enlargement of the number of transects and countries, as well as our knowledge, greatly improves the quality of the indicator. This is also illustrated by the development of European bird indicator (EBCC, 2013). Adding butterfly indicators to the monitoring and indicator programmes at the national and EU levels on a permanent basis would also add the important group of insects to the structural indicators of biodiversity.

For a more elaborate discussion on further improving the indicator, please check Annex 3.

9 Conclusions

- This report gives an update on the indicator for grassland butterflies, which gives the trend of a selection of butterflies characteristic of European grasslands.
- The indicator is based on national Butterfly Monitoring Schemes from across Europe, most of them members of the European Union (see Map 1.1).
- The results show that the index of grassland butterfly abundance has declined by almost 50 % since 1990, indicating a dramatic loss of grassland biodiversity. Since some of the monitoring schemes are biased towards natural and species-rich areas, this trend is probably an underestimate.
- In north-western Europe, intensification of farming is the most important threat to grassland butterflies. CAP funding in support of sustainable farming of HNV areas is vital to halt further losses and support recovery.
- The completion of the Natura 2000 network across Europe is an important way to maintain butterfly populations across Europe. In addition, restoration or recreation of mosaics of habitats at a landscape scale are needed.
- In many parts of the rest of Europe, abandonment is the key factor in the decline of numbers of grassland butterflies. To stop abandonment, farmers in marginal areas need enhanced support and increased public support for agriculture's role in the provision of public goods.
- The European Grassland Butterfly Indicator has the potential to become one of the headline indicators for biodiversity in Europe. It could also be used as a measure of the success of agriculture policies. Sustainable funding of this and other butterfly indicators can guarantee the development of more robust indices and their extension to other habitats. This would assist the validation and reform of a range of sectoral policies and help achieve the goal set by European heads of government to halt biodiversity losses and by 2020 restore, insofar as it is feasible, biodiversity and ecosystem services.

Photo: Örsegg, Hungary, 25 May 2011 © Chris van Swaay

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Annex 1 Butterfly Monitoring Schemes in the indicator

Since the start of the first BMS in the United Kingdom in 1976, more and more countries have joined in. This annex summarises the most important features of the schemes used for the European Grassland Butterfly Indicator.

Field methods

All schemes apply the method developed for the British BMS (Pollard and Yates, 1993). The counts are conducted along fixed transects of 0.5 to 3 km, consisting of smaller sections, each with a homogeneous habitat type; however, the exact transect length varies among countries. The fieldworkers record all butterflies 2.5 m to their right, 2.5 m to their left, 5 m ahead of them and 5 m above them (van Swaay et al., 2012). Butterfly counts are conducted between March–April and September–October, depending on the region. Visits are only conducted when weather conditions meet specified criteria. The number of visits varies from 30 in Catalonia to 3–5 visits annually in France (Table A1.1).

Transect selection

To be able to draw proper inferences on the temporal population trends at national or regional level, transects should best be selected in a grid, random or stratified random manner (Sutherland, 2006). Several recent schemes, for example, in France and Switzerland, have been designed in this manner (Henry et al., 2005). If a scheme aims to monitor rare species, scheme coordinators preferably locate transects in areas where rare species occur, leading to an overrepresentation of special protected areas. In the older schemes, such as in the Netherlands and the United Kingdom, but also in the recently established scheme in Germany, transects were selected by free choice of observers, which in some cases has led to the overrepresentation of protected sites in natural areas and the undersampling of the wider countryside and urban areas (Pollard and Yates, 1993). In Germany this effect was not that pronounced (Kühn et al., 2008). Obviously, in such a case the trends detected may only be representative for the areas sampled, while their extrapolation to national trends may produce biased results. Such bias can however be minimised by post-stratification of transects. This implies an *a posteriori* division of transects by, for example, habitat type, protection status and region, where counts per transect are weighted according to their stratum (van Swaay et al., 2002).

Species set

The grassland indicator is based on 7 widespread grassland species (*Ochlodes sylvanus, Anthocharis cardamines, Lycaena phlaeas, Polyommatus icarus, Lasiommata megera, Coenonympha pamphilus and Maniola jurtina*) and 10 grassland-specialists (*Erynnis tages, Thymelicus acteon, Spialia sertorius, Cupido minimus, Phengaris arion, Phengaris nausithous, Polyommatus bellargus, Cyaniris semiargus, Polyommatus coridon and Euphydryas aurinia*). See also Figure 2.1.

Table A1.1 Characteristics of the Butterfly Monitoring Schemes used for the European Grassland Butterfly Indicator

Country	Starting year	Area represented (c = country, r = region)	Average transect length (km)	Number of transects per year 2009–2011 (average or range)	Number of counts on a transect per year (average or range)	Counts by (v = volunteers, p = professionals)	Method to choose sites	Representative for agricultural grassland *	Nature reserves overrepresented *
Andorra	2004	c	1.5	6	20–30	v	Free	Yes	No
Belgium — Flanders	1991	r	0.8	10	15–20	v	Free	No	No
Estonia	2004	c	1.8	11	7	p	By co-ordinator	No	No
Finland	1999	c	3	65–67	ca 11	v ~ 70 %, p ~ 30 %	Free for volunteers	Yes	No
France	2005	c	1	611–723	4.4 (1–15)	v	Half random, half free	Yes	No
France — Doubs	2001–2004	r	1	0	10–15	p	By co-ordinator	Yes	No
Germany	2005	c	0.5	400	15–20	v	Free	Yes	Yes
Germany — Nordrhein Westfalen	2001	r	1	0	15–20	v	Free	No	Yes
Germany — Pfalz (Phengaris nausithous only)	1989	r	0.5	50–87	1	p	By co-ordinator	Yes	No
Ireland	2007	c	1.5	190	16.3	v	Free	Yes	No
Jersey	2004	c	1	0	15–25	v	Free	Yes	No
Lithuania	2009	c	1.3	14	6–9	v	Free	No	No
Luxemburg	2010	c	0.34	30	8.2 (3–11)	v ~ 10 %, p ~ 90 %	Random	Yes	No
Norway	2009	r	1	9–18	3	v ~ 42 %, p ~ 58 %	Grid	Yes	No
Portugal	1998–2006	c	1	0	3–5	v	Free	No	No
Romania	Starting up								
russia — Bryansk area	2009	r	1.2	2–14	3–5	v ~ 90 %, p ~ 10 %	Free	Yes	No
Slovenia	2007	c	1.3	9–14	6.25– 7.53	v	By co-ordinator	Yes	No
Spain — Catalonia	1994	r	1	60–70	30	v	Free	Yes	No
Sweden	2010	c	0.65	90	4	v	Free	Yes	No
Switzerland	2003	c	2 x 2.5	90–95	7 (4 alpine region)	p	Grid	Yes	No
Switzerland — Aargau	1998	r	2 x 0.250	101–107	10	p (civil service)	Grid	Yes	No
The Netherlands	1990	c	0.7	430	17 (15–20)	v	Free	Yes	No
Ukraine — Carpathians and adjacent parts	1990	r	1	158	5 (2–10)	p	Free	Yes	Yes
United Kingdom	1973 (1976)	c	2.7	819–977	19	v	Free	Yes	Yes

Note: * Assessed by experts. In case a monitoring scheme is not representative for agricultural grasslands and/or nature reserves are overrepresented, it means that the resulting trends may be biased towards non-agricultural areas (often nature reserves), where management is focusing on the conservation of biodiversity. Such a scheme probably underestimates the (mostly negative) trend of butterflies in the wider countryside.

Annex 2 Method

We used the following procedure to compute the grassland indicator.

- The national coordinators of monitoring schemes provided their count data. More specifically, we received yearly counts per site per year for which the results of various visits were aggregated. We used this to calculate **national indices** for each species for which monitoring data were available. The indices were produced using Poisson regression as implemented in the widely used programme TRIM (Pannekoek and van Strien, 2003). In addition to indices, TRIM calculates overall slopes for the entire time series available or selected parts of the time series, such as from 1990 onwards.

- The national indices were checked on reliability and magnitude of confidence intervals. Indices were not used if the time series were very short, based on few sites or observations only, or if standard errors of the overall slopes were extremely large (> 0.5).

- To generate **supranational indices**, the differences in national population size of each species in each country were taken into account. This weighting allows for the fact that different countries hold different proportions of a species' European population (Gregory et al., 2005). But we applied area weighting rather than population weighting, as in Gregory et al. (2005), because no national population estimates for butterflies are available. This implies that we treated as weights the proportions of each country (or part of the country) in the European distribution of a species (based on van Swaay and Warren, 1999 and adapted according to van Swaay et al., 2010a). The missing year totals in particular countries with short time series were estimated by TRIM in a way equivalent to imputing missing counts for particular transects within countries (Gregory et al., 2005). Missing yearly indices of a particular country (national all-sites totals) are imputed from data of other countries in TRIM. The assumption behind this approach is that butterfly species are expected to have had similar changes in population numbers, which is indeed confirmed by the national trends in the countries where available. This may not be true in all cases, but we regard it a better approximation of missing indices than alternatives.

- In this updated indicator, we also took into account differences in the number of visits and transect lengths between schemes. Three different types of data were received from the national coordinators: (i) the average yearly number across all visits per site; (ii) the yearly sum of the number of individuals seen during all visits as well as the associated number of visits for each site; and (iii) the yearly sum of the number of individuals seen during all visits but without exact information on the number of visits per site. The second data type was made equivalent to the first data type by applying 1/number of visits for each site as weights in the calculation of *national* indices. The third data type was made equivalent by applying weights in the calculation of *supranational* indices. These latter weights were based on the estimated average number of visits and the number of generations covered. Differences in transect length were also included in the weights in the calculation of supranational indices. The weights to account for the different number of visits and transect lengths were then combined with the area weights.

- Species indices were combined in a **grassland indicator** by taking the geometric mean of the supranational indices.

- Few species had missing indices for some years at the supranational level. These were estimated using a chain index before calculating the indicator.

- Results of supranational indices per species were checked on consistency with national indices and results in van Swaay et al. (2010b). Supranational indicators were compared with national indicators to test if the supranational indicators were mainly based on the results of one or a few countries only. This was not the case.

- Because of a small rise of the index of some species in 2010 and 2011, the trend of the indicator over the period 1990–2011 shows a smaller decline than the previous indicator (van Swaay et al., 2010b).

- Trend classification: the multiplicative overall slope estimate (trend value) in TRIM (Pannekoek and van Strien, 2003) is used to classify the trend (Tables 3.1 and 3.2):

  – decline: significant decline where the upper limit of the confidence interval < 1.00. A moderate increase or decline means a significant change of less than 5 % per year since 1990; in a steep decrease or decline this is more than 5 %;

  – stable: no significant increase or decline, and it is certain that the trends are less than 5 % per year;

  – uncertain: no significant increase or decline, lower limit of confidence interval < 0.95 or upper limit > 1.05.

Potential biases

Although the BMS are very similar, there are differences in choice of location, number of counts, corrections for unstratified sampling and other aspects. These are summarised in Annex 1. These changes can potentially lead to biases. It is also important to note that in countries where the choice of location for the transect is free (Table A1.1), there is an oversampling in species-rich sites, nature reserves or regions with a higher butterfly recorder density. The trend of butterflies within nature reserves may be expected to be better than in the wider countryside, since the management of these reserves focuses on reaching a high biodiversity and positive population trends. This suggests that the grassland indicator is probably a conservative measure of the real trend across the European landscape. There is a risk that the decline in the population size of butterflies is actually more severe than the indicator shows. We hope to be able to test this in the future.

Questions and answers to the method

Our method follows closely the one for the Pan-European Common Bird Monitoring Scheme (PECBMS). They have compiled a list with questions and answers that apply to this European Grassland Butterfly Indicator as well. They can be found at http://www.ebcc.info/index.php?ID=441 online.

Annex 3 Improving the indicator and building other butterfly indicators

This report presents the fourth version of the European Grassland Butterfly Indicator. In this section we indicate important ways to further improve the quality of the indicator and possibilities for new indicators.

Like the previous versions, this European Grassland Butterfly Indicator was produced on an ad hoc basis. Although this generates a useful indicator, there are many procedures that could be improved if more structural funding becomes available. Many of these would lead to the same improvements that the bird indicators have undergone. Some of these are highlighted here.

- Full and standardised quality control. Although all controls have now been made on an ad hoc basis, this is relatively time consuming and offers the possibility that controls are forgotten or misinterpreted. We would prefer to build a solid database in which all possible controls and assessments could be standardised and performed on demand. These controls should also include checks for all existing combinations of species and country, and a comparison with earlier assessments of species trends per country. This involves a long-term investment, although it will be cheaper in the long run.

- As described in Annex 2, national data are weighted to build supranational trends. Besides a correction for the part of the European distribution, corrections are performed for the average length of a transect (if transects in one country are much longer than in others, the numbers have to be down-weighted), the number of counts (if much more counts are made in one country, the numbers have to be down-weighted) and the number of generations — if the species has more than one generation per year — (if the numbers of two or three generations are added, they have to be down-weighted to compare them with a country where only the data of one generation are given). It would be good to standardise the input as much as possible and to perform the weighting as much as possible per species (now often per country). This can be built into a database as a long-term investment.

- If the data needed to build the indicator were collected from the national coordinators in a more standardised way every year (i.e. not on an ad hoc basis), the preparation of new indicators could be much more flexible. There is already good evidence that butterflies are very suitable for producing a European Butterfly Climate Change Indicator (van Swaay et al., 2008). It would also be possible to produce valuable indicators of other habitats, including a woodland, heathland and wetland indicator.

Smaller improvements that could be done on shorter notice:

- select the analysis to grassland habitats only;

- add an analysis of agricultural grasslands only.

European Environment Agency

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