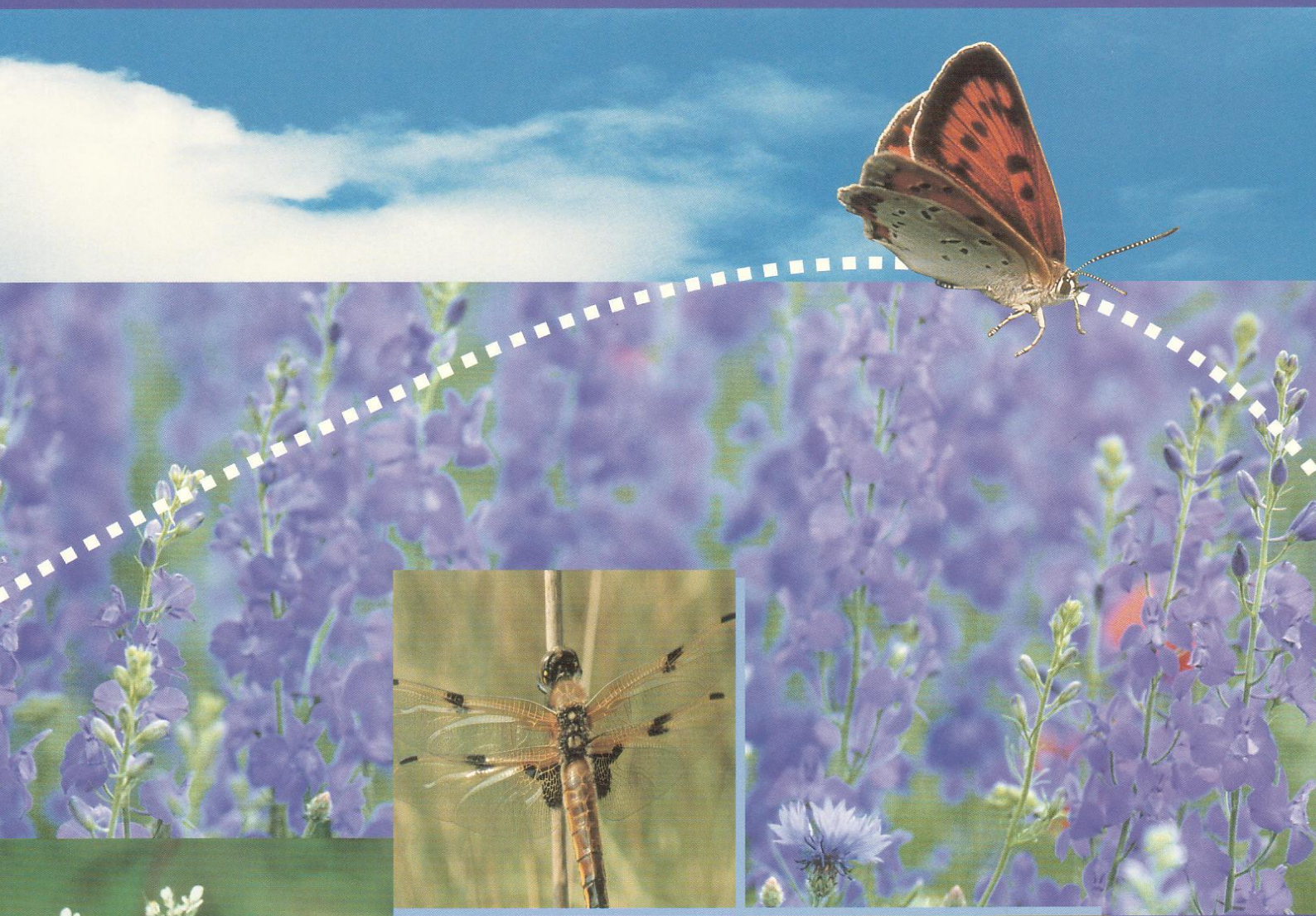
De Vlinderstichting

The European Butterfly Indicator for Grassland species: 1990-2009



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Butterfly Conservation Europe

The European Butterfly Indicator for Grassland species 1990-2009

Acknowledgements

Special thanks goes to all the volunteers for their data collection. They are vital in producing overviews and indicators on the state of Europe's butterflies.

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Commissioner

European Environment Agency

This study/report was funded by and is the property of the European Environment Agency (EEA). The opinions expressed therein are those of the Contractor only and do not represent the Agency's official position.

Production

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Statistics Netherlands, www.cbs.nl

Preferred citation

Van Swaay, C.A.M., Van Strien, A.J., Harpke, A., Fontaine, B., Stefanescu, C., Roy, D., Maes, D., Kühn, E., Õunap, E., Regan, E., Švitra, G., Heliölä, J., Settele, J., Warren, M.S., Plattner, M., Kuussaari, M., Cornish, N., Garcia Pereira, P., Leopold, P., Feldmann, R., Jullard, R., Verovnik, R., Popov, S., Brereton, T., Gmelig Meyling, A., Collins, S. (2010). *The European Butterfly Indicator for Grassland species 1990-2009.* Report VS2010.010, De Vlinderstichting, Wageningen

Keywords:

Butterfly, Monitoring, Trend, Index, Europe, European Union, Indicator, Biodiversity

May 2010

The Mazarine Blue (*Cyaniris semiargus*) is a typical butterfly of semi-natural grasslands.

Photo: Chris van Swaay

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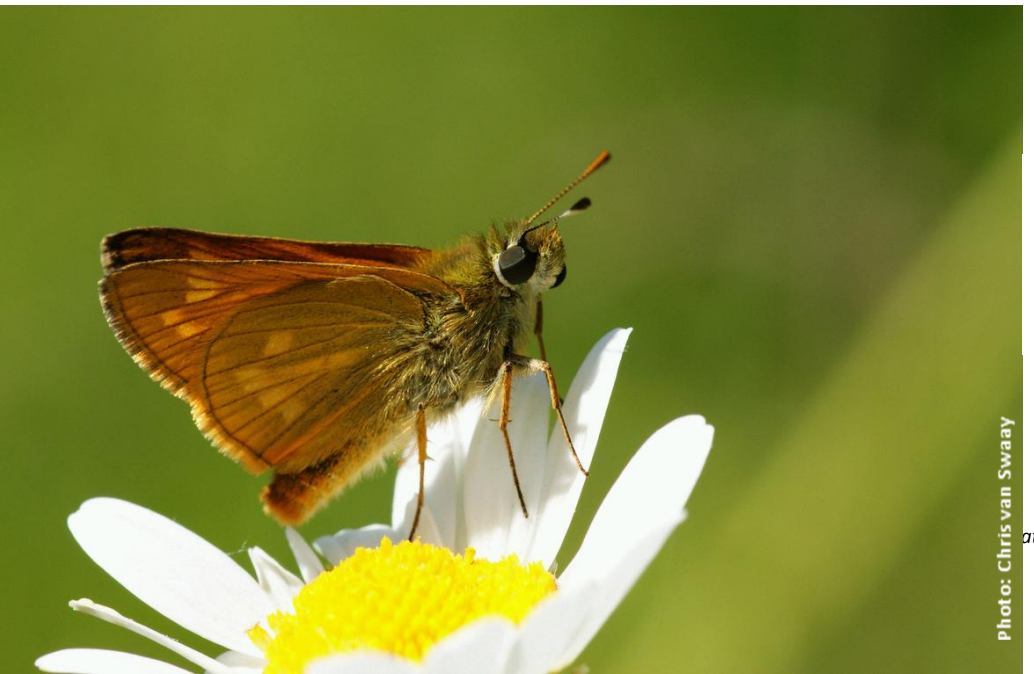
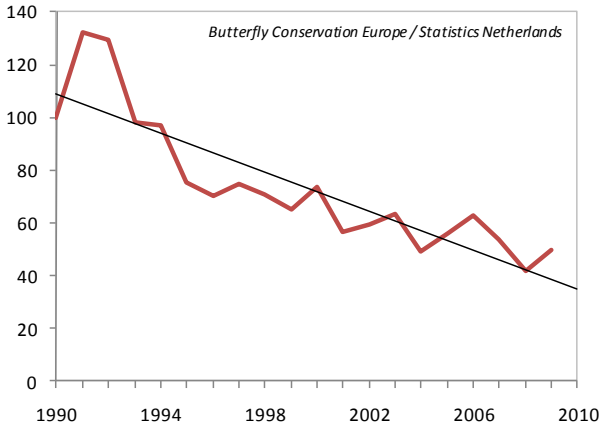


The Large Skipper (Ochlodes sylvanus) *is a widespread and common butterfly in most of Europe.*

Summary

- This report presents the third version of the European Grassland Butterfly Indicator, one of the indicators for biodiversity in the SEBI2010 (Streamlining European 2010 Biodiversity Indicators), a pan-European initiative led by the European Environment Agency.
- The indicator is based on national Butterfly Monitoring Schemes in fifteen countries from all over Europe, most of them active in the European Union
- The indicator shows that since 1990, butterfly populations have declined by almost 70%, indicating a dramatic loss of grassland biodiversity. This also means the situation has not improved since the previous version of the indicator.
- Of the seventeen species, ten have declined in Europe and two have remained stable. For five 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, abandonment in mountains and wet areas, mainly in Eastern and Southern Europe.
- Agricultural intensification leads to uniform, almost sterile grasslands, where the management is so intensive that grassland butterflies can only survive in traditional farmed low input systems (High Nature Value Farmland) as well as nature reserves, and marginal land such as road verges and amenity areas.
- Abandonment is caused by socio-economic factors. When farming of low productivity land brings low incomes, young farmers leave their villages and the land is left unmanaged. The grassland quickly becomes tall and rank and is soon replaced by scrub and woodland.
- The implementation of the Natura 2000 areas will be most beneficial in the intensified parts of Europe, especially North-west Europe, whereas the support of High Nature Value farmland is vital to stop abandonment, especially in Eastern and Southern Europe.
- 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 endorsed by the EU and its member states.
- Butterflies offer the possibility to be used as a structural headline indicator, not only for grasslands, but also for other habitats and pressures such as climate change.



The European Grassland Butterfly Indicator *shows a dramatic decline of almost 70%.*

Chapter 1 / Introduction

This is the third version of the European Grassland Butterfly Indicator. It is based on the population trends of seventeen butterfly species in fifteen countries. As more and more countries develop robust monitoring schemes, the relevance of butterflies as European biodiversity indicators grows.

The European Union and its member states are committed to halting the loss of biodiversity across Europe by 2010. This is complemented by a target to significantly reduce the global rate of biodiversity loss by 2010. These targets are accompanied by a growing consensus on the need for structured European coordination of biodiversity monitoring, indicators, assessment and reporting efforts, with a long-term perspective and a sound funding basis.

In this report we give an overview of the trends of seventeen grassland butterflies in Europe and the European Union. Furthermore these trends are combined to produce a European Grassland Butterfly Indicator. This indicator is one of the 26 headline indicators for inclusion in the set of European biodiversity indicators (European Environment Agency, 2007), and will be used in the 2010 Assessment Report on Biodiversity in the pan-European region.

The Small Blue *(*Cupido minimus*) is indeed one of the smallest European butterflies. It's a specialist species of calcareous grasslands.*

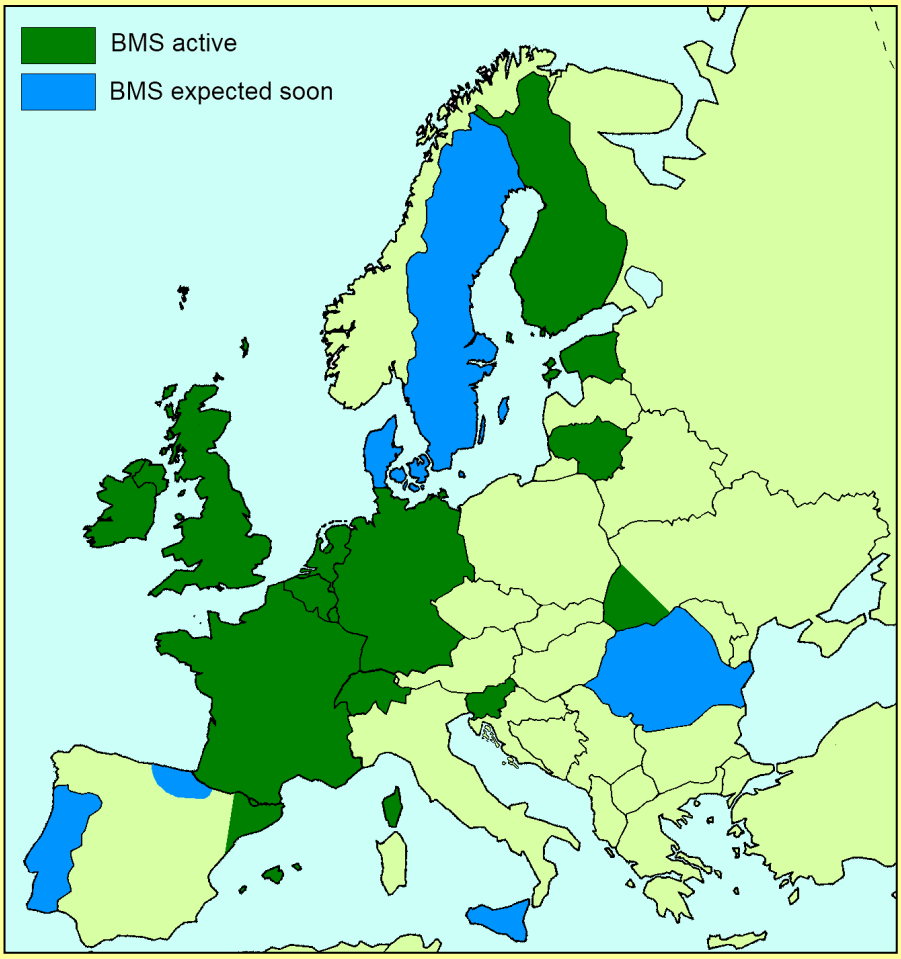
Butterfly monitoring enjoys a growing popularity in Europe. Map 1 shows the current Butterfly Monitoring Schemes (BMS) and the countries where they are expected soon. Although Butterfly Monitoring Schemes are present in a growing number of countries and new ones are being initiated in many places, long time-series are only available for a limited number of countries. For this new indicator data were used from 15 countries: Belgium, Estonia, Finland, France, Germany, Ireland, Lithuania, Jersey, Portugal, Slovenia, Spain, Switzerland, The Netherlands, Ukraine and the United Kingdom. Andorra is included in the Catalonian (Spanish) scheme.

In this report we update the European Grassland Butterfly Indicator, first published by Van Swaay & Van Strien in 2005. The updated indicator not only has a longer time-series, with data from the 2005-2009 field seasons now included, but also the method of calculating the indicator has been improved and enhanced. Furthermore three new countries have been added.

The method closely follows the one for the bird indicators (Gregory *et al*., 2005).

***Map 1: Countries contributing their data to the European Grassland Butterfly Indicator**:*
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 P. nausithous since 1989)
Ireland: since 2007
Lithuania: since 2009
Jersey: since 2004
Portugal:1998-2006
Slovenia: since 2007
Spain (Catalonia, including Andorra): since 1994
Switzerland (Aargau): since 1998
The Netherlands: since 1990
Ukraine (Transcarpathia): since 1990
United Kingdom: since 1976

In 2009 more than 3000 transects were counted.



Chapter 2 / Building the European Grassland Butterfly Indicator

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

Fieldwork

The Butterfly Indicator is based on the fieldwork of thousands of trained professional and volunteer recorders, counting butterflies on more than 3000 transects scattered widely across Europe (see map 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 I.

Butterflies are recorded along transects. Most of these counts are done by volunteers, who are vital to the Butterfly Monitoring Schemes and to produce the indicator.

Grassland butterflies

The same selection of grassland butterflies was used as in the previous two versions of this indicator. European butterfly experts selected species they considered to be characteristic of European grassland and which occurred in a large part of Europe, covered by the majority of the Butterfly Monitoring Schemes and having grasslands as their main habitat (Van Swaay *et al.*, 2006). The species are listed in figure 1.

Widespread Grassland butterflies

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

Specialist Grassland Butterflies

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

Figure 1: *Seventeen butterflies were used to build The European Grassland Butterfly Indicator, comprising seven widespread and ten specialist species.*

Population trend

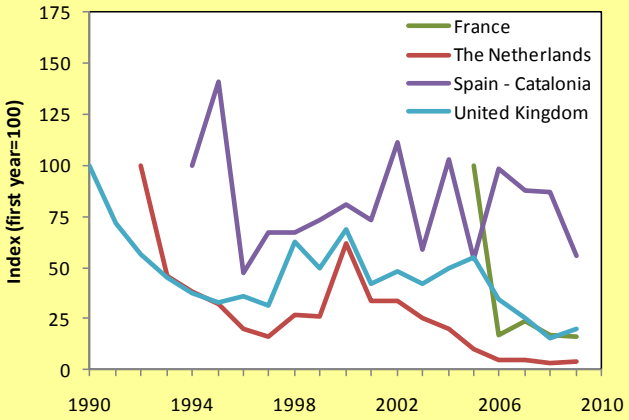
National population trends from the Butterfly Monitoring Schemes (map 1), calculated by the program TRIM (Pannekoek & Van Strien, 2003) are combined to form supra-national species trends (chapter 3). These trends per butterfly species are then combined into an indicator: a unified measure of biodiversity 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 report of the previous indicator (Van Swaay & Van Strien, 2008). Although the Butterfly Monitoring Schemes are very similar, there are differences in choice of location, number of counts, etc. These are summarised in Annex 1.

Chapter 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 2 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 (figure 2). The results show that this butterfly declined in the 1990s, had a few better years around 2000, but declined again since then. Table 1 shows the trend for the 17 individual species of the indicator, both in the EU and in Europe as a whole. In Europe ten species are declining and two are stable. The trend for the remaining species is uncertain. In the EU, eight species show a decline and five are stable. For four species the trend is uncertain. No species show a significant increase.



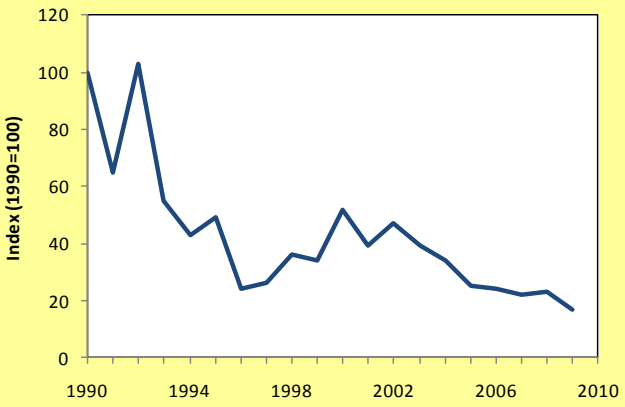


***Figure 2: National and European trends for the Wall Brown* (Lasiommata megera).**
The upper graph shows the trend for four selected Butterfly Monitoring Schemes. Note that the starting year (see also map 1) for each scheme is different. All indexes are set to 100 for the first year of a scheme.
The lower graph shows the European trend, resulting from the four Butterfly Monitoring Schemes in the upper graph plus nine other countries.

Table 1: Supra-national trends of the 17 butterfly species of the European Grassland Butterfly Indicator. For the trend classification see annex II.

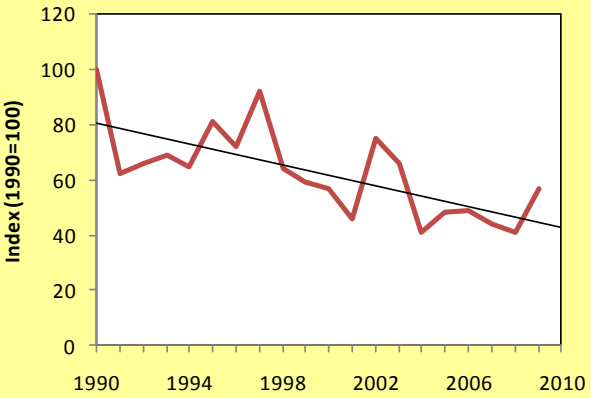
Species	Trend in Europe	Trend in EU
Phengaris nausithous	decline	decline
Erynnis tages	decline	decline
Lasiommata megera	decline	decline
Lycaena phlaeas	decline	decline
Thymelicus acteon	decline	decline
Ochlodes sylvanus	decline	decline
Coenonympha pamphilus	decline	decline
Cupido minimus	decline	decline
Anthocharis cardamines	decline	stable
Polyommatus icarus	decline	stable
Maniola jurtina	stable	stable
Polyommatus coridon	stable	stable
Cyaniris semiargus	uncertain	stable
Polyommatus bellargus	uncertain	uncertain
Spialia sertorius	uncertain	uncertain
Euphydryas aurinia	uncertain	uncertain
Phengaris arion	uncertain	uncertain

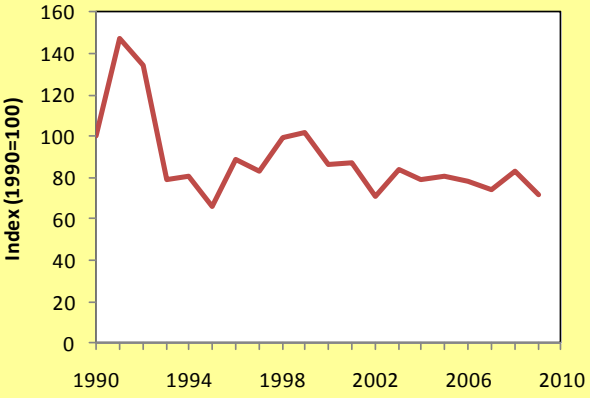
When interpreting the species trends it is important to realise that:

- 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 map 1). As more countries join in later, 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 half of the EU countries, and even more non-EU countries, there is no Butterfly Monitoring Scheme yet. The trends shown only represent the countries in map 1. However, because they are based on a wide range of countries, we believe that they are reasonably representative of Europe as a whole.

Figure 3 shows some examples of European Butterfly trends:

- The Dingy Skipper (*Erynnis tages*), a brown butterfly with a preference for nutrient poor, often dry grasslands.
- The Meadow Brown (*Maniola jurtina*), a widespread and in many countries very common and abundant butterfly, occurring on all kinds of grasslands.
- The Marsh Fritillary (*Euphydryas aurinia*), a specialist species of both wet meadows and calcareous grasslands.





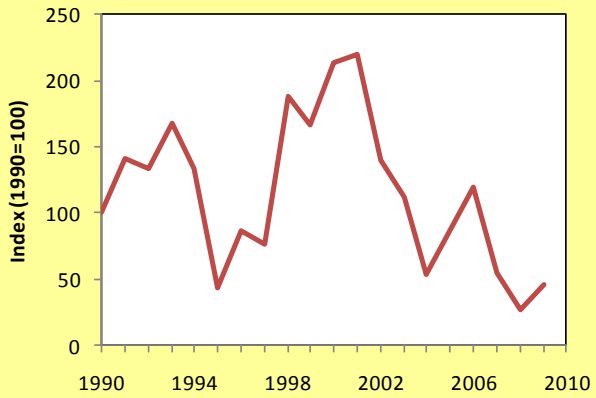


Figure 3: European trends of three butterflies in Europe.
*Top: The Dingy Skipper (*Erynnis tages*) shows a significant decline, in spite of year to year fluctuations.*
*Middle: The Meadow Brown (*Maniola jurtina*) is considered stable, in spite of a short term peak in 1991 and 1992.*
*Bottom: Large fluctuations make the trend of the Marsh Fritillary (*Euphydryas aurinia*) uncertain.*

Chapter 4 / The indicator

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

Figure 4 shows the European Grassland Butterfly Indicator, as well as the indicator for the countries of the EU alone. The indicator is based on the supra-national species trends as presented in chapter 3. As in previous versions, both indicators showed a marked decline between 1990 and 2009. Compared to 1990, the European populations of the 17 indicator species have declined by, on average, almost 70%. Although the decline seems to have slowed a little in the last few years, it has not stopped. So far 2008 was the worst year for these butterflies, both on a European and EU scale. The negative trend in the EU countries alone is a little less than in Europe as a whole, with a decline of almost 60% over the period . As discussed in the new Red List of European Butterflies (Van Swaay *et al*., 2010), this might be due to the fact that the large decline of butterflies in NW Europe (countries all already in the EU for a long time) happened before 1990.

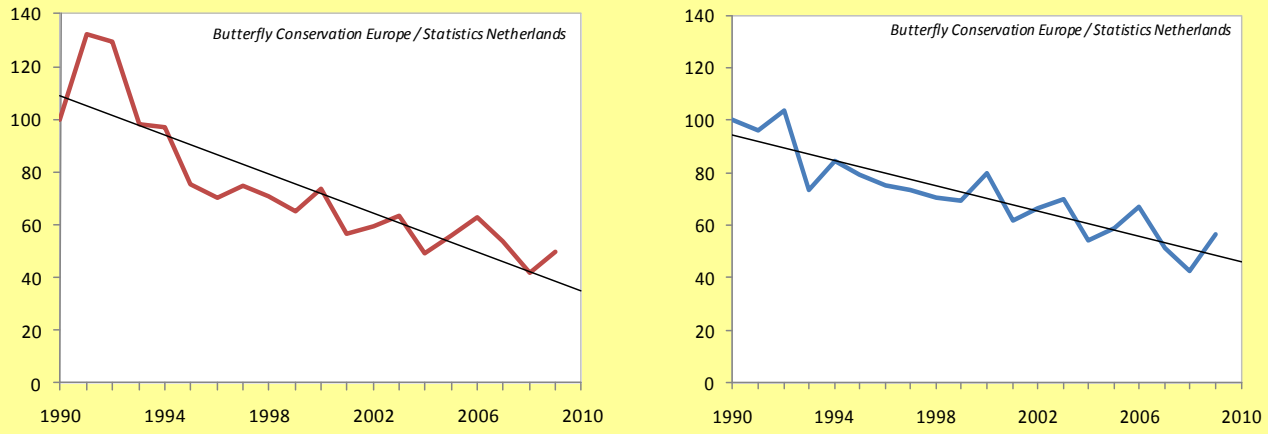


Figure 4: The Grassland Butterfly Indicators for Europe (left) and the EU (right).
The indicators are based on the countries in map 1 and characteristic grassland butterfly species in figure 1. Both indicators show a marked decline of the population sizes of the 17 species.

Chapter 5 / Drivers behind the changes in grassland butterflies

Grassland butterflies have undergone a huge overall decrease in numbers. Their populations declined by almost 70% from 1990 to 2009. Although the causes for the decline are different for each species and country, the two main drivers are agricultural intensification and abandonment.

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%) occur 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. The most species-rich biotopes in Europe are dry grasslands: dry calcareous grasslands and steppes (274 butterfly species), alpine and subalpine grasslands (261), mesophile grasslands (223) and dry siliceous grasslands (220 species) (Van Swaay *et al*., 2006).

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 wellbeing.

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.

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 North-western Europe, farming has intensified rapidly and over the last fifty 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 development towards intensification, especially on relatively flat and nutrient rich places. In contrast, steeper and less productive areas have tended to become abandoned. The effects of intensification and abandonment on traditional grassland are:

- **Intensification**
  Intensification comprises a wide range of activities, including the conversion of unimproved grasslands to arable crops, heavy use of fertilisers, drainage, the use of herbicides, insecticides and pesticides, enlargement of fields, and the use of heavy machines. In its most extreme form (e.g. in the Netherlands and Flanders, Maes & Van Dyck, 2001) the remaining agricultural land is virtually sterile with almost no butterflies. In such situations, butterflies can survive only on road verges, in remaining nature reserves and urban areas. In these countries the biggest loss of butterflies probably occurred before the start of the Butterfly Monitoring Schemes in the 1980s and 1990s. As a result butterfly populations in these areas are at a low level and are vulnerable to further losses of sustainably managed grassland or fragmentation.

- **Abandonment**
  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 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. At the end scrubland and forest remains only, leaving no room for grassland butterflies.

Intensification and abandonment are the main drivers for the decline of grassland butterflies in Europe.
Left: intensification leads to sterile grasslands, where there is no room for butterflies. Right: after abandonment butterflies can flourish for a few years before scrubs and trees invade and the grassland also become unsuitable for grassland butterflies.

Apart from intensification and abandonment fragmentation and climate change have an impact on grassland butterflies. *In some regions habitats have been destroyed by urbanisation.*

Intensification is the most important threat to butterflies on the relatively flat areas of the 'old-EU', ranging from the eastern half of the UK over the north of France, Belgium, Netherlands, Northern Germany and Denmark, as well as in flat areas in the other parts of Europe. This trend may soon extend into parts of Poland as well. In contrast, abandonment and lack of sustainable grazing is the chief threat in Southern and Eastern Europe, where the land is often mountainous or rocky and the soils relatively poor.

In addition to these two main drivers, there are other threats to grassland butterflies in Europe, including fragmentation 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 but also makes it more difficult for butterflies to re-colonise if they become locally extinct.

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.

This Purple-edged Copper (*Lycaena hippothoe*) is another wet-grassland butterfly that has declined following intensification in Western Europe.

Photo: Chris van Swaay

Chapter 6 / Implications

The European Grassland Butterfly Indicator shows that butterfly numbers on grasslands have decreased by almost 70%. What can we do to stop further decline, and how can we get these beautiful insects back to Europe's meadows?

What does the European Grassland Butterfly Indicator tell us?

The European Grassland Butterfly Indicator shows a strong negative trend (figure 4). **The indicator shows that since 1990 butterfly populations have declined by almost 70%.** Thus the trend identified in the first two versions of this indicator in 2005 and 2008 has not stopped, but has continued (Van Swaay & Van Strien, 2005, 2008). This shows that butterflies are still disappearing from Europe's grasslands at an alarming rate.

This huge decline has important implications to the conservation of biodiversity because butterflies are considered to be representative indicators of trends observed in 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 to the EU target of halting biodiversity loss by 2010.

Butterflies appeal both to the general public and decision-makers (Kühn *et al*., 2008). They are also fairly easy to recognize 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 & Yates, 1993; Van Swaay *et al*., 2008). 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).

The Common Blue (*Polyommatus icarus*) is still a widespread and common grassland butterfly in most of Europe. It shows however a significant decrease.

Photo: Chris van Swaay

The Small Heath (*Coenonympha pamphilus*) is a inconspicuous butterfly of grasslands throughout Europe. It is declining in the EU and Europe.

Photo: Chris van Swaay

Can the trend be reversed?

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. 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.

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 consist 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 by 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.

Photo: Chris van Swaay

In urban areas traditional lawn management can be changed to a traditional hay making regime.
Where the right side of this lawn is managed by weekly mowing, the left side is now full of flowers and rich in insects and butterflies. Places like this are easy and cheap to create, and can form a safe-haven for many widespread grassland butterflies, like the Common Blue and Small Heath, thus preventing their further decline.

This photo shows the two main causes for the decline of grassland butterflies: intensification and abandonment. *The dark green flat area in the foreground is now under intense agricultural use and unsuitable for butterflies. In the hills in the background the small semi-natural grasslands are abandoned and slowly turn into forest. Grassland butterflies are declining here at an alarming rate. So although this area is still rich in grassland butterflies, it can be expected that many species will disappear within the next years.*

In order to achieve recovery it is urgent to stop the loss in semi-natural grassland extent and quality to sustain remaining butterfly populations and provide a reservoir for re-colonisation in adjacent areas of restored habitat.

In the intensively farmed parts of the European Union, the completion of the Natura 2000 network, as part of the **Habitats (92/43/EEC) and Species (79/409/EEC) Directive,** is one of the most important tools to prevent further loss of grassland biodiversity. The network could give could give a positive lead on the conservation of the butterfly fauna of grasslands. Of the species listed in the Annexes of the 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 European Union and across Europe. The trend of *Phengaris (Maculinea) arion* and *Euphydryas aurinia* is uncertain. Although there are signs that directed conservation effort can in some circumstances reverse a negative trend for these species (e.g. Wynhoff, 2001), 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 recolonisation 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.

After abandonment scrubs and trees invade the grasslands, leaving no room for grassland butterflies.

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 thus requires the creation of a viable European countryside where people can obtain sustainable livelihoods from grassland farming. To stop abandonment, we need to give farmers with High Nature Value farmland much better support and give young farmers in these areas a future, while at the same time respecting long established farming traditions, as prescribed by the geography and landscape.

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 **HNV farmland (High Nature Value farmland).** A first overview of the distribution of HNV farmland in Europe has been produced by Paracchini *et al*. (2008). Examples of high nature value 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.

This will only be possible if there is a redirection of some Common Agriculture Policy funding into a new scheme to support such sustainable management and livelihoods in HNV areas.

Butterflies as indicators

This indicator shows that there are huge changes in butterfly diversity on European grasslands. Incorporating butterflies in EU policy, as described above, and monitoring the changes with this indicator, is an important next step. We urge the European Union to use the possibilities of butterflies as indicators (not only for grasslands, but also for other habitats), as it makes a very good (and cheap) addition to the existing bird indicators. Furthermore it gives a deeper insight in the well being of not only butterflies, but also other insects and small animals.

Given the evidence of declines, we urge decision makers to act swiftly to integrate biodiversity concerns into sectoral policies and invest more in habitat protection, restoration and recreation, where feasible. The consequences of continuing existing trends in land management will result in further declines which in time will be catastrophic for the whole food chain which depends on invertebrates. EU Heads of Government recently committed themselves to avoiding such consequences and the time to act is now.

Butterflies are excellent indicators for biodiversity. *Male of the Small Copper (*Lycaena phlaeas*), one of the species of the Grassland Butterfly Indicator.*

Chapter 7 / How to continue with monitoring and indicator production?

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

In this third 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. This makes butterflies, after birds, the first group for which European trends can be established and used for the evaluation of biodiversity. From the headline indicators which have been proposed by the European Environment Agency (2007), the bird and butterfly indicators are used in the indicator 'abundance and diversity of groups of species'. 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).

The Chalkhill Blue (*Polyommatus coridon*) is one of the indicator species of the European Grassland Butterfly Indicator.

Although this is already the third version of the Grassland Butterfly Indicator, we are still in the building phase. The construction of ad-hoc indicators, as this and the two previous versions of the Grassland Butterfly Indicator, leave no room for the long term investments needed to ensure continuity and further improvements in indicator quality. 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 becomes longer, resulting in more robust trends and smaller standard errors. As new knowledge becomes available (e.g. the new Red List for European Butterflies; Van Swaay *et al.*, 2010), this has an influence on the indicator.

This is an inevitable consequence of the enlargement of the number of transects and countries, as well as our knowledge, which improves the quality of the indicator. The same process has happened for the bird indicators. However, the system of ad-hoc indicators, which has been followed so far, is not a solid basis to produce such important indicators. Therefore the authors urge the EU to ensure proper and structural funding to further develop the indicators and their quality, thus ensuring a robust product which can be used for multiple purposes. Adding butterfly indicators to the monitoring- and indicator programs of the EU would also add the important group of insects to the structural indicators of biodiversity.

Chapter 8 / Conclusions

- This report gives an update of an 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 all over Europe, most of them active in the European Union (see map 1).
- Since 1990 the results show that the index of grassland butterfly abundance has declined by almost 70%, indicating a dramatic loss of grassland biodiversity. Since the monitoring schemes are biased towards natural and species-rich areas, this trend is probably conservative.
- In North-western Europe intensification of farming is the most important threat to grassland butterflies. Redirection of CAP funding to support sustainable farming of HNV areas is vital to halting further losses and supporting some recovery.
- The completion of the Natura 2000 network across Europe is an important way to help these butterflies. 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 grassland butterflies. Only if young farmers see a future for their families, while at the same time respecting long established farming traditions, can grassland butterflies be saved. The support of HNV farmland would be a critical way to achieve this.
- The European Grassland Butterfly Indicator should become one of the headline indicators for biodiversity in Europe. It should also be used as a measure of the success of agriculture policies. Core funding of this and other butterfly indicators can guarantee the development of more robust indices and their extension to other habitats. This would assist with 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, in so far as feasible, biodiversity and ecosystems.

Semi-natural grasslands still support a wealth of butterflies. *Respecting old farming traditions, while at the same time given young farmers a future, is one of our challenges. The support of High Nature Value Farmland could be one of the ways to achieve this.*

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Annex I / Butterfly Monitoring Schemes in the indicator

Since the start of the first Butterfly Monitoring Scheme in the UK in 1976 more and more countries have joined in. This annex summarizes 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 Butterfly Monitoring Scheme (Pollard & Yates, 1993). The counts are conducted along fixed transects of 0.5 to 3 kilometres, consisting of smaller sections, each with a homogeneous habitat type, but the exact transect length varies among countries. The fieldworkers record all butterflies 2.5 metres to their right, 2.5 metres to their left, 5 metres ahead of them and 5 metres above them (Van Swaay *et al*., 2002). Butterfly counts are conducted between March-April to September-October, depending on the region. Visits are only conducted when weather conditions meet specified criteria. The number of visits varies from every week in e.g. the UK and the Netherlands to 3-5 visits annually in France (table 2).

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, e.g. in Switzerland and France, 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 UK and the Netherlands, 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 & Yates, 1993), while in Germany this effect was not that pronounced (Kühn *et al.*, 2008). Obviously, in such a case the trends detected may be only representative for the areas sampled, while their extrapolation to national trends may produce biased results. Such bias can however be minimized by post-stratification of transects. This implies an a posteriori division of transects by e.g. 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 seven widespread grassland species (*Ochlodes sylvanus, Anthocharis cardamines, Lycaena phlaeas, Polyommatus icarus, Lasiommata megera, Coenonympha pamphilus and Maniola jurtina*) and ten grassland-specialists (*Erynnis tages, Thymelicus acteon, Spialia sertorius, Cupido minimus, Phengaris arion, Phengaris nausithous, Polyommatus bellargus, Cyaniris semiargus, Polyommatus coridon and Euphydryas aurinia*).

Table 2: Characteristics of the Butterfly Monitoring Schemes used for the European Grassland Butterfly Indicator.

	Starting year	Number of transects per year 2007-2009	Number of counts on a transect per year (average or range)	Counts by (v=volunteers, p=professionals)	Method to choose sites	Representative for agricultural grasslands*	Nature reserves over-represented*
Belgium - Flanders	1991	10	15-20	v	free	no	no
Estonia	2004	7-10	9	p	by co-ordinator	no	no
Finland	1999	65-67	ca 11	v ~70%, p ~30%	free for volunteers	yes	no
France	2005	549-660	4.2	v	half random, half free	yes	no
France - Doubs	2001-2004	0	10-15	p	by co-ordinator	yes	no
Germany	2005	400	15-20	v	free	yes	yes
Germany - Nordrhein Westfalen	2001	50	15-20	v	free	no	yes
Germany – Pfalz (*Phengaris nausithous* only)	1989	50-87	1	p	by co-ordinator	yes	no
Ireland	2007	16-63	16.3	v	free	yes	no
Lithuania	2009	14	6-9	v	free	no	no
Jersey	2004	15	15-25	v	free	yes	no
Portugal	1998-2006	0	3-5	v	free	no	no
Slovenia	2007	9-14	6.25 - 7.53	v	by co-ordinator	yes	no
Spain - Catalonia	1994	60-70	30	v	free	yes	no
Switzerland - Aargau	1998	101-107	10	p	grid	yes	no
The Netherlands	1990	430	15-20	v	free	yes	no
Ukraine – Carpathians and adjacent parts	1990	158	5 (2-10)	p	free	yes	yes
United Kingdom	1973 (1976)	819-977	19	v	free	yes	yes

**: assessed by experts opinion. 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 focussing on the conservation of biodiversity. Such a scheme probably underestimates the (mostly negative) trend of butterflies in the wider countryside.*

Butterflies are counted on fixed transects and under standardised weather conditions (which can be summarised to: nice, sunny weather).

Annex II / Method

We used the following procedure to compute the grassland indicator.

- The national coordinators of monitoring scheme provided their count data. More specific, we received yearly counts per site per year in 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 program TRIM (Pannekoek & Van Strien, 2005). 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 supra-national 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 & Warren, 1999 and adapted according to Van Swaay *et al*., 2010). 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).
- In this updated indicator, we also took into account differences in the number of visits and transect length 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 the *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 length 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 & Van Strien (2005; 2008). 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.
- Trend classification: the multiplicative overall slope estimate (trend value) in TRIM (Pannekoek & Van Strien, 2003) is used to classify the trend (table 1):
    - Decline: significant decline where the upper limit of the confidence interval < 1.00
    - 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 Butterfly Monitoring Schemes are very similar, there are differences in choice of location, number of counts, corrections for unstratified sampling, etc. 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 the location for the transect is free (table 2), 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 future.

The Large Blue (*Phengaris arion*), one of the indicator species, is listed on annex II and IV of the Habitats Directive.

Annex III / Improving the indicator and building other butterfly indicators

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

Like the two previous versions, this Grassland Butterfly Indicator was produced on an ad-hoc basis. Although this works well as it is, there are also some issues which could be improved if more structural funding would become available. Many of these would lead to the same improvements as the bird indicators have undergone. They include:

- A full and standardized quality control. Although all controls have now been made on an ad-hoc basis, this is relatively time-consuming and offers the chance that controls are forgotten or misinterpreted. We would prefer to build a solid database, in which all possible controls and assessment could be standardized and performed on demand. However this involves a long term investment, although it will be cheaper on the long run.

- As described in Annex II, national data are weighted to build supra-national trend. Besides a correction for the part of the European distribution, corrections are performed for the average length of a transect (if transects in a country are much longer than in others, the numbers have to be downweighted), the number of counts (if much more counts are made in one country, the numbers have to be downweighted) 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 downweighted to compare them with a country where only the data of one generation are given). It would be good to standardize the input as much as possible and to perform the weighting as much as possible per species (now often per country). This can be build into a database as a long-term investment.

- If the data needed to build the indicator would be collected from the national co-ordinators at a more standardized way every year (so 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 to produce a European Butterfly Climate Change Indicator (Van Swaay *et al.*, 2008). But also the preparation of a woodland, heathland or wetland indicator would be possible.