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A new methodology for compiling national Red Lists applied to butterflies (Lepidoptera, Rhopalocera) in Flanders (N-Belgium) and the Netherlands

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The compilation of the Red Lists of butterflies in Flanders and the Netherlands was based on two criteria: a trend criterion (degree of decline) and a rarity criterion (actual distribution area). However, due to the large difference in mapping intensity in the two compared periods, a straightforward comparison of the number of grid cells in which each species was recorded, appeared inappropriate. To correct for mapping intensity we used reference species that are homogeneously distributed over the country, that have always been fairly common and that did not fluctuate in abundance too much during this century. For all resident species a relative presence in two compared periods was calculated, using the average number of grid cells in which these reference species were recorded as a correction factor. The use of a standardized method and well-defined quantitative criteria makes national Red Lists more objective and easier to re-evaluate in the future and facilitates the comparison of Red Lists among countries and among different organisms. The technique applied to correct for mapping intensity could be useful to other organisms when there is a large difference in mapping intensity between two periods.

Keywords: Red List; methodology; butterflies; Flanders; the Netherlands.

Introduction

Since their conception in 1963 by Sir Peter Scott, Red Lists have been increasingly used as nature conservation tools (Collar, 1996). Red Lists or Red Data Books may have several uses: (i) to set up research programmes for conservation, (ii) to derive conservation priorities, and (iii) to propose protection for sites that are inhabited by threatened species (Mace, 1994; Collar, 1996). Their usage stresses that categorization of the different species should be based on reliable and objective criteria. In the past, almost all Red Lists were compiled on the basis of a best professional judgement by a group of experts. With their introduction for use in the compilation of international Red Lists by the International Union for the Conservation of Nature and Natural Resources (IUCN) (IUCN, 1994; Mace and Stuart, 1994), quantitative criteria are slowly finding their way into national Red Lists as well (e.g. Schnittler *et al.* (1994) in Germany). However, since much more data are available on vertebrates and on vascular plants, the proposed IUCN criteria are more easily applicable to these groups than to lower organisms, such as invertebrates or lower plants (Hallingbäck *et al.*, 1995).

The method proposed by Stroot and Depiereux (1989) for compiling the Red List of the Trichoptera in Belgium, which is based on the χ^2-distribution, cannot be applied to the data set of the butterflies in Flanders and the Netherlands. In order to use their method, the chance of finding a species should be equal in both compared periods; this condition is certainly not fulfilled since in the past more emphasis was on recording rare species while nowadays the common species represent the majority of the records. Recently, Avery *et al.* (1995) proposed another method for compiling the national Red List of British birds. The combination of three axes (axis 1 = the national threat status, axis 2 = the international importance and axis 3 = the European / global conservation status) was used as the basis for setting UK conservation priorities. However, due to lack of sufficient data, their method is difficult to use for invertebrates and in that case, they propose the use of qualitative information. Since the IUCN proposed a new approach for compiling Red Lists, it is recommended to develop methods that use quantitative

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criteria, even for invertebrates or other lower organisms.

In Flanders (N-Belgium) and the Netherlands, Maes *et al.* (1995) and Van Ommering (1994) recently proposed categories and criteria for the compilation of the respective national Red Lists. Although it is only a region of Belgium, we apply the terms 'country' and 'national' for Flanders for simplicity. The principal idea in this new method for compiling national Red Lists is that the present rarity of a species is compared with its rarity in a reference period. The distribution area in the reference period is considered as being the more or less natural distribution of most species. In the Netherlands, a lot of butterflies showed a marked and strong decrease in the period 1950–1980 (van Swaay, 1990). In this period the Dutch landscape lost many suitable butterfly habitats due to the intensification of agriculture, acidification, etc. Therefore, the year 1950 marks the end of the reference period in the Netherlands. The start in 1901 was chosen arbitrarily. The number of butterfly records before this year was very low.

The method proposed for the compilation of the Red Lists in Flanders and the Netherlands uses a combination of the actual rarity and the degree of decline in distribution area to assign all resident species to a Red List category. The actual rarity is expressed as the extent of the present day distribution area and is measured as the number of grid cells wherein a species was recorded in the period 1981–1995 in Flanders and the period 1986–1993 in the Netherlands (= period 2). This is a fairly straightforward procedure. The second criterion compares the present day distribution area with that in the period 1901–1980 in Flanders and 1901–1950 in the Netherlands (= period 1). Due to the large difference in mapping intensity between the two compared periods, we had to work out a way to compensate for this difference. In this paper we describe the general methodology for compiling the Red Lists in Flanders and the Netherlands. In particular, we introduce a technique that corrects for differences in mapping intensity among sampling periods. This technique may also be used to compare distribution areas of other groups of organisms when there is a large difference in mapping intensity between two sampling periods. The use of a standardized method with well-defined quantitative criteria, such as the one we propose in this paper, makes national Red Lists more objective and easier to re-evaluate in the future and facilitates the comparison of Red Lists among countries as well as among different groups of organisms.

Methods

The data for compiling the Red Lists of Flanders and the Netherlands were gathered by the Flemish Butterfly Study Group and by Dutch Butterfly Conservation respectively. At first, we gathered data from the literature and from museum and private collections. These data mainly date from before 1980 and comprise about 16 000 records in Flanders and about 125 000 in the Netherlands. Afterwards, both countries organized intensive campaigns with the help of numerous volunteers which greatly increased the data set. In Flanders, this butterfly mapping scheme started in 1991 and the complete data set now comprises about 145 000 records of 69 resident species. In the Netherlands, the mapping project started in 1981 and the complete data set now contains about 430 000 records of 70 resident species (Wynhoff and van Swaay, 1995). As the basis for mapping the distribution of each species, we used grid cells of 5 km × 5 km both in Flanders (UTM projection, $n = 636$) and the Netherlands (Amersfoort projection, $n = 1677$).

Red List categories in Flanders and the Netherlands

The Red List categories in Flanders and the Netherlands are based on those of the IUCN (1994) and are given in Table 1. Both national Red Lists only refer to resident species, present in the country throughout the year and known to reproduce in the wild over a period of at least ten years. Thus, we excluded migratory species such as *Vanessa atalanta* (red admiral), *Cynthia cardui* (painted lady), *Colias hyale* (pale clouded yellow) and *Colias crocea* (clouded yellow). We used two criteria to classify species into the Red Lists of Flanders and the Netherlands: a rarity criterion and a trend criterion (Table 2).

The rarity criterion is defined by the number of grid cells in which a species was recorded in period 2. The limits that determine rarity are arbitrarily chosen. For rare but fairly mobile species (e.g. *Aporia crataegi* (black-veined white), *Argynnis paphia* (silver-washed fritillary), *Issoria lathonia* (Queen of Spain fritillary), *Leptidea sinapis* (wood white), *Nymphalis polychloros* (large tortoiseshell) and *N. antiopa* (Camberwell beauty)), grid cells with single, vagrant individuals were excluded for compiling the Red Lists since they do not relate to populations.

The trend criterion is derived from the comparison between the actual rarity of a species and the extent of its distribution area in the past, expressed as the number of grid cells in which a species was recorded in period 1. However, due to the large difference in map-

Table 1. Red List categories and criteria used in Flanders and the Netherlands based on the new IUCN criteria (IUCN, 1994)

Red List category	Description
Extinct in the wild in Flanders/ the Netherlands (EXF/EXN)	Species that did not have reproducing populations in Flanders/the Netherlands in the last ten years but have been recorded as such before. Some of these species are still observed as vagrants.
Critically endangered (CE)	Very rare species that decreased by at least 75% in distribution area between the two compared periods. In Flanders, species that have only a few isolated populations also qualify for this category.
Endangered (EN)	Very rare species that have decreased in distribution area by 50–75% between the two compared periods or rare species that have decreased by at least 50% in distribution area between the two compared periods.
Vulnerable (VU)	Very rare or rare species that have decreased in distribution area by 25–50% between the two compared periods or fairly rare species that have decreased in distribution area by at least 25% between the two compared periods.
Susceptible (SU)	Very rare species that have decreased in distribution area by less than 25% between the two compared periods (subcategory ‘Rare’ in Flanders) or common species that have decreased in distribution area by at least 50% between the two compared periods (subcategory ‘Near-threatened’ in Flanders).
Data deficient (DD)	Species for which there are insufficient data to place them in a Red List category.
Safe/Low risk (S/LR)	Rare and fairly rare species that have decreased in distribution area by less than 25% between the two compared periods or common species that have decreased in distribution area by less than 50% between the two compared periods.

Table 2. Classification scheme for the Red Lists of Flanders and the Netherlands; the number of grid cells that determine rarity are arbitrarily chosen

	Presence and percentage of grid cells			
	Very rare	Rare	Fairly rare	Common
	< 1%	1–5%	5–12.5%	> 12.5%
	Number of grid cells Flanders			
	1–6	7–32	33–80	> 80
Decline in distribution area	Number of grid cells the Netherlands			
between the two compared periods (%)	1–17	18–83	84–209	> 209
76–100	Critically endangered	Endangered	Vulnerable	Susceptible
51–75	Endangered	Endangered	Vulnerable	Susceptible
26–50	Vulnerable	Vulnerable	Vulnerable	Safe/Low risk
≤ 25	Susceptible	Safe/Low risk	Safe/Low risk	Safe/Low risk

ping intensity between past and present, a simple comparison of the number of grid cells in the two periods is inappropriate. In Flanders there are about 13 000 records from the first period and about 130 000 from the second period, while in the Netherlands respectively 42 000 and 260 000 records are available. Furthermore, in the first period, mostly rare butterflies were collected or reported in literature, while after 1981 all species were recorded. To tackle the problem of the large difference in mapping intensity in the two compared periods, we use reference species to calculate a relative presence for each species in both periods. The decline in distribution area, calculated with the relative presences, will then be used as a trend criterion.

Determining reference species

For determining reference species, we used a method proposed by Latour and van Swaay (1992) that was already applied to determine the changes in butterfly abundances in the Netherlands (van Swaay, 1995).

First, for each resident species, the number of grid cells in which it was observed was counted per pentad (= period of five years; pentad 1 = 1901–1905, pentad 2 = 1906–1910, etc.). We subsequently expressed the number of grid cells in which a species was observed per pentad as a percentage of the total number of mapped grid cells in that pentad by

$$pp_{i,p} = 100 \times \frac{x_{i,p}}{n_p} \qquad (1)$$

where $pp_{i,p}$ is the presence in percentage of species i in pentad p, $x_{i,p}$ is the number of grid cells in which species i was recorded in pentad p and n_p is the total number of mapped grid cells (i.e. grid cells wherein at least one species was recorded) in pentad p. Secondly, we regressed the presence in percentage against pentad number for those species that are presently common, i.e. that were recorded in at least half of the total number of grid cells, and that are homogeneously distributed over the country. We applied this linear regression only for the periods before which the intensive mapping schemes started: up to and including pentad 18 (1986–1990) in Flanders and up to and including pentad 16 (1976–1980) in the Netherlands. Mapping intensity was considered more or less equal before the beginning of the intensive mapping schemes in both countries.

Reference species should then fulfil the following criteria: (i) the species should not have fluctuated too much during this century (i.e. the coefficient of determination $R^2 \geq 0.20$), (ii) the species should have been observed in at least 10% of the mapped grid cells at the beginning of this century (i.e. the intercept on the Y-axis $a \geq 10$), and (iii) the species should not have increased or decreased too strongly during this century (i.e. $-1 <$ regression slope $b < +1$). The habitat in which reference species occur is not taken into account.

Using reference species to compile the Red List

As a measure of the mapping intensity during the periods 1 and 2, the average number of grid cells in which the reference species were recorded in these two periods, was calculated as

$$\bar{r}_j = \frac{\sum_{t=1}^{n_r} x_{t,j}}{n_r} \qquad (2)$$

where $\bar{r}_j$ is the average number of grid cells in which all reference species were recorded in period j, $x_{t,j}$ is the number of grid cells in which reference species t was recorded in period j and n_r is the total number of reference species. Using the average number of grid cells in which the reference species were recorded, we corrected for mapping intensity in both periods by calculating a relative presence for each species by

$$rp_{i,j} = 100 \times \frac{x_{i,j}}{\bar{r}_j} \qquad (3)$$

where $rp_{i,j}$ is the relative presence of species i in period j, $x_{i,j}$ is the number of grid cells in which species i was recorded in period j and $\bar{r}_j$ is the average number of grid cells in which the reference species were recorded in period j. By using the relative presences in both periods, the decline in distribution area for all resident species was estimated by

$$d_i = 100 - \left[100 \times \frac{rp_{i,2}}{rp_{i,1}} \right] \qquad (4)$$

where d_i is the decline in distribution area of species i, $rp_{i,1}$ is the relative presence of species i in period 1 and $rp_{i,2}$ is the relative presence of species i in period 2.

Using the number of grid cells in which a species was recorded in period 2 ($x_{i,2}$) as a rarity criterion and the decline in distribution area (d_i) as a trend criterion, we classified all resident butterfly species into the Red

Table 3. Results of the linear regression on the species presence in percentage per pentad

	Flanders			the Netherlands		
	R^2	*a*	*b*	R^2	*a*	*b*
Aglais urticae	**0.56**	−1.1	2.13	**0.78**	−5.3	1.67
Araschnia levana	**0.67**	−7.6	2.02	**0.51**	−5.1	1.55
Celastrina argiolus	**0.22**	8.9	**0.71**	0.09	**11.8**	0.18
Coenonympha pamphilus	**0.61**	4.7	1.22	**0.57**	**11.9**	**0.71**
Gonepteryx rhamni	**0.48**	2.2	1.33	**0.75**	4.3	1.03
Inachis io	**0.60**	−2.4	2.06	**0.71**	−3.5	1.42
Lasiommata megera	**0.26**	**9.7**	**0.77**	**0.57**	6.29	**0.78**
Lycaena phlaeas	**0.30**	**12.1**	**0.86**	**0.29**	**14.9**	**0.39**
Maniola jurtina	**0.34**	8.3	**0.83**	**0.28**	**13.7**	**0.30**
Pararge aegeria	**0.42**	3.7	1.62	–	–	–
Pieris brassicae	**0.48**	1.6	1.43	**0.93**	−2.9	1.27
Pieris napi	**0.31**	**11.5**	1.26	**0.90**	−1.9	1.29
Pieris rapae	**0.43**	3.5	1.70	**0.89**	−3.7	1.51
Polygonia c-album	**0.56**	−2.5	1.51	–	–	–
Polyommatus icarus	**0.20**	**14.3**	**0.69**	0.05	**17.7**	**0.15**
Thymelicus lineola	**0.74**	−1.4	1.08	**0.43**	6.0	**0.35**

R^2 = coefficient of determination, a = intercept on the y-axis, b = regression slope. When figures are in bold they fulfil the criterion for reference species.

Lists of Flanders and the Netherlands according to the scheme in Table 2.

Results

The results of the linear regression analyses applied on the species presence in percentage per pentad are shown in Table 3. We determined three reference species in both countries: *Lasiommata megera* (wall brown), *Lycaena phlaeas* (small copper) and *Polyommatus icarus* (common blue) in Flanders and *Coenonympha pamphilus* (small heath), *L. phlaeas* (small copper) and *Maniola jurtina* (meadow brown) in the Netherlands.

With Equation (2), we calculated the average number of grid cells in which the reference species were recorded in the first and second period: in Flanders $\bar{r}_1$ is 154 and $\bar{r}_2$ is 379, and in the Netherlands $\bar{r}_1$ and $\bar{r}_2$ are 238 and 750 respectively. With Equations (3) and (4) we subsequently calculated the relative presences and the declines in distribution area of all resident butterfly species (Appendix 1). According to the scheme in Table 2, we then assigned all species to a Red List category (Appendix 1).

The use of these criteria results in 20 (29%) and 17 (24%) species in the 'Extinct' category and a further 25 (36%) and 30 (43%) species considered threatened (categories 'Critically endangered', 'Endangered', 'Vulnerable' and 'Susceptible') on the Red Lists in Flanders (Maes and Van Dyck, 1996) and the Netherlands (Wynhoff and van Swaay, 1995) respectively. In both countries, 23 species are presently considered as not threatened (Table 4).

Table 4. Number of species and percentage (in parentheses) per Red List category in Flanders and the Netherlands

	Flanders	the Netherlands
Extinct	20 (29)	17 (24)
Critically endangered	8 (12)	7 (10)
Endangered	6 (9)	11 (16)
Vulnerable	7 (10)	10 (14)
Susceptible	4 (6)	2 (3)
Data deficient	1 (1)	–
Safe/Low risk	23 (33)	23 (33)
Total number of resident species	69	70

Discussion

The classification of the resident butterfly species in Flanders and the Netherlands into the national Red Lists, using the proposed method, has led to useful results for national nature conservation purposes. All butterflies listed as threatened on both Red Lists are indeed specialists of typical habitats that need urgent protection in Flanders and the Netherlands. The same classification method has already been successfully applied for compiling national Red Lists of a wide variety of other organisms like carabid beetles (Desender *et al*., 1995), amphibians and reptiles (Bauwens and Claus, 1996) and dragonflies (De Knijf and Anselin, 1996) in Flanders, and mammals (Hollander and van der Reest, 1994), birds (Osieck and Hustings, 1994) and grasshoppers (Odé, in press) in the Netherlands.

Criteria like rarity and decline are used in most Red Lists, such as the British Red Data Books (Shirt, 1987; Bratton, 1991), but decline is usually described in a qualitative way (‘rapid’, ‘continuous’, etc.). In the newly proposed IUCN criteria (Mace and Stuart, 1994), the decline and the rarity criterion are used independently from one another: a species that has either declined in distribution area by at least 80% or that is very rare, is categorized as being ‘Critically endangered’. Adopting the IUCN criteria for the national Red Lists of Flanders and the Netherlands would have placed respectively 14 and 15 species in the ‘Critically endangered’ category, 7 and 12 species in the ‘Endangered’ category and 1 and 6 species in the ‘Vulnerable’ category. The additional criteria (the degree of potential immigration to counteract the decline) that the IUCN proposed for applying Red List categories at the national level (agreed at the National Red List Workshop in Gland, Switzerland, 23–24 March 1995) are difficult to apply to butterflies. Although some of the threatened or extinct butterflies are potentially fairly mobile, they do not seem to be able to found new populations in our countries. In Flanders and the Netherlands (but also in Germany (Schnittler *et al*., 1994)), the combined usage of the decline and rarity criteria, resulted in a classification into Red List categories on a national level that corresponded better with our judgements on butterfly threats in both countries than if IUCN criteria had been used.

Method for correcting for mapping intensity

Our method first identifies reference species which will consequently be used to calculate a decline in distribution area. Since reference species should be homogeneously distributed over the country, it is not surprising that only grassland species qualify, since grasslands are the only habitats that are homogeneously distributed over both countries. Furthermore, these species are best represented in the families Lycaenidae and Satyrinae. The fact that the reference species are only found among grassland species strictly means that this method should only be used to evaluate the change in distribution area of grassland species. For species from other habitats, this method requires the additional assumption that butterflies in other habitats (e.g. forests, heathlands, etc.) were mapped with a similar effort as those in grasslands during both compared periods.

In most European countries, 10 km × 10 km UTM grid cells are used for mapping invertebrates (e.g. Geijskens and van Tol, 1983; Desender, 1986; Emmet and Heath, 1989). The large amount of data in Flanders and the Netherlands made mapping possible on a 5 km × 5 km scale. The imprecision of the older data (where often only the name of a town or an approximate location is given) did not allow the use of a finer scale. In Flanders, species that declined in distribution area on the basis of 5 km × 5 km grid cells also did so when 10 km × 10 km grid cells were used ($r = 0.951$, $n = 67$, $p < 0.001$). The use of 5 km × 5 km grid cells, instead of the usual 10 km x 10 km grid cells, certainly allowed a better estimation of the decline in distribution area, but for most species we still underestimated the decline, since declines on distribution maps are only detected when all populations have disappeared from a grid cell (Thomas and Abery, 1995). The use of 10 km × 10 km grid cells in Flanders instead of the 5 km × 5 km grid cells, would have underestimated the decline of the rare species for 4% on average and for 36% on average for the intermediately rare species (see Thomas and Abery, 1995).

The method applied here to correct for mapping intensity, yielded informative results for the butterflies in Flanders and the Netherlands and proved to be useful for other groups of organisms that have been relatively well recorded throughout this century. This technique allowed a fairly good estimation of the decline in distribution area of rare and intermediately rare species, but not for the very common species. This is due to the fact that the latter were largely underrecorded in the past. Since we were compiling a list of threatened species, used to set conservation priorities in Flanders and the Netherlands, the presently common species were of a lesser concern for this purpose. For species with a very localized distribution area within both countries and which were recorded very well in the past, this method calculated a large decline in distribution area by correcting for mapping intensity (e.g. a decline of 73% and 59% for *Cupido minimus* and *Heteropterus morpheus* respectively in Flanders or 75% and 68% for *Boloria aquilonaris* and *Vacciniina optilete* respectively in the Netherlands). Most of these species inhabit typical and very localized habitats (chalk grasslands, peat bogs, etc.) and data suggest that their distribution area did not undergo changes. Species in such cases are classified in the subcategory 'Rare' of the Red List category 'Susceptible' in Flanders because of their restricted distribution area in both the past and present.

Comparing the Red Lists of Flanders and the Netherlands

The method we used to compile our Red Lists is repeatable and fairly objective. Furthermore, by using the same classification technique in Flanders and the Netherlands, their respective Red Lists become more easily comparable. However, the category 'Susceptible' has to be interpreted differently in the two countries. The four species in this category in Flanders have always had a restricted and localized distribution and are therefore put in the subcategory 'Rare'. The two species in the category 'Susceptible' in the Netherlands on the other hand, are still common but have decreased in distribution area by at least 50%. A second difference between both Red Lists is that the reference periods are not identical (1901–1980 vs. 1981–1995 in Flanders and 1901–1950 vs. 1986–1993 in the Netherlands). However, this does not affect the composition of the Red Lists: by applying the reference periods from the Netherlands to the data of Flanders, we obtained exactly the same Red List for Flanders as with the presently used periods. Since national Red Lists are used for shaping national public policy (Bean, 1987), each country can set different but appropriate reference periods.

Comparing the Red Lists of Flanders and the Netherlands shows that the group of threatened species is almost identical in both countries. Only two species were categorized differently: *Callophrys rubi* is 'Vulnerable' in Flanders but 'Safe/Low Risk' in the Netherlands, while *Papilio machaon* is 'Susceptible' in the Netherlands but 'Safe/Low Risk' in Flanders. For the species both countries have in common, the degree of decline is very similar (decline in distribution area in Flanders vs. the Netherlands, $r = 0.809$, $n = 63$, $p < 0.001$). This fact is not surprising since both countries have a similar landscape and have undergone similar declines in the number of suitable butterfly habitats (heathlands, forest, nutrient-poor unimproved grasslands) through changes in agricultural management and building activities. Fragmentation of suitable habitats can strongly decrease or even stop the exchange of individuals between populations leading to a higher risk of extinction (e.g. Thomas and Jones, 1993). Furthermore, a lot of butterfly habitats have deteriorated qualitatively through bad management or lack of management. A management plan for threatened butterflies, both on the population and on the landscape level, has already been produced in the Netherlands (Ministerie voor Landbouw, Visserij en Natuurbeheer, 1990) and is being prepared for Flanders (Maes and van Dyck, in prep.).

A comparison of our Red Lists of butterflies with those in other north-western European countries or regions (not compiled with the new IUCN criteria) reveals that the group of extinct and threatened species varies from 52% (91 species) in Germany (Pretscher *et al*., 1984), over 63% (80 species) in Baden-Württemberg (Ebert, 1991) to 66% (51 species) in Wallonia, South-Belgium (Goffart *et al*., 1992). In Great Britain only 18% (10 species) of the species are extinct or threatened (Shirt, 1987). Although the global figures are alike (except for Great Britain) the proportion of extinct species is clearly higher in Flanders (29%) and in the Netherlands (24%) than in the other countries or regions. With 16 extinct species (16%), Wallonia (South-Belgium) is intermediate between our countries and the other European countries or regions; Germany with only two (1%), Baden-Württemberg with only four (3%) and Great Britain with only three extinct species (5%) do much better on this point. A comparison of threatened butterflies between countries is difficult due to different techniques used for compiling the national Red Lists. It would therefore be interesting to apply our technique to existing data sets in other countries or regions. Only by using the same technique will national Red Lists become comparable. Since a European Red List is being prepared, an objective and repeatable method, like the one proposed here, would be recommended.

Future Red Lists

Since butterfly distribution and threats are variable, Red Lists will have to be updated regularly (e.g. every ten years). Thanks to the large number of records that are gathered annually by numerous volunteers, the distribution of butterflies in Flanders and the Netherlands can now be easily monitored. The next Red Lists in both countries could, for example, compare the distribution of the species in the period 1991–2000 with that in the period 2001–2010. Due to the similar collecting technique (direct observations) and probably fairly similar mapping intensities, the number of grid cells of each species in both periods will be more easily comparable. Harmonization of the change-over date in future Red Lists should be aimed for throughout Europe and the year 2000 could be ideal for this purpose.

In the future, the Butterfly Monitoring Scheme in Flanders and the Netherlands, based on transect counts (Pollard and Yates, 1993), might be used in addition to the method proposed in this article, in order to take the trends in the numbers of individuals in the monitored populations of threatened butterfly species into account (van Swaay *et al*., 1997).

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* The documented Red Lists of Flanders and the Netherlands can be ordered from the authors' addresses.

Appendix 1

Number of grid cells in which the species was recorded in the periods 1901–1980 in Flanders and 1901–1950 in the Netherlands (x_1) and 1981–1995 in Flanders and 1986–1993 in the Netherlands (x_2) and their relative presence in both periods (rp_1, 100% = 154 in Flanders and 238 in the Netherlands; rp_2, 100% = 379 in Flanders and 750 in the Netherlands), the decline in distribution area (*d*, in percentage points) and the Red List category (RLC). – = the species is not indigenous; [v]all observations concern vagrant individuals; [(x)]the number of grid cells with reproducing populations is given in brackets, the major part of the observations concern vagrant individuals; [i]re-introduced species. For the abbreviations of the Red List categories refer to Table 1.

	Flanders						the Netherlands					
Species	x_1	x_2	rp_1	rp_2	*d*	RLC	x_1	x_2	rp_1	rp_2	*d*	RLC
Aglais urticae	149	542	96.8	143.0	–48	S/LR	101	1008	42.4	134.4	–217	S/LR
Anthocharis cardamines	111	381	72.1	100.5	–40	S/LR	161	518	67.7	69.1	–2	S/LR
Apatura ilia	0	1	0	0.3	–	CE	–	–	–	–	–	–
Apatura iris	14	12	9.1	3.2	65	EN	31	28	13.0	3.7	71	EN
Aphantopus hyperantus	92	239	59.7	63.1	–6	S/LR	149	428	62.6	57.1	9	S/LR
Aporia crataegi	30	19[v]	19.5	5.0	74	EXF	98	16[v]	41.2	2.1	95	EXN
Araschnia levana	101	434	65.6	114.5	–75	S/LR	73	694	30.7	92.5	–202	S/LR
Argynnis paphia	30	21[(1)]	19.5	5.5	72	CE	59	28[v]	24.8	3.7	85	EXN
Aricia agestis	35	59	22.7	15.6	32	VU	107	149	45.0	19.9	56	VU
Boloria aquilonaris	–	–	–	–	–	–	9	7	3.8	0.9	75	CE
Brenthis ino	–	–	–	–	–	–	5	0	2.1	0	100	EXN
Callophrys rubi	53	56	34.4	14.8	57	VU	115	212	48.3	28.3	42	S/LR
Carcharodus alceae	14	0	9.1	0	100	EXF	–	–	–	–	–	–
Carterocephalus palaemon	38	64	24.7	16.9	32	VU	44	65	18.5	8.7	53	EN
Celastrina argiolus	115	366	74.7	96.6	–29	S/LR	166	707	69.8	94.3	–35	S/LR
Clossiana euphrosyne	13	0	8.4	0	100	EXF	31	0	13.0	0	100	EXN
Clossiana selene	51	1	33.1	0.3	99	CE	175	53	73.5	7.1	90	EN
Coenonympha arcania	3	0	2.0	0	100	EXF	14	2	5.9	0.3	95	CE
Coenonympha hero	4	0	2.6	0	100	EXF	4	0	1.7	0	100	EXN
Coenonympha pamphilus	156	328	101.3	86.5	15	S/LR	245	742	102.9	98.9	4	S/LR
Coenonympha tullia	16	5	10.4	1.3	87	CE	73	18	30.7	2.4	92	EN
Cupido minimus	6	4	3.9	1.1	73	SU	8	0	3.4	0	100	EXN
Cyaniris semiargus	64	2[(1)]	41.6	0.5	99	CE	57	1[v]	24.0	0.1	99	EXN
Erynnis tages	29	2[v]	18.8	0.5	97	EXF	64	2	26.9	0.3	99	CE
Eurodryas aurinia	20	0	13.0	0	100	EXF	64	0	26.9	0	100	EXN
Fabriciana adippe	9	0	5.8	0	100	EXF	–	–	–	–	–	–
Fabriciana niobe	7	0	4.6	0	100	EXF	76	41	31.9	5.5	83	EN

Gonepteryx rhamni	129	444	83.8	117.2	–40	S/LR	174	892	73.1	118.9	–63	S/LR
Heodes tityrus	91	4[v]	59.1	1.1	98	EXF	191	146	80.3	19.5	76	VU
Hesperia comma	29	22	18.8	5.8	69	EN	101	98	42.4	13.1	69	VU
Heteropterus morpheus	5	5	3.3	1.3	59	SU	6	14	2.5	1.9	26	VU
Hipparchia semele	82	79	53.3	20.8	61	VU	179	270	75.2	36.0	52	SU
Hipparchia statilinus	5	0	3.3	0	100	EXF	10	16	4.2	2.1	49	VU
Inachis io	144	543	93.5	143.3	–53	S/LR	87	1003	36.6	133.7	–266	S/LR
Issoria lathonia	69	25[(2)]	44.8	6.6	85	EXF	199	90	83.6	12.0	86	VU
Ladoga camilla	50	55	32.5	14.5	55	VU	104	95	43.7	12.7	71	VU
Lasiommata megera	146	347	94.8	91.6	3	S/LR	188	825	79.0	110.0	–39	S/LR
Leptidea sinapis	12	8[(1)]	7.8	2.1	73	CE	–	–	–	–	–	–
Limenitis populi	8	0	5.2	0	100	EXF	9	3	3.8	0.4	89	CE
Lycaeides idas	4	0	2.6	0	100	EXF	14	0	5.9	0	100	EXN
Lycaena dispar	–	–	–	–	–	–	15	6	6.3	0.8	87	CE
Lycaena phlaeas	150	388	97.4	102.4	–5	S/LR	237	742	99.6	98.9	1	S/LR
Maculinea alcon	25	23	16.2	6.1	63	EN	58	89	24.4	11.9	51	VU
Maculinea alcon arenaria	–	–	–	–	–	–	5	0	2.1	0	100	EXW
Maculinea arion	–	–	–	–	–	–	9	0	3.8	0	100	EXN
Maculinea nausithous	–	–	–	–	–	–	14	2[i]	5.9	0.3	95	EXN[1]
Maculinea teleius	9	0	5.8	0	100	EXF	17	2[i]	7.1	0.3	96	EXN[1]
Maniola jurtina	133	414	86.4	109.2	–27	S/LR	233	765	97.9	102.0	–4	S/LR
Melanargia galathea	7	18[(1)]	4.6	4.8	–5	SU	–	–	–	–	–	–
Melitaea cinxia	37	6[(4)]	24.0	1.6	93	CE	63	1	26.5	0.1	99	CE
Melitaea diamina	6	0	3.9	0	100	EXF	18	0	7.6	0	100	EXN
Mellicta athalia	21	0	13.6	0	100	EXF	84	20	35.3	2.7	92	EN
Mesoacidalia aglaja	25	6[v]	16.2	1.6	90	EXF	97	27	40.8	3.6	91	EN
Normannia ilicis	53	40	34.4	10.6	69	VU	115	96	48.3	12.8	74	VU
Nymphalis antiopa	34	18[v]	22.1	4.8	79	EXF	94	15[v]	39.5	2.0	95	EXN
Nymphalis polychloros	65	40[(10?)]	42.2	10.6	75	EN	139	30	58.4	4.0	93	EN
Ochlodes venatus	122	312	79.2	82.3	–4	S/LR	174	503	73.1	67.1	8	S/LR
Palaeochrysophanus hippothoe	0	1	0	0.3	–	CE	22	0	9.2	0	100	EXN
Papilio machaon	126	310	81.8	81.8	0	S/LR	204	248	85.7	33.1	61	SU
Pararge aegeria	134	493	87.0	130.1	–50	S/LR	135	513	56.7	68.4	–21	S/LR
Pieris brassicae	138	493	89.6	130.1	–45	S/LR	88	873	37.0	116.4	–215	S/LR
Pieris napi	165	525	107.1	138.5	–29	S/LR	102	965	42.9	128.7	–200	S/LR
Pieris rapae	153	558	99.4	147.2	–48	S/LR	81	1011	34.0	134.8	–296	S/LR
Plebejus argus	63	40	40.9	10.6	74	VU	111	191	46.6	25.5	45	VU

Appendix 1 Continued

	Flanders						the Netherlands					
Species	x_1	x_2	rp_1	rp_2	d	RLC	x_1	x_2	rp_1	rp_2	d	RLC
Polygonia c-album	110	439	71.4	115.8	–62	S/LR	141	576	59.2	76.8	–30	S/LR
Polyommatus icarus	167	402	108.4	106.1	2	S/LR	267	651	112.2	86.8	23	S/LR
Pyrgus armoricanus	3	0	2.0	0	100	EXF	–	–	–	–	–	–
Pyrgus malvae	42	11	27.3	2.9	89	EN	132	38	55.5	5.1	91	EN
Pyronia tithonus	99	358	64.3	94.5	–47	S/LR	146	451	61.3	60.1	2	S/LR
Quercusia quercus	52	102	33.8	26.9	20	S/LR	108	306	45.4	40.8	10	S/LR
Satyrium w-album	17	1	11.0	0.3	98	DD	11	1	4.6	0.1	97	CE
Spialia sertorius	3	1	2.0	0.3	87	SU	7	1[v]	2.9	0.1	95	EXN
Thecla betulae	25	22	16.2	5.8	64	EN	54	28	22.7	3.7	84	EN
Thymelicus acteon	–	–	–	–	–	S/LR	4	4	1.7	0.5	68	EN
Thymelicus lineola	87	359	56.5	94.7	–68	SL/R	136	628	57.1	83.7	–47	S/LR
Thymelicus sylvestris	52	165	33.8	43.5	–29	S/LR	137	288	57.6	38.4	33	S/LR
Vacciniina optilete	–	–	–	–	–	–	4	4	1.7	0.5	68	EN