Habitat quality and biodiversity indicator performances of a threatened butterfly versus a multispecies group for wet heathlands in Belgium

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Abstract

We analyzed whether a single species (i.e., the threatened Alcon Blue butterfly *Maculinea alcon*) was a useful indicator for the quality and area of wet heathlands in Belgium. During a survey of 18 wet *Erica tetralix* heathlands, we identified 624 species from 20 different taxonomic groups. Sites with the single indicator species *M. alcon* were significantly richer in typical wet heathland species and in Red List species but did not show significant differences in biotope quality (i.e., the number of different typical wet heathland biotope attributes) than sites without. In addition, we used a multispecies indicator approach including a group of nine species from five different taxonomic groups (two birds, two dragonflies, two butterflies, two vascular plants and one grasshopper). High quality sites (5–9 species from the multispecies indicator group present) tended to have more Red list species than low quality sites (0–4 species from the multispecies indicator group present) but did not expose differences in overall species richness, typical wet heathland species or in biotope quality. The number of species in this umbrella group, however, was positively correlated with both the diversity of typical wet heathland species and with biotope quality. Furthermore, the complementary information of the species in the multispecies indicator group usefully signalled distinctions in biotope area and configuration, vulnerability to fragmentation, eutrophication, desiccation and contained species of different trophic levels; this was not the case for *M. alcon* as a single indicator species. We discuss the use of a single indicator and of a multispecies group as conservation umbrella and advocate a much wider use of combined knowledge from different taxonomic groups in conservation planning and evaluation.

Keywords: Belgium; Indicator species; *Maculinea alcon*; Multispecies approach; Wet heathland

1. Introduction

In many regions of the world, natural landscapes comprised human-dominated biotopes several centuries ago (Thomas, 1993). Increasing industrialization and human population densities have lead to a growing pressure on both the physical environment and on biodiversity. Conservation efforts in industrialised countries are, therefore, typically focused on semi-natural, traditionally managed landscape remnants or biotopes (e.g., nutrient-poor hay meadows, heathlands). A continuous decline of several species, even in nature reserves – as for butterflies in NW Europe (Maes and Van Dyck, 2001; Warren et al., 2001) – has accelerated the debate on the quantitative use of species as explicit targets or as tools for the conservation of semi-natural biotopes. This contrasts with the management of ecosystems along traditional lines without reference to particular species (Pullin and Knight, 2001; Pullin et al., 2004; Simberloff, 1998). Species have the benefit that several requirements relating to biotope quality, quantity and configuration can be defined or estimated, and this ecological knowledge may consequently be used as a standard for management planning and/or evaluation (Brooks et al., 2004; Hilty and Merenlender, 2000; McGeoch, 1998). But, then the question arises, which species to work with? Available knowledge is an obvious bottleneck here. Moreover, conservation practitioners place a premium on simple, straightforward approaches that can be readily implemented by non-experts and that minimise effort and expense (Fleishman et al., 2000). Therefore, the use of a short-cut concept like that of the indicator species is highly attractive to protect, manage or restore habitats and local biodiversity (Lambeck, 1997). Proposed indicator species have usually been conspicuous mammals (e.g., Beier, 1993; Wilcox, 1984), birds (e.g., Martikainen et al., 1998; Mikusinski et al., 2001; Rubinoff, 2001) or vascular plants (e.g., Kati et al., 2004; Oliver et al., 1998; Pharo et al., 1999). However, the use of a single species or a single taxonomic group as a conservation umbrella for other sympatric species or ecosystems has been criticized (e.g., Landres et al., 1988; Niemi et al., 1997; Prendergast et al., 1993). The effectiveness of the concept has indeed often been assumed, but rarely tested (Andelman and Fagan, 2000; Andersen, 1999; Fleishman et al., 2001; Simberloff, 1998).

Recently, several authors have advocated multispecies approaches in conservation biology, i.e., using a group of species rather than a single indicator species as a conservation umbrella (e.g., Hilty and Merenlender, 2000; Fleishman et al., 2001; Root et al., 2003; Roberge and Angelstam, 2004). The underlying rationale is that a carefully selected group of species is more likely to provide a complementary, integrative picture of the quality and/or configuration of a reserve (network) than a single species. Multispecies groups with, ideally, easily recognizable and ecologically well-known species, enable non-experts (wardens and volunteer nature managers) to evaluate the appropriateness of a reserve for biotope specialists. Well selected multispecies groups make the evaluation of management measures more efficient than a time consuming and extensive survey of a large number of ecologically poorly-known taxonomic groups (Roberge and Angelstam, 2004). Furthermore, Collins and Thomas (1991) and Samways (1993), amongst others, have pleaded for a more prominent use of insects and other invertebrates in conservation biology. This may be particularly appropriate in traditionally managed, man-made biotopes where specialist species strongly depend on specific types of vegetation structures and associated microclimates (Murphy and Wilcox, 1986; Thomas, 1994). Hence, to incorporate ecological aspects at smaller scales, insects and/or other invertebrates should not a priori be excluded from multispecies groups (Brown, 1997; Kotze and Samways, 1999; Kremen et al., 1993; McGeoch, 1998).

The majority of studies dealing with indicator species and with cross-taxa comparisons of species richness focus on reserve (network) selection, often at a rather coarse scale (e.g., Poiani et al., 2000; van Jaarsveld et al., 1998). Depending on the type of conservation question, the spatial scale of indicator evaluation needs to be carefully considered (Pearson and Cassola, 1992). In industrialised countries with considerable competition for open space (e.g., Belgium – OECD, 1998), decisions on the configuration of reserve networks are usually not based on scientific arguments but more often depend on political agreements with other land-users and socio-economic priorities. However, even in such situations, there is a growing interest in using species-specific knowledge (such as the indicator species concept) as a tool to develop and adapt biotope management and restoration plans once reserves or local reserve networks have been established (Root et al., 2003).

Here, we evaluate the indicator performance of a single species and that of a multispecies group as a conservation and management tool for temperate wet heathlands in Belgium. In Europe, Northern Atlantic wet heaths with *Erica tetralix* are of high conservation value (EU Habitat Directive 92/43/EEC). We used *M. alcon* and wet heathlands as model systems because both have been extensively studied recently in Belgium (Maes et al., 2003, 2004; Van Dyck et al., 2001). The threatened Alcon Blue butterfly (*Maculinea alcon* Denis & Schiffermüller 1775), confined to wet heathland in Belgium (Maes et al., 2004), was tested as a potential indicator species of typical species richness and wet heathland quality. All *Maculinea* butterfly species are of conservation concern throughout Europe (Munguira and Martín, 1999) and have a complex life history. Therefore, *Maculinea* butterflies have attracted much attention in ecological and conservation biology studies (Thomas et al., 1998 and references therein). For the multispecies approach, we incorporated species from several taxonomic groups (vertebrates, invertebrates and vascular plants), and adopted selection criteria to compile a list of species covering a wide range of ecological information.

2. Materials and methods

2.1. *Maculinea alcon*

M. alcon has a scattered distribution in Europe (Wynhoff, 1998). Its distribution in Belgium is limited to the Campine region (Fig. 1) where it only occurs on wet heathlands with *Erica tetralix*. *M. alcon* is an obli-

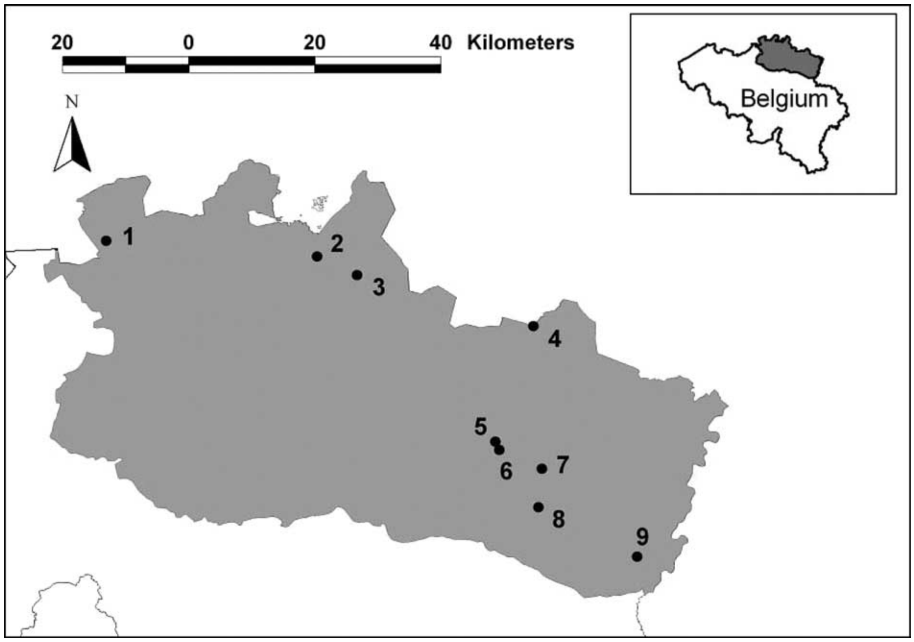

Fig. 1. Location of the investigated sites within the Campine region (shaded in grey) in Belgium. The numbers correspond with the site numbers in Table 1.

gate ant brood parasite (in Belgium mainly of *Myrmica ruginodis* ; Elmes et al., 1994) and only uses *Gentiana pneumonanthe* as a larval host plant (Maes and Van Dyck, 1999). Both the butterfly and the host plant are threatened in Flanders, the northern federal state of Belgium (Biesbrouck et al., 2001; Maes et al., 2004). The selection of *M. alcon* as a potential indicator species is based on its assumed indicator capacities (e.g., Bink, 1992) and on its high conservation value (van Swaay and Warren, 1999). Contrasting in approach to that of many authors (e.g., Martikainen et al., 1998; Wilcox, 1984), we selected a potential indicator species that does not necessarily have very large area requirements, but one that is demanding in attributes both of landscape and of biotope (cf. the 'extended umbrella concept' of Roberge and Angelstam, 2004).

2.2. Sampling sites

We selected nine wet *Erica tetralix* heathland areas within the Campine region (NE Belgium – Fig. 1). Within each area two 'paired sites' were selected: one with a population of *M. alcon* and one where the species was never documented (Table 1). This site selection procedure corrects for possible geographical differences among sites. Due to the small total area of wet heathland in Belgium, some sites had to be chosen within relatively short distances of one another; since most of the (Red List or typical) species are sedentary invertebrates or plants, the effect of these small distances between some of the paired sites is assumed to be negligible. This assumption was supported by tests excluding sites separated by <500 m. Sites varied from 0.08 to 5.29 ha, but patches with and without *M. alcon* did not significantly differ in area (Kruskall–Wallis test H (1,18) = 1.875, $p > 0.2$). Most common plant species on the sites were *Erica tetralix*, *Molinia caerulea*, *Calluna vulgaris*, *Gentiana pneumonanthe* and *Scirpus cespitosus*.

2.3. Sampling methods

Appropriate techniques were used to sample 20 taxonomic groups (Southwood, 1978; Table 2). We applied threshold values (i.e., minimum numbers observed) for several species (mostly invertebrates) to establish the presence of a local population (e.g., >5 individuals for butterflies, grasshoppers, etc.). Invertebrate species caught by pitfalls, water traps and sweep net were sorted out in the laboratory and classified with a binocular microscope; species seen on transect walks, during visual searching and in the vegetation surveys were identified in the field.

At all sites, we measured wet heathland patch area using a GPS (precision 1 m) and we scored the absence or presence of seven biotope attributes that characterize high quality wet heathlands: soil humidity (permanently wet = 1, dry in summer = 0), bare ground (an important attribute for ground dwelling invertebrates and germination of typical vascular plants: present = 1, absent = 0), scattered trees (important for insectivorous birds and territories of butterflies: present = 1, absent = 0), moorland pools (important for aquatic invertebrates of nutrient poor water, e.g., dragonflies, dolichopodid flies: present = 1, absent = 0), microtopography (i.e.,

Table 1
Investigated plots (the site numbers correspond with those on Fig. 1)

Site (locality)	Site info				Species info			
	M. alcon	PA	SA	Status	All	RL	TWH	Dist.
1. Kalmthoutse heide (Kalmthout)								3.082
1.a WIT-1	+	2.59	72	GNR	174	18	25	
1.b KAL-4		1.32	836	GNR	147	13	25	
2. Zwart water (Turnhout)								1.359
2.a ZWW-1	+	2.69	21	PNR	239	18	25	
2.b KOE-1		1.07	8	PP	170	13	21	
3. Liereman (Oud-Turnhout)								1.073
3.a LIE-2	+	1.75	175	PNR	162	25	28	
3.b LIE-3		4.34	175	PNR	133	13	19	
4. Hageven (Neerpelt)								0.426
4.a HAG-5	+	0.68	205	PNR	154	23	28	
4.b HAG-15		0.08	205	PNR	175	20	15	
5. Panoramaduinen (Hechtel-Eksel)								0.401
5.a ZWB-3	+	2.99	2746	MA	143	21	26	
5.b ZWB-6		1.94	2746	MA	205	25	21	
6. Fonteintje (Koersel-Beringen)								0.403
6.a ZWB-2	+	5.29	2746	MA	175	23	33	
6.b ZWB-5		0.99	2746	MA	172	20	29	
7. Sonnisheide (Houthalen-Helchteren)								0.230
7.a HHH-1	+	1.24	2183	MA	185	26	26	
7.b HHH-3		2.02	2183	MA	250	21	24	
8. Teut (Zonhoven)								0.949
8.a TEU-1	+	4.77	317	GNR	164	23	30	
8.b TEU-3		0.40	317	GNR	147	12	23	
9. Vallei van de Ziepbeek (Zutendaal)								1.094
9.a ZIE-3	(+)	1.06	170	GNR	141	24	27	
9.b ZIE-1		2.02	170	GNR	144	24	24	

Site info: *M. alcon* +, present; (+), extinct recently (1998), but scored as present in the analysis; , absent; PA, patch area (in ha); SA, Site area (in ha); Status, GNR, Government nature reserve; PNR, private nature reserve; PP, private property; MA, military area; Species info: number of species found in the different plots; All, all species; RL, Red List species; TWH, Typical wet heathland species; Dist., distance between patches in the same site in kilometers.

vegetation structure, important for variation in microclimatic conditions: present = 1, absent = 0), seepage (important for the compensation of nutrient rich deposition: present = 1, absent = 0) and typical *Sphagnum* mosses (indication of undisturbed wet heathland: present = 1, absent = 0). Biotope quality is subsequently expressed as the sum of the different biotope attributes (Dennis et al., 1998; Tews et al., 2004).

Red Lists in Flanders (north Belgium) are available for 11 of the investigated taxonomic groups (Table 2). A Red List species sensu stricto is a species that belongs to the categories 'Extinct', 'Critically endangered', 'Endangered' or 'Vulnerable'. For our purpose, a typical wet heathland species is a species that is confined to, or has its highest densities in, wet heathland in Belgium. The full list of references used to identify the species, assess the Red List status and classify species as typical for wet heathland can be obtained from ftp://ftp.instnat.be/Users/Dirk_M/wetheathlandindicator.rtf.

2.4. Compiling a multispecies group for wet heathlands

Hilty and Merenlender (2000) outlined a step-wise decision-making framework for the compilation of a set of taxonomically diverse indicator species. We slightly modified this concept incorporating recommendations in Caro and O'Doherty (1999), Fleishman et al. (2000, 2001), Landres et al. (1988), McGeoch (1998), Poiani et al. (2000) and Roberge and Angelstam (2004):

Step 1. Decide what ecosystem attributes indicator taxa should reflect.

A wet heathland with high conservation value can be defined as large and containing the necessary biotope attributes for a variety of specialist species. Therefore, a multispecies group should contain species that need relatively large areas of wet heathland (to Belgian standards), that are sensitive to fragmentation, desiccation and eutrophication, and that are dependent on one or

Table 2
Sampling method

Taxonomic group	Sampling Method	All	RL	TWH
Amphibians and reptiles	O/(P)	8	–	2
Ants (*Hymenoptera - Formicidae*)	P/W	27	.	1
Birds	O/T	25	8	4
Bugs (*Hemiptera – Heteroptera*)	P/W/S	38	.	–
Burrying beetles (*Coleoptera – Silphidae*)	P/W	4	.	–
Butterflies (*Lepidoptera – Rhopalocera*)	O/T	24	6	3
Carabid beetles (*Coleoptera – Carabidae*)	P/W	71	7	9
Centipedes (*Myriapoda*)	P/W	5	.	–
Cockroaches (*Dictyoptera – Blattodea*)	P/W	4	.	–
Day flying moths (*Lepidoptera* partim)	O/S/T	13	.	1
Dolichopodid flies (*Diptera – Dolichopodidae*)	W/P/S	25	1	4
Dragonflies (*Odonata*)	O	37	12	12
Empidid flies (*Diptera – Empididae*)	W/P/S	19	2	1
Grasshoppers (*Orthoptera*)	O/S/P/T	16	3	2
Hoverflies (*Diptera – Syrphidae*)	W/P/S	41	.	4
Leafhoppers (*Hemiptera – Homoptera*)	P/W/S	34	.	–
Small mammals	P	8	–	–
Vascular plants	V	33	3	13
Sphecid wasps (*Hymenoptera – Sphecidae*)	W/P/S	4	.	–
Spiders (*Araneae*)	P/W/S	188	56	8
Total		624	98	64

O, Observations (active searching during 30 min twice a month from May to August 2000), P, Pitfalls (three pitfall traps (diameter = 9 cm) per site at 10 m intervals between 30 March 2000 and 15 March 2001), S, sweep net (15 m twice a month from May to August 2000), T, transect walk (50 m twice a month from May to August 2000; Pollard and Yates, 1993), V, vegetation surveys (Londo scale in four plots of 2 m · 2 m during summer of 1999 and 2000; Londo, 1976), W, water traps (three white water traps per site from 30 March to 30 September 2000) and total number of species (All), Red List species (RL;–, no Red List species present,., no Red List available) and typical wet heathland species (TWH) for the different taxonomic groups.

more of the typical biotope attributes as stated above. As a whole, the multispecies group should encompass all of the biotope attributes more than once.

Step 2. List all species or taxonomic groups that meet baseline information criteria.

Baseline information was considered sufficient when taxonomy is clear, biology and life history are sufficiently well studied, the species' distribution is sufficiently well known, the tolerance levels to environmental pressures are known and the correlation to ecosystem changes is established.

Step 3. Use only intermediately rare and easily detectable species, that are evenly distributed in the focal area.

After Step 2, we only retained easily observable species (diurnal, no trapping devices needed) that are identifiable by non-experts (using a field guide and or binoculars); furthermore, species should be intermediately rare (Fleishman et al., 2000; Honnay and Hermy, 1997), i.e., between 20 and 60 mapping grid cells (5 km · 5 km) and homogeneously distributed in the focal region.

Step 4. List available information on niche and life history and on sensitivity to environmental stressors.

Niche and life history criteria concern trophic level, reaction time to environmental changes, mobility, minimum area requirements, detailed niche of the species (necessary structural biotope attributes) and the sensitivity to different environmental stressors (eutrophication, desiccation, fragmentation, etc.).

Step 5. Compile a set of complementary species from different taxonomic groups to satisfy every criterion from Step 1 by more than one taxon.

From the list obtained after Step 4, a group of species was selected that is complementary (all criteria of Step 1 should preferably be present at least twice) and that consists of species of different taxonomic groups.

2.5. *Analysis*

Differences in overall species richness, Red List species richness and typical wet heathland species richness among sites with and without *M. alcon* were tested with a paired *t*-test for dependent samples (Sokal and Rohlf, 1995). *M. alcon* itself was excluded from the number of species on sites where the butterfly was present. Data were $\log_{10}$-transformed prior to analysis to obtain normality. We split the 18 sites into two groups: nine low quality sites with 0–4 species of the multispecies group and nine high quality sites with 5–9 species of the multispecies group. Subsequently, we applied a *t*-test to analyse whether species diversity (all, Red List or typical wet heathland species) and biotope quality differs between high and low quality sites. Species from the multispecies group were excluded from the numbers of overall species richness, Red List species richness and typical wet heathland species richness. Additionally, we tested whether the number of species in the multispecies group was correlated with the number of typical biotope attributes and with species diversity for the 18 sites (all, Red List or typical wet heathland species) by means of a one-tailed Spearman Rank correlation (Sokal and Rohlf, 1995). All analyses were done with the STATISTICA 6.0 software package (StatSoft Inc., 2001).

3. Results

3.1. General

Species numbers differed considerably among sites, varying from 133 to 250 for overall species richness, from 12 to 26 for Red List species and from 15 to 33 for typical wet heathland species (Table 1). Spiders were the most species-rich taxonomic group while burying beetles, cockroaches and sphecid wasps were only represented by four species. Vascular plants and dragonflies were well represented in the typical wet heathland species (Table 2).

The patch size of the wet heathlands we studied proved not to be a suitable substitute for the total number of species (Spearman $r = 0.041$, $p > 0.87$), the number of Red List species (Spearman $r = 0.083$, $p > 0.74$), the number of typical wet heathland species (Spearman $r = 0.224$, $p > 0.37$) or biotope quality (Spearman $r = 0.198$, $p > 0.43$). Biotope quality rather than site area was correlated with the number of species, indicating that quality is at least as important as area in the fragmented wet heathlands in Belgium (cf. Dennis and Eales, 1997; Thomas et al., 2001).

3.2. *M. alcon* as a single indicator species

Sites with *M. alcon* were significantly richer in Red List species and in typical wet heathland species but not in overall species diversity. Although the average biotope quality was higher in sites with *M. alcon*, the difference was not significant between sites with and without *M. alcon* (Table 3a). Patches with and without *M. alcon* did not differ significantly in vegetation cover of the most abundant plant species (*Erica tetralix*, *Calluna vulgaris*, *Molinia caerulea* and *Scirpus cespitosus*; *t*-test, $p\ P\ 0.31$), except for *Gentiana pneumonanthe* that was more abundant on sites with *M. alcon* (*t*-test, $t = 2.828$, $p = 0.03$).

3.3. A multispecies approach for wet heathland in Flanders

Ninety species were considered as typical of wet heathland in Belgium. We found 64 of these species during our survey and baseline information was considered sufficient for 52 species (Step 2). Of the 52 remaining species, 14 species were easily detectable and classifiable species of intermediate rarity. For these 14 candidate species, the best available information on niche, life history and sensitivity to environmental pressures was gathered (Step 4, Table 4). From this list we selected a group of species in which all selection criteria from Step 1 were met with by more than one taxon. If species carried the same information, the most conspicuous and easiest to classify or observe was chosen. Finally, we selected nine species for the multispecies group for wet heathland in Flanders: two birds (*Numenius arquata* and *Saxicola torquata*), two butterflies (*Callophrys rubi* and *Plebeius argus*), two plant species (*Narthecium ossifragum* and *Rhynchospora* spec.), two dragonflies (*Ceriagrion tenellum* and *Leucorrhinia dubia*) and one grasshopper (*Metrioptera brachyptera*).

3.4. The multispecies conservation umbrella

Using the multispecies group to split sites into high (5–9 species of the multispecies group) and low (0–4 species of the multispecies group) quality sites, the analysis showed that high quality sites tended to have more Red list species than low quality sites; overall species richness, typical wet heathland species and biotope quality did not differ significantly between high and low quality sites (Table 3b).

Table 3a
Average number of all species, Red List species, typical wet heathland species and biotope attributes in sites with and without *M. alcon* and the results of the *t*-test for dependent samples

Maculinea alcon	Present	Absent	*t*-test	*p*-value
All species	170.0 ± 29.4	171.4 ± 36.6	0.026	0.980
Red-List species	21.6 ± 2.7	17.9 ± 5.2	2.389	0.044
Typical wet heathland species	26.8 ± 2.5	22.4 ± 3.7	3.406	0.009
Biotope attributes	4.0 ± 1.7	3.1 ± 1.4	1.042	0.328
Species of multispecies group	5.0 ± 1.1	4.1 ± 0.9	2.286	0.052

Table 3b
Average number of all species, Red List species, typical wet heathland species and biotope attributes in sites with 0–4 species of the multispecies group (low quality sites) and in sites with 5–9 species of the multispecies group (high quality sites) and the results of the *t*-test

Multispecies group	Low quality	High quality	*t*-test	*p*-value
All species	158.9 ± 35.3	174.2 ± 28.3	1.016	0.325
Red-List species	15.7 ± 4.9	19.6 ± 3.6	1.924	0.072
Typical wet heathland species	19.2 ± 3.6	21.7 ± 2.9	1.584	0.133
Biotope attributes	3.8 ± 1.6	4.4 ± 2.2	0.732	0.475

Table 3c
One tailed Spearman Rank correlations between the number of species from the multispecies group and the overall number of species, the number of Red List species, the number of typical wet heathland species and biotope quality (i.e., the number of biotope attributes, $n = 7$)

Multispecies group	Spearman *r*	*p*-value
All species	0.326	0.093
Red-List species	0.211	0.201
Typical wet heathland species	0.442	0.033
Habitat heterogeneity	0.435	0.035

Table 4
Remaining species after Step 3 of the multispecies approach for wet heathlands in Belgium and information on area and structure requirements, life history criteria and vulnerability for environmental stressors

	Trophic level	Reaction time	Mobility	Area (ha)	Structure	Pressure
Amphibians and reptiles						
Lacerta vivipara	Insectivore	Intermediate	Low	<5	Su	F
Birds						
Anthus trivialis	Insectivore	Slow	High	5–25	T	F
Lullula arborea	Insectivore	Slow	High	5–25	T	F
*Numenius arquata**	Insectivore	Slow	High	>25	W	F
*Saxicola torquata**	Insectivore	Slow	High	5–25	T	F
Butterflies						
*Callophrys rubi**	Herbivore	Fast	Low	<5	Su/T	D/E/F
Maculinea alcon	Insectivore/herbivore	Fast	Low	<5	Su/Se	D/E/F/M
*Plebeius argus**	Herbivore	Fast	Low	<5	Su	D/E/F
Dragonflies						
*Ceriagrion tenellum**	Insectivore	Fast	Low	<5	F/Se/R	D/E/F
*Leucorrhinia dubia**	Insectivore	Fast	Low	<5	F	D/E/F
Grasshoppers						
*Metrioptera brachyptera**	Insectivore/herbivore	Fast	Low	<5	Su	F/M
Vascular plants						
*Narthecium ossifragum**	Autotrophic	Slow	Intermediate	<5	Sp/Se/W	D/E
*Rhynchospora alba/fusca**	Autotrophic	Fast	High	<5	Su/W	D/E/M^+
Scirpus cespitosus	Autotrophic	Slow	Low	<5	Sp/W	D/E

Reaction time is expressed as a function of the number of offspring per year: Slow (one generation per year), Intermediate (one generation per year but relatively low number of eggs or young), Fast (more than one generation per year or high numbers of eggs or offspring per year); Structural attributes: Su, different succession stages; T, scattered trees; F, fens, Se, seepage; R, microtopography; W, permanently wet; Sp, Sphagnum mosses; Pressure (sensitivity to environmental pressure): F, fragmentation, D, desiccation, E, eutrophication, M , sensitive to intensive management, M^+, reacts quickly to management measures. Species marked with an asterix were selected for the multispecies group.

However, the total number of all typical wet heathland species ($n = 64$) was positively correlated with the number of biotope attributes, i.e., sites with greater biotope quality had higher numbers of typical wet heathland species (Fig. 2; cf. Tews et al., 2004). The subset of species of the multispecies group in the different sites remained positively correlated with the number of typical wet heathland species and with biotope quality, but not with the overall number of species or the number of Red List species (Table 3c). Furthermore, sites with

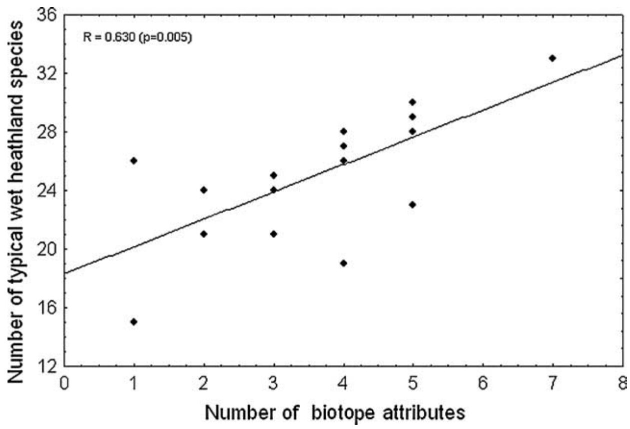

Fig. 2. Correlation between the number of habitat attributes (*x*-axis) and the number of typical wet heathland species (*y*-axis).

M. alcon tended to have a larger number of species of the multispecies umbrella group (Table 3a).

4. Discussion

Nature conservation in Belgium is largely non-scientifically based. Sites are often acquired on the basis of threatened biotope types (e.g., EU Habitat Directive) while others are managed for the assumed maintenance of ecological processes (e.g., nutrient cycles, hydrology). Several authors have shown that species can become extinct under such site- or ecosystem-based conservation policies that fail to consider species-specific biotope features (Pickett et al., 1992; Simberloff, 1998). Until recently, the quantitative use of species in decisions about site selection or management measures has been rather scarce in Belgium (Van Dyck et al., 1999), and also elsewhere (Pullin et al., 2004; Prendergast et al., 1999). However, the integration of quantitative species information, as applied here for wet heathland, can render nature conservation considerably more efficient by using species as tools for site selection, management evaluation and/or the evaluation of nature conservancy policy (Lawton, 1997).

4.1. Single or multispecies indicators

Our results suggest that *M. alcon* and the multispecies group have complementary indicator capacities. *M. alcon* has been shown to be a good indicator for both threatened and typical species and has some capacity as an indicator for biotope quality. Wet heathlands with *M. alcon* can therefore be considered of fairly high quality (WallisDeVries, 2004). The multispecies group did not perform as well as *M. alcon* when the number of species of the multispecies group was used to split sites into high and low quality wet heathlands. However, when applied as a metric measure, the multispecies group proves to be a good indicator for both typical wet heathland species and for biotope quality and, therefore, gives complementary information to that of *M. alcon*. By definition, the multispecies group has the benefit of including species with different ecological requirements. Management evaluation with a multispecies group is, therefore, more subtle than with a single indicator species (Fleishman et al., 2000). In our particular case, *M. alcon* and the multispecies group both have useful indicator capacities; but, care should be taken to distinguish between the use of species (in our case *M. alcon*) as a tool or as a target; measures taken for target species (i.e., the conservation of the species is the ultimate goal) do not obviously benefit other species in the same biotope (Landres et al., 1988). A major disadvantage of *M. alcon*, however, is its rarity and therefore its limited geographical applicability as an indicator species. Intermediate rarity is one of the criteria for the selection of species in the multispecies group and makes the multispecies group more widely applicable than the very rare *M. alcon*. Neither *M. alcon* nor the multispecies group, however, can be used as indicators for total species richness. Contrary to findings for more natural biotopes, typical species contribute relatively little to the total species richness in semi-natural biotopes and total species richness is therefore not a good measure for biotope quality here.

4.2. Practical advantages of the multispecies approach

The multispecies approach as applied here meets the suggestions made by several authors in bringing science closer to conservation practitioners (Deem et al., 2001; Pullin and Knight, 2001; Robertson and Hull, 2001; Roberge and Angelstam, 2004): the species of the multispecies group are easily recognizable by non-experts and at the same time provide information on other threatened or typical species and on biotope quality (expressed as the number of typical biotope attributes). Additionally, the information content of the multispecies group can be explicitly used in the evaluation of, or the establishment of, conservation measures (McGeoch, 1998). The presence or absence of particular species of the multispecies group could be used as a signalling function: the absence of both species of relatively large wet heathlands, for example, could indicate site conditions below a minimum area threshold or an unsuitable habitat configuration; conservation practitioners can subsequently use this information to direct adequate management measures to enlarge, restore or connect existing habitat patches. However, even the use of a group of taxonomically different species for the planning or evaluation of conservation measures remains a simplification following on from inevitable pragmatism in conservation practice (Roberge and Angelstam, 2004). By skipping Step 3 in the stepwise selection procedure (i.e., easily recognisa-

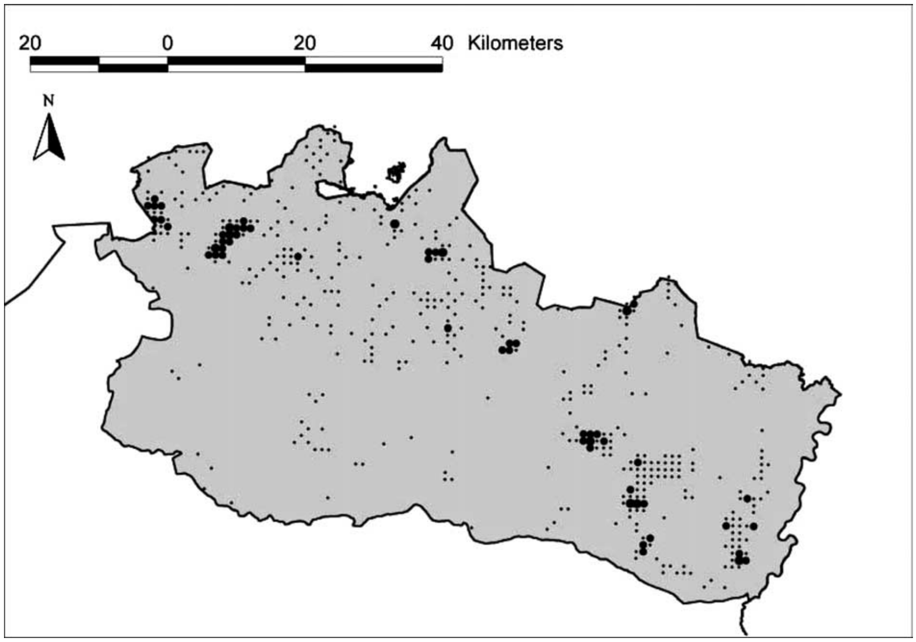

Fig. 3. Number of species from the wet heathland multi-species group per km^2 in the Campine region (shown in grey) in NE Belgium. Small dots, 1–3 species; intermediate dots, 4–6 species; large dots, 7–9 species.

ble species), the multispecies group can be enlarged with additional species that fulfil all other criteria in the stepwise selection procedure. This will, however, inevitably increase both effort (more time and material will be needed for detecting and capturing the species) and costs (more experts will have to be involved for the classification of the additional species) that, in turn, will reduce feasibility of the use of such an extended multispecies group.

But these multispecies groups have the clear benefit of forcing managers to 'cross' taxonomic boundaries and hence, explicitly, to take different requirements (including different scales) into account that are relevant for different biodiversity components. As the composition of multispecies groups relies strongly upon available knowledge of taxonomy, distribution and ecology, the use of multispecies approaches represents a continuous process rather than a one-off operation (Fleishman et al., 2001); additionally, one or a few species (that are absent in some sites) can locally be interchanged with other species having the same 'information content'. Other authors have proposed statistical ways to select indicator species (e.g., the umbrella index; Fleishman et al., 2000) but this index is only applicable within taxonomic groups and cannot be used to determine umbrella species from a taxonomically diverse dataset (Fleishman et al., 2001).

4.3. Other multispecies applications

Multispecies approaches can be used in various conservation applications, e.g., evaluation of biotope quality, impact of nature management, setting conservation priorities, site selection, etc. The impact of nature management on the species composition of wet heathland can be evaluated by monitoring not only the presence/absence of the different species, but also by incorporating estimates of their abundances; increasing abundances of species that indicate a divergence from the pre-set goal can be used to alter the actual nature management scheme, or at least to signal the need for more detailed, mechanistic research to detect what is wrong or lacking. A further extension of the multispecies approach is that it allows the prioritization of sites in a focal region: counting the number of species from the multispecies group per km^2 (the smallest grid unit used in mapping schemes in Belgium) rapidly indicates the high quality wet heathlands (heathlands with a large number of species in the multispecies group; Fig. 3); interpreting the absence of certain species from the multispecies group in intermediately (4–6 species of the multispecies group present) or low quality (1–3 species of the multispecies group present) rated wet heathlands, can indicate appropriate management measures or acquisition policies for surrounding sites to fulfil the needs of the missing specialist species.

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