A decision tool for listing species for protection on different geographic scales and administrative levels

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ABSTRACT

An important task in conservation biology is to assess the spatial scale pertinent for species protection since some species may require protection throughout their distribution, others in only part of their range. Once this is done, species can be correctly identified for listing at different administrative levels (e.g. continental, national, and local). Here, we propose an objective method to list taxa at nested administrative levels based on three criteria (responsibility, rarity and vulnerability). We tested the method using quantitative data on the distribution, abundance and decline of orchids in France. The proposed method enables increased protection status in regions where species’ abundance and diversity are higher, gives priority to species for which an individual administrative unit has high responsibility and allows objective integration of species decline at different administrative levels. The method also enables the integration of locally rare species at their distribution limits and avoids repetition of species listing across second-level administrative units. The use of an objective method such as this could contribute to a standardised system of priority setting that integrates the geographic scale of rarity in relation to different administrative levels for protection.

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Introduction

Effective conservation requires the establishment of priorities (Bottrell et al. 2008; Margules & Pressey 2000). A key task here is to assess the geographic and administrative levels necessary for priority setting since some species may require protection throughout their distribution (across administrative units), others in only part of their distribution where their populations are highly threatened. Policy for habitat and species protection at different administrative levels thus requires articulation across different geographic scales and administrative levels (Abbitt et al. 2000; Hartley & Kunin 2003; Pfeifer et al. 2010; Schmeller et al. 2008). Indeed, decisions concerning species listing or protected area selection often occur within administrative units that rarely reflect the scales of species’ distributions. Articulating priorities across different administrative units thus remains a serious challenge. Two major issues are at stake here and require careful thought for their integration into any methodology for priority setting across administrative units.

The question of assessing priorities at different spatial scales is particularly clear for species in peripheral parts of their range (Abeli et al. 2009; Hartley & Kunin 2003). Listing species for protection that are locally rare but globally common may lack pertinence for conservation planning due to their marginal nature in that region (Abbitt et al. 2000; Rodrigues & Gaston 2002; Vazquez et al. 2008). Indeed, administrative divisions can have an important influence on conservation recommendations (Erasmus et al. 1999), bias allocation of conservation funding (Hunter & Hutchinson 1994), and reduce cost efficiency (Kark et al. 2009). However, for many plants and invertebrates with restricted dispersal mechanisms, peripheral populations may be important areas of ongoing diversification (Lesica & Allendorf 1995; Pfeifer et al. 2009, 2010; Thompson 2005; Thompson et al. 2010) or represent leading edge populations in the ecological and evolutionary response of species to environmental change (Channell & Lomolino 2000; Gibson et al. 2009). Hence, correctly assessing priorities for the populations of species on the periphery of their range is an important challenge (Abeli et al. 2009; Leppig & White 2006; Millar & Libby 1991).

The second issue that requires attention concerns the need to identify the geographic gradients of climate, geology and human activities that can commonly cause gradients in species diversity and rarity; as has been illustrated for endangered species in North America (Dobson et al. 1997) and for the European Union member states where resource allocation is centred on southern Europe due to the presence of many range limited species of conservation importance (Bladt et al. 2009). It is thus important to have criteria that identify important areas of endemism and rarity and where species are endangered (Gauthier et al. 2010; Pärtel et al. 2005; Schmeller et al. 2008). As recent methodological propositions clearly illustrate (Bacchetta et al. 2012; Gauthier et al. 2013), a critical issue of priority setting here concerns the need to
distinguish naturally rare and endemic species which may often occur in stable habitats from those which currently incur high treatments due to the vulnerability of their habitat. It is also of primary importance to adapt the thresholds used for different ranking criteria to the geographic and biological realities of the study area, as Martin (2009) has shown for biodiversity on oceanic islands where endemism (and thus local responsibility) are high and species may most often be scarce (low local abundance). Finally, wherever possible, criteria should enable a taxonomically unbiased process of ranking that does not focalise attention on emblematic species (Martin et al. 2010).

A standardised method for priority setting which allows for scaling of criteria of rarity and vulnerability across administrative units and levels is now necessary for “the strategic allocation of flexible, but limited resources in global conservation planning” (Schmeller et al. 2008, p. 3625). Databases on patterns of species distribution and abundance are improving rapidly in terms of numbers of groups that are being inventoried and the quality of the data they contain. In future decades such databases will provide sources of information for decision makers to establish priorities in an interactive manner across their respective administrative units. It is thus important to develop methods to articulate priority setting across administrative units that rely on quantitative data to produce objective lists of protected species.

In this study we develop a simple and objective method for priority setting on two different administrative levels based on three criteria to assess the spatial scales of rarity and decline: responsibility; rarity; and, vulnerability. These three criteria have been tested at different spatial scales and administrative levels (Gauthier al. 2010, 2013) but their articulation across different scales and administrative levels for a given set of species has not been tested. This paper has three aims. First, we build a decision rule based on the three criteria to establish lists of species for protection on a first order administrative level (in our study this is at the national level) and on a range of different units at a second administrative level (in our study this is done for the 22 administrative regions within France). Second, to test the applicability of the method, we used data bases and information on distribution, abundance and decline for orchid taxa in France and Europe to score species for the three criteria at each administrative level and produce lists at two administrative levels: national listing; and, listing in each region. Third, to assess the pertinence of our method we compared these lists with the current regional and national lists in France, and also the IUCN regional list for France (IUCN 2010).

Methods
Criteria and administrative context

In this paper we test a method to list species at two administrative levels in France: at the national level; and, within each of the 22 French regional administrative units (including Corsica). In France, a list of nationally protected plant species was established in 1982, and lists of protected species have been produced for each region from 1986 to 2004 (Danton & Baffray 1995). A national red list has been compiled by Olivier al. (1995). Regional lists were produced independently, causing much repetition of species on different lists (Gauthier et al. 2009).

Our study is based on the use of three criteria (responsibility, local rarity and vulnerability) that allow for information and questions concerning rarity to be synthesised on different spatial scales (Gauthier et al. 2010, 2013). Responsibility provides an assessment of the biogeographic scale of rarity (which species are endemic and which species are widespread), local rarity provides an assessment of abundance within a study unit (national or regional) and thus accounts for spatial variation in rarity and vulnerability identifies which species show a decline and whether this decline is widespread across regions or localised in particular parts of the distribution of a species.

A decision tool for listing species at two administrative levels

We propose a decision tool to allocate species for listing at either the national or regional level. The decision procedure is first performed using data for all species at the national level (Table 1a) and subsequently for the species present within each region (Table 1b). The process depends on scores for each of the three criteria at the national level and in each region where they are present. In the decision tool, scores for responsibility and rarity ranged from one to five (following Gauthier al. 2010) and vulnerability was assessed as an observed decline (or not), and we distinguished species which showed a decline in more than two regions from those which showed a decline in only one or two regions. To compare actual lists of protected species with those proposed by the decision tool we distinguished five scores for vulnerability as for the other two criteria (Table 2).

The decision process works across the columns of Table 1 from left to right in an “if,” “and,” “then” iterative procedure across the table. “If” a species satisfies the three criteria “then” a form of listing is proposed. Going down the table, all the different possible combinations of the three criteria are treated.

For listing species at the national scale (Table 1a), the procedure we propose gives priority to taxa which are either endemic or sub-endemic to France or show a widespread decline across the study area, whatever their rarity in France. Hence, if a species (sub-) endemic to France is given a score of five for national responsibility then it is proposed for national listing, whatever its rarity or vulnerability (line 1 in Table 1a). If a species has a score of four for national responsibility then it can be allocated for either national or regional or no listing, depending on its rarity and vulnerability. If the species has a high score for national rarity (4–5) then it will be listed for national protection (line 2 in Table 1a). For more common species (a score of national rarity of 1–3), or for species with a low national responsibility (1–3) if they show widespread decline then they are proposed for national protection (lines 3 and 7), if they show a localised decline (one or two regions) then they are proposed for regional protection in the regions where a decline is observed (lines 4 and 8), if no decline has been observed then they remain unlisted (line 5). Finally, regional protection is proposed for geographically widespread species (national responsibility of 1–3) that show no decline but only occur in one or two regions (Table 1a line 6). These species, along with the sub-endemic species proposed in line 2, represent species that occur in France as peripheral populations.

In the analysis of the different regional data sets, proposals for regional protection concern any species that shows a decline in a given region (Table 1b lines 1–4), and species that do not show a decline in the given region but which are rare in the region or because the region has a high responsibility for such species within France (Table 1b lines 1–2). For taxa in the classes 3–4 of regional responsibility (line 2), since the classes are based on the percentage of national point occurrences that occur in the region, taxa may occur in more than two regions and thus are not selected in the procedure based on the national data set in which rarity is based on the number of regions. Hence they are not all automatically selected in Table 1a. Hence the analysis based on regional data sets allows us to propose additional species for regional protection that are rare at the national level in terms of abundance and distribution but which are missed in the first step because they occur in more than one other country and in more than two regions in France and show no observed decline. However, the point occurrence data show that they are very rare wherever they occur and the decision process
Table 1
Proposed protocol for allocating species to either regional (RP) or national (NP) protection status based on classes of national (step 1) and regional (step 2) responsibility, rarity and vulnerability (observed decline). Species recommended for national protection are automatically excluded from the regional procedure (step 2). Species that do not satisfy criteria are not proposed for listing (UP). The decision process works from left to right in an “if-then” iterative procedure down the table. “If” a species satisfies the three criteria “then” a form of listing is proposed.

(a) National level

<table>
<thead>
<tr>
<th>National responsibility</th>
<th>Rarity</th>
<th>Vulnerability</th>
<th>Proposed listing</th>
<th>Number of orchid taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>National responsibility</td>
<td>Rarity</td>
<td>Vulnerability</td>
<td>Proposed listing</td>
<td>Number of orchid taxa</td>
</tr>
<tr>
<td>5</td>
<td>1–5</td>
<td>Yes or No</td>
<td>NP</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>4–5</td>
<td>Yes or No</td>
<td>NP</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>1–3</td>
<td>&gt;2 regions</td>
<td>NP</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1–3</td>
<td>1–2 regions</td>
<td>RP</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1–3</td>
<td>No</td>
<td>UP</td>
<td>1</td>
</tr>
<tr>
<td>1–3</td>
<td>4–5</td>
<td>Yes or no</td>
<td>RP</td>
<td>25</td>
</tr>
<tr>
<td>1–3</td>
<td>1–3</td>
<td>&gt;2 regions</td>
<td>NP</td>
<td>19</td>
</tr>
<tr>
<td>1–3</td>
<td>1–3</td>
<td>1–2 regions</td>
<td>RP</td>
<td>22</td>
</tr>
<tr>
<td>1–3</td>
<td>1–3</td>
<td>No</td>
<td>UP</td>
<td>53</td>
</tr>
</tbody>
</table>

(b) Regional level

<table>
<thead>
<tr>
<th>Regional responsibility</th>
<th>Rarity</th>
<th>Vulnerability</th>
<th>Proposed listing</th>
<th>Number of orchid taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3–5</td>
<td>Yes or no</td>
<td>RP</td>
<td>b</td>
</tr>
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<td>3–4</td>
<td>3–5</td>
<td>Yes or no</td>
<td>RP</td>
<td>6</td>
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<tr>
<td>1–2</td>
<td>3–5</td>
<td>Yes</td>
<td>RP</td>
<td>b</td>
</tr>
<tr>
<td>1–2</td>
<td>1–2</td>
<td>Yes</td>
<td>RP</td>
<td>b</td>
</tr>
<tr>
<td>1–2</td>
<td>1–2</td>
<td>No</td>
<td>UP</td>
<td>c</td>
</tr>
<tr>
<td>1–2</td>
<td>1–2</td>
<td>No</td>
<td>UP</td>
<td>c</td>
</tr>
</tbody>
</table>

* In regions where a decline has been observed.
* Taxa already selected in step 1.
* All remaining UP species in each region.

At the regional level (Table 1b line 2) allocates these species for protection in regions with a high responsibility for their protection.

Empirical test using data on orchids

We use data on the distribution and abundance of the 157 orchid taxa (species and subspecies) that occur in France to score taxa for the three criteria at the national and administrative regional level. Their current declines in presence or population size (Whigham & Willem 2003), their emblematic status (Cribb et al. 2003), their widespread (illegal) collection from the wild, and their high rates of endemism and variation in geographic distribution (Bournéria et al. 2005; Delforge 2005) make orchids a particularly interesting group for the study of how to articulate priorities at different spatial scales and administrative levels. For orchids, a large database on species distribution and abundance in France has been recently published by the French Orchid Society in an atlas based on presence/absence in a 10 km × 10 km grid scale (Dusak & Prat 2010). The atlas is the result of 20 years data compilation by ~3000 amateurs of 420,000 data points in a total of 5911 grid cells (10 km × 10 km) covering the national territory. This database provides a valuable source of information to assess criteria for conservation priorities at different spatial scales.

For each taxon, national responsibility was calculated using the number of countries where taxa occur in Europe, North Africa and the Middle East (obtained from Delforge 2005). This author reported the presence of species across Europe, the major Mediterranean islands, North Africa and the Middle East countries that border the Mediterranean Sea (a total of ~50 administrative units beyond France). Note that species totally endemic to France were allocated to class 5, and sub-endemic species (present in only one other country) to class 4, and so on. We thus score this criteria based on an objective assessment of the degree of endemism. Using information in the atlas, national rarity was determined as the

Table 2
Criteria used to assess national and regional responsibility, rarity and vulnerability for the 157 orchid taxa in France. We scored all taxa for the three criteria with quantitative values in databases. National responsibility is based on the number of countries where a taxon is recorded including France and national rarity is the number of regions where a taxon has been recorded in France. Regional responsibility is the percentage of national point occurrences in a given region relative to the total number of point occurrences in France, and regional rarity is the number of point occurrences in the region. Vulnerability is assessed as the percentage of “departments” where a taxon reported by Bournéria (1998) was not reported by Bournéria and Prat (2005). The construction of the five classes is described in the text.

(a) National level

<table>
<thead>
<tr>
<th>Class</th>
<th>Responsibility</th>
<th>Number of taxa</th>
<th>National rarity</th>
<th>Number of taxa</th>
<th>Vulnerability</th>
<th>Number of taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>18</td>
<td>1</td>
<td>31</td>
<td>&gt;30</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>20</td>
<td>2</td>
<td>24</td>
<td>16–30</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>3–5</td>
<td>26</td>
<td>3–5</td>
<td>25</td>
<td>5–15</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>6–8</td>
<td>15</td>
<td>6–10</td>
<td>31</td>
<td>&lt;5</td>
<td>23</td>
</tr>
<tr>
<td>1</td>
<td>9 (or more)</td>
<td>78</td>
<td>&gt;10</td>
<td>46</td>
<td>0</td>
<td>107</td>
</tr>
</tbody>
</table>

(b) Regional level

<table>
<thead>
<tr>
<th>Class</th>
<th>Regional responsibility</th>
<th>Regional rarity</th>
<th>Vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>100%</td>
<td>1</td>
<td>&gt;30%</td>
</tr>
<tr>
<td>4</td>
<td>67–99%</td>
<td>2–5</td>
<td>16–30%</td>
</tr>
<tr>
<td>3</td>
<td>30–66%</td>
<td>6–20</td>
<td>5–15%</td>
</tr>
<tr>
<td>2</td>
<td>5–29%</td>
<td>21–50</td>
<td>&lt;5%</td>
</tr>
<tr>
<td>1</td>
<td>&lt;5%</td>
<td>&gt;50</td>
<td>0</td>
</tr>
</tbody>
</table>
number of regional administrative regions occupied in France, regional responsibility as the percentage of national point occurrences that occur in a given region, and regional rarity was determined as the number of point occurrences in a given region. National and regional vulnerability were assessed in terms of observed decline. This was done by quantifying the percentage of local administrative units within regions (“départements” that vary in number from two to eight per region) where a taxon reported by Bournières (1998) was not reported by Bournières and Prat (2005).

Once the criteria were scored for all taxa they were subjected to the decision tool process in Table 1 to propose taxa for national and regional listing. We also classified taxa according to their current listed status as nationally protected (NP), regionally protected (RP) and unlisted (UP) taxa. We assessed patterns of orchid distribution and abundance in relation to listed status by quantifying the numbers of taxa in each category in both current and proposed lists (NP, RP and UP taxa) per region, the numbers of regions where each taxon occurs, the number of regions where each taxon has been proposed to be listed and the national and regional responsibility for each of each taxon. We also compared these lists to their current IUCN status (IUCN 2010).

We tested for correlations of the number of orchid taxa per region with latitude and surface area. We also explored whether the mean values of responsibility, rarity and vulnerability show geographic variation. To avoid any spurious findings that are more due to differences in surface area of regions than their geography, mean values were standardised in relation to the surface area of the region (individual mean value multiplied by mean surface area and divided by individual mean surface area). Maps were constructed using the Quantum GIS 1.7.0-Wroclaw software (2011) to visualise the regional differences. Finally, we examined the relationship between listed status and taxonomic history by identifying taxa first described after 1982.

Results

Numbers of taxa on present and proposed lists

The 157 orchid taxa that occur in France (Dusak & Prat 2010) comprise 148 individual species, one species with two subspecies in France, one species with three subspecies in France and four taxa that are subspecies of a species distributed outside of France. Twenty-one taxa are currently listed at the national level (NP species), 78 are listed in at least one region (RP species) and 58 lack any conservation status (UP species). Of the 78 taxa currently listed for regional protection, 29 occur on a single regional list, 13 on two lists and 11 on three regional lists, while another 20 taxa occur on 4–10 lists and five taxa are listed for protection on 10–12 regional lists. As a result, the number of taxa by list combinations reaches a total of 262 listings. Our analysis also revealed that eight taxa are protected in regions where they are not currently present (due to species loss since the lists were established).

By subjecting scores for the three criteria of national responsibility, rarity and decline for each taxon we were able to propose taxa for inclusion on national or regional lists using the decision tool in Table 1. Assessment of the national data set in the decision tool (Table 1a) produced the majority of proposals for species listings, including most propositions for regional listing. The decision tool procedure produced a list of 56 taxa for inclusion on the national list, 52 taxa for listing in at least one region and 49 unlisted taxa. Compared to current lists there is a slight increase in the total number of listed taxa (from 99 to 108 taxa), with a more than two-fold increase in the number of taxa proposed for national protection but a marked decrease in the number of species proposed for regional protection. In addition, the proposed lists for regional protection involve regional protection for 29 taxa in a single region or 23 taxa on two regional lists only. As a result the number of taxa by list combinations reaches a total of only 75 listings.

An additional six taxa were proposed for regional protection using the individual regional data sets (Table 1b). These six taxa show no decline but high scores of regional rarity and/or responsibility. One of these six taxa was already proposed by step one of the decision tool for regional protection in a region where a decline has been observed. This species is proposed again in a different region by step two of the decision process due to a high score of regional responsibility in this second region. Hence the number of additional species proposed in step two is only five and not six (Table 1b).

Latitudinal gradients in numbers of species on proposed and current lists

The number of orchid taxa per region is significantly negatively correlated with latitude ($R = -0.833$, $df = 21$, $p < 0.001$) with a strong geographic gradient of increasing numbers of taxa toward the south-east and in particular the two regions bordering the Mediterranean Sea, which both contain more than 100 taxa (Fig. 1a and c). There is also a significant correlation between numbers of taxa and regional surface area ($R = 0.459$, $df = 21$, $p = 0.05$; Fig. 1b and d) although this is slightly blurred by the fact that the two Mediterranean regions, which have the highest numbers of taxa are not the largest regions (Fig. 1d). The standardised mean values in each region of the data used to score the three criteria showed (Fig. 2a–c) a significant negative correlation between latitude and mean regional responsibility ($R = -0.578$, $df = 21$, $p < 0.01$), a significant positive correlation between latitude and vulnerability ($R = 0.586$, $df = 21$, $p < 0.01$), and no correlation for regional rarity ($R = 0.332$, $df = 21$, $p > 0.1$).

The proportion of currently listed taxa in a region increases with the numbers of taxa across regions with a small number of taxa, but then declines dramatically as the number of taxa increases above 60 taxa (Fig. 3a). We did not test for significance of this trend due to the fact that the two data sets lack independence, but regions with the highest number of taxa tend to have proportionally fewer protected taxa. When the proposed lists produced by our decision tool are analysed, the proportion of listed taxa per region increases continuously with the numbers of taxa present in a region (Fig. 3b). For current lists there is an increase in the number of nationally listed taxa in administrative regions in the Mediterranean climate zone of France and more generally in all southern regions (Fig. 4a). This trend is not observed for regionally protected taxa whose numbers increase toward the north and west (Fig. 4c). For proposed lists, the geographic gradient of increasing numbers of nationally protected taxa per region in the southern-eastern regions is clearer (Fig. 4b) and variation in the number of taxa on regional lists also increases toward the south and west (Fig. 4d).

Differences among current and proposed lists in relation to the three criteria

Seventy-eight taxa (i.e. 50%) are widespread: they occur in at least nine countries (Table 2). At the other extreme, 18 taxa are endemic to France and 20 occur in France and in only a single neighbouring country. Of these 38 taxa, only 13 are currently listed for protection in France (six at the national level, seven in one or more regions) while 67 of the 78 taxa that are present in at least nine countries have a current protection status in France – eleven listed for national protection and 56 for regional protection (Fig. 5a). A similar pattern of a proportional increase in the numbers of listed species is observed in the low classes of rarity (Fig. 5b) and for the 107 taxa which show no evidence of decline in terms of loss from administrative units (Fig. 5c). For the 50 taxa which do show
evidence of a decline, all but one have a listed status but some taxa with a fairly extensive decline (class 4) are listed for regional protection. For the rarity criterion, the taxa that are the most rare in France tend to be unlisted species (Fig. 5b). Although these trends are primarily due to an increase in the number of regionally protected taxa in the low classes of the three criteria, it is also clear that there is no proportional increase in nationally protected taxa in the high classes of national responsibility and rarity and several nationally protected taxa have not yet evidenced decline (Figs. 5a–c).

Very different trends are observed for proposed lists (Figs. 5d–f). First, all the 38 taxa that only occur in France or in a single neighbouring country are listed for national protection and species listed for regional protection are more evenly distributed across the different classes of responsibility (Fig. 5d). For the rarity criterion, the high classes of rarity (in terms of numbers of regions occupied and also in terms of the number of grid cells occupied) are now exclusively composed of regionally or nationally protected taxa and all unlisted taxa are in the low classes or rarity (Fig. 5e). For vulnerability (Fig. 5f), our method produces a similar but less marked shift; no unlisted species show a decline and the 19 taxa with extensive decline (>2 regions) are allocated to national protection rather than regional protection; the latter being limited to taxa that show a decline in only one or two regions. The seven taxa classified as unprotected taxa which show a decline (Fig. 5f) were designated for regional protection by our method, however they are no longer present in the region where the decline has occurred and thus cannot be on the regional list. Their scores for the three criteria do not make them eligible for listing at the national level or in other regions.

When compared to the IUCN categories for orchid taxa in France (IUCN 2010), taxa on the current list for national protection are essentially in the near-threatened, vulnerable and endangered categories and very few are considered of least-concern (Fig. 6a). Taxa on the current lists for regional protection are in contrast mostly those allocated to the least-concern category. The comparison with our proposed lists (Fig. 6b) also shows that taxa proposed for national protection are more evenly distributed across IUCN categories such that in addition to numerous taxa in the near-threatened, vulnerable and endangered categories, several taxa occur in the least-concern category and several taxa are considered as data-deficient species. Taxa proposed for regional protection are evenly distributed across the IUCN categories but less often taxa of least-concern than on current lists.

Recently described species

Thirty-four new taxa have been described since 1982, of which 19 are endemic or sub-endemic to France, i.e. categories 5 and 4 of national responsibility and 20 species occur in only one or two regions within France, i.e. categories 5 and 4 of national rarity (see Table 2 for these categories). As a result, a total of 25 of the 34 taxa have a score of four or five for at least one of these criteria, but mostly remain unlisted at the present time.

Discussion

Planning for conservation at the level of integrated administrative units can be ecologically more representative (Rodrigues & Gaston 2002; Vázquez et al. 2008) and significantly more cost efficient (Kark et al. 2009) than combining the plans of individual countries or administrations. Here we propose a decision tool to list species for protection across administrative units and levels that avoids repetitive listing of species on different lists, gives weight to the occurrence of a significant portion of a species range in the considered unit and allows for inclusion of range limit populations.

Our analysis of the current lists of protected orchid species in France illustrates the problems of independent listing in several administrative regions. First, we observed a decrease in the proportion of currently listed species in regions with the highest number of species, which are also regions with the highest responsibility for many species. Second, as we have observed for the French flora in general (Gauthier et al. 2009), there is currently marked
repetition of species on multiple lists for regional protection (several species on more than 10 lists), which contrasts with a relatively low number of species on a list for national protection (i.e. throughout their distribution in France). This is primarily due to the presence of taxa that show a decline in several regions on several regional lists. Third, current lists only include nine of the 38 taxa which only occur either in France or in one adjacent country, while 67 of the 78 taxa that are present in nine countries or more have a current protection status in France – eleven listed for national protection and 56 for regional protection. In addition, 25 of the 34 orchid taxa that have been described since the national list of protected species was published have high scores for national responsibility and/or national rarity.

Application of our proposed method produced important shifts in the allocation of species to different lists. First, whereas regions (particularly in the south-east of France) with a high number of species and on average high regional responsibilities for the species present currently have proportionally fewer protected species, the decision process underlying our proposal gives more priority to listing species in such regions thus allowing centres of diversity to become priority areas for species protection. Second, our proposed listing at the two administrative levels avoids repetition of species listing. There are now only 75 combinations of species and lists for regional protection compared to the current 262 listings due to repetition of species on several regional lists. With our method no species can be on more than two regional lists. Third, enhanced attribution of species to a single national list is now made for species that show widespread decline instead of listing on several regional lists where decline is observed. Hence, such species become protected throughout their distribution in the administrative unit with the largest scale. As a result, our method introduces a way of bringing attention to the need to attempt to prevent any future decline where it has not yet been observed. Our proposition thus goes beyond conservation practice that treats symptoms (observed decline) towards action that is preventive in terms of the possibility of future decline.

Our method brings to the fore the necessary compromise between listing species in areas which have a high responsibility, i.e. priorities for endemic species or “significant populations” of more widespread species (Greenwald 2009; Millar & Libby 1991) and the potential importance of peripheral populations in species conservation. In this context, our method identifies species which occur in only one or two regions in France (high classes of national rarity) but which may be more widespread elsewhere (low national responsibility) as priority species for a protected status in France. With our method such species are proposed for listing in the one or two regions where they occur within France, i.e. the 19 sub-endemic taxa proposed for national protection and the 25 widespread taxa that are proposed for regional listing. These too may be “significant populations” in the future evolution of a given species (Lesica & Allendorf 1995; Pfeifer et al. 2010; Thompson et al. 2010). Our proposed method does not involve a dramatic increase in the number of proposed taxa for protection. Hence, allocating species for listing based on the presence of peripheral populations does not necessarily take scarce resources away from other priority species (Leppig & White 2006). We thus provide a means of assessing conservation priorities at different spatial scales that integrates the special situation of peripheral populations, as
Fig. 4. The number of listed taxa per region: (a) and (b) the number of nationally protected species on current and proposed lists respectively, (c) and (d) the number of regionally protected species on current lists and proposed lists respectively.

Fig. 5. Current (a)–(c) and proposed (d)–(f) numbers of listed taxa in relation to three criteria: national responsibility (a) and (d), national rarity (b) and (e) and vulnerability (c) and (f). Black columns – national listing, grey columns – regional listing, open columns – unlisted species.
recommended in recent previous work on these issues (Abeli et al. 2009; Hartley & Kunin 2003).

The method we propose relies on a small number of criteria with few and well defined ranks that provide a simple hierarchy for decision-making. This is a key point for the generalisation and practical acceptance of a priority setting method (Gauthier et al. 2010; Schmeller et al. 2008). Our method also provides a tool that could be rapidly employed in the future to update lists of protected species as the acquisition of new information on species presence, abundance or decline continues to be gathered. This is critical; the objective of any list is ultimately the removal of species from the list. Whereas data on responsibility and rarity are generally easily accessible, data on species-specific vulnerability are more difficult to acquire for each area of presence. This criterion is however fundamental to assess priorities for conservation management (Blanca et al. 1998; Gauthier et al. 2013; Pártel et al. 2005). It is also critical to be able to distinguish naturally rare species in a region from those that incur important threats. As Bacchetta et al. (2012) and Gauthier et al. (2013) illustrate this is a particularly important issue in areas with high endemism where endemic species are not necessarily the most threatened with extinction. In common with these previous studies, our method based on different criteria allowed us to identify the reasons why a species should be considered for listing and thus for the implementation of appropriate conservation measures.

In conclusion, several authors have identified the lack of objectivity and the need for a standardised method for listing species at different administrative levels (Keith et al. 2000; Mooers et al. 2007). Here, we explore a method of priority setting that could be used within a decision process for the co-construction of a single list covering many administrative units and a large number of individual but not independent lists within the larger area. We tested the decision tool on a single family in a single country: orchid taxa in France at two administrative levels. This is simply an application of the decision tool using a group of species and a region where data were rapidly available to provide a test. This family has an exemplary database and atlas of species distribution, abundance and vulnerability in France that has been generated by a network of amateur and professional naturalists. The comprehensive nature of the data made available by the network of naturalists allows us to test a method for priority setting. Although for most plant species’ groups we do not currently have such accuracy, new databases are appearing and being developed in many plant families and species groups; as these databases appear our method could be more widely tested; for example at a biogeographic scale such as the western Mediterranean region. Indeed, for Europe (Bladt et al. 2009) and the Mediterranean region (Kark et al. 2009) there is growing interest in the need for integrated planning at the level of biogeographic units that go beyond administrative frontiers. Our methodology could thus constitute a means to instigate collaboration among neighbouring countries to harmonise species listing at the biogeographic scale necessary for efficient conservation.

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References


Fig. 6. Current (a) and proposed (b) numbers of listed taxa in relation to their IUCN red list status (DD, data deficient; LC, least concern; NT, near-threatened; VU, vulnerable; EN, critically endangered). Black columns – national listing, grey columns – regional listing, open columns – unlisted species.


