Priority ranking scheme for Red Data plants in Gauteng, South Africa

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The Gauteng Department of Agriculture, Conservation, Environment and Land Affairs is often faced with the necessity of priority setting for the distribution of limited resources. As conservation action cannot be targeted simultaneously to all 32 Red Data plant taxa in the province of Gauteng, a hierarchical priority ranking scheme was developed using criteria reflecting species distribution, current conservation status and factors of threat. The current top five Red Data plant taxa in Gauteng are *Khadia beswickii*, *Delosperma macellum*, *Ceropegia decidua* subsp. *pretoriensis*, *Delosperma* *purpureum* and *Delosperma gautengense*. The resulting priority list will be used to distribute resources for the development of long-term monitoring programmes and extensive ecological and population studies for priority taxa. The priority ranking scheme forms the basis of a departmental policy to assist with the evaluation of development applications and environmental impact assessments affecting Red Data plant taxa in Gauteng. The scheme will also be used as a factor in setting priority conservation areas for future conservation action in the province.

Introduction

Conservation organisations are often faced with the necessity of priority setting so that limited resources can be distributed in the most effective and beneficial manner possible. The Gauteng Department of Agriculture, Conservation, Environment and Land Affairs is no exception. As a provincial conservation organisation and in terms of the Convention on Biological Diversity, this Department is obliged to ensure that the biodiversity of Gauteng, the smallest and most developed (urban, industrial, agricultural) province in South Africa, is conserved. Threatened plant species listed in Red Data lists according to the new IUCN categories and criteria (IUCN Species Survival Commission 2000) represent an important component of this biodiversity. Conservation action cannot be targeted simultaneously to all of the 23 threatened and nine Data Deficient plant taxa currently recorded within Gauteng (see Pfab and Victor 2002). It is therefore essential to prioritise these threatened taxa by ranking them from the highest priority plant taxon that requires immediate conservation action, to the lowest.

Priority setting of threatened species has been used for a range of organisms, including Indian primates (Choudhury 1988), vascular plants in Britain (Perring and Farrel 1977) and Central Europe (Schnittler and Günther 1999), fish and wildlife species in Florida (Millsap *et al.* 1990), mammalian fauna (Freitag and Van Jaarsveld 1997), as well as threatened medicinal plant species in KwaZulu-Natal (McKean 1993) and in South Africa (Cunningham 1996, Mander *et al.* 1997). In general, many priority lists are compiled using linear ranking techniques where each species is scored against a number of criteria and species are ranked in order of total scores or integrated indices.

However, linear ranking schemes result in considerable information loss, such that species can have the same total score but for very different reasons. The total scores may be artefacts, as the individual criteria used to derive the total scores or indices are not necessarily equivalent or independent. Assigning a particular score to two criteria assumes that the score is equally important for both criteria. Due to these problems, a hierarchical approach to priority setting is highly desirable (Given and Norton 1993).

Many different criteria have been used for threatened species priority setting. These criteria may reflect factors of threat, although other factors are often included. Thus a clear distinction has to be made between threat and priority (Given and Norton 1993), where priority setting is often based on factors in addition to those that actually threaten a species. Criteria that reflect factors of threat may include the extent of habitat/population fragmentation (Choudhury 1988), the percentage decline of populations, the attractiveness of the species, the remoteness of species localities, and the accessibility of the species (Perring and Farrel 1977). Additional criteria that do not necessarily reflect threats include taxonomic uniqueness, associations with other threatened taxa (Choudhury 1988), distribution information (Schnittler and Günther 1999), the extent of existing conservation (Perring and Farrel 1977), biological vulnerability, state of knowledge and management needs (Millsap *et al.* 1990).

This paper presents a hierarchical priority ranking scheme

developed for the Red Data plant taxa (including those listed as threatened as well as Data Deficient in Pfab and Victor 2002) of Gauteng province, South Africa, using criteria reflecting factors of threat, species distribution and current conservation.

Methods

Locality information for all the Red Data plant taxa of Gauteng was collated from five sources:
1. Former Transvaal Provincial Administration (Nature Conservation Division) records, specifically field dossiers compiled for threatened plant species during the Transvaal Threatened Plants Programme (Fourie 1986);
2. The Pretoria National Herbarium Computerised Information System (PRECIS);
3. The CE Moss Herbarium at the University of the Witwatersrand;
4. Professional and amateur botanists;

5. Populations recorded in the field by the Technological Services division of the Gauteng Directorate of Nature Conservation using the Global Positioning System.

A Red Data plant database was subsequently developed. Using this database and information sourced from the Red Data List of Southern African Plants (Hilton-Taylor 1996), TRAFFIC (Trade Records Analysis of Flora and Fauna in Commerce), the Internet and general distribution records from general botanical literature (Fabian and Germishuizen 1997, Retief and Herman 1997), each taxon was assessed in terms of eight criteria (Table 1). Criterion A considers endemism, criteria B, D and E consider species distributions at decreasing spatial scales, criterion C considers IUCN listings of taxa evaluated at the national (South Africa) level (Pfab and Victor 2002), criterion F considers the protection of each taxon within conservation areas and criteria G and H represent the factors of threat that are specifically important within Gauteng.

Due to the problems associated with linear ranking

Table 1: Criteria used for the priority setting exercise for the Red Data plant taxa occurring within the province of Gauteng, South Africa. Criteria are ranked from the most important to the least, with criteria scores arranged in descending order of importance

	CRITERION	SCORE
A	*Endemic to southern Africa?**	
	Yes	1
	No	2
B	*Distribution within southern Africa*	
	Gauteng	1
	Gauteng + one other province/country*	2
	Gauteng + two or more other provinces/countries*	3
C	*Red Data status in South Africa* (see Pfab and Victor 2002)	
	Critically Endangered	1
	Endangered	2
	Vulnerable	3
	Data Deficient	4
D	*Distribution within the Northern Provinces* (Retief and Herman 1997)	
	One subregion	1
	Two subregions, two over Gauteng	2
	Two subregions, one over Gauteng	3
	Three subregions, two over Gauteng	4
	Three subregions, one over Gauteng	5
	Four/five subregions	6
E	*Distribution within Gauteng*	
	One recorded locality	1
	2–4 recorded localities	2
	5–9 recorded localities	3
	10 or more recorded localities	4
F	*Occurrence in conservation areas*	
	No recorded localities inside conservation areas	1
	One or more localities inside conservation areas	2
G	*Urbanisation threat*	
	Recorded localities in Johannesburg, Pretoria and other large towns	1
	Recorded localities in Johannesburg and Pretoria	2
	Recorded localities in Johannesburg or Pretoria and other large towns	3
	Recorded localities in Johannesburg or Pretoria	4
	Recorded localities in other large towns	5
	Recorded localities outside of urban areas	6
H	*Utilisation*	
	Traded/collected/utilised taxon	1
	Potentially traded/collected/utilised taxon	2
	No known or potential trade/collection/utilisation	3

* Including former Transvaal province (now includes Gauteng, North West province, Northern province and Mpumalanga), former Cape province, Free State and KwaZulu-Natal and the countries Lesotho, Swaziland, Namibia, Botswana and Zimbabwe

schemes (Given and Norton 1993), a hierarchical approach to priority setting was adopted, where the most important criterion, endemism (Table 1), was used for the initial sorting. Each group was then sorted progressively using the next important criterion. This process was continually repeated, each subsequent group being sorted progressively until all the criteria had been used, following the order indicated below and in Table 1, until the final priority list was produced.

A. Endemism was deemed the most important criterion — in terms of conserving biodiversity, a taxon restricted to southern Africa would be of a higher priority than those occurring elsewhere.

B. Similarly, in terms of distribution, taxa restricted to Gauteng or to the northern provinces of South Africa (Gauteng, Mpumalanga, Northern and North West provinces, i.e. the former Transvaal province) would be of a higher priority for the Gauteng Directorate of Nature Conservation than those taxa more widely distributed.

C. Red Data status was based on national (South Africa) evaluations completed under the SABONET Red Listing project according to the new IUCN categories and criteria (IUCN Species Survival Commission 2000) and using the RAMAS Red Listing software (Pfab and Victor 2002). All taxa listed in the threatened categories of Critically Endangered, Endangered and Vulnerable are included as well as those listed as Data Deficient. As it is possible that a Data Deficient taxon may qualify for a threatened category, it is important to follow the precautionary approach and ensure that conservation action is also targeted to these taxa (IUCN Species Survival Commission 2000).

D. Taxa having a narrow distribution within the northern provinces would be of a higher priority than those taxa with a wider distribution in these provinces. Taxa restricted to subregions falling predominantly over Gauteng (central and south; see Retief and Herman 1997 for the positions of the five subregions) should receive higher priority than those taxa falling into one or more subregions that do not fall over Gauteng (north, east and west; see Retief and Herman 1997).

E. Similarly, taxa recorded at fewer localities should receive higher priority than those taxa recorded at more localities.

F. After considering distributions, it was then necessary to sort those taxa with populations protected within conservation areas from those taxa that essentially remain unprotected. Conservation areas include provincial, private and municipal nature reserves as well as the Magaliesberg Protected Natural Environment, the Sterkfontein, Kromdraai, Swartkranz and Environs Cradle of Humankind World Heritage Site, all natural heritage sites and conservancies.

G. Urbanisation is the greatest threat to species in Gauteng (Pfab and Victor 2002), and therefore constituted the next level of sorting. Urbanisation threat to taxa with populations occurring in all major urban areas in the province is expected to be higher than to those taxa with populations occurring in fewer urban areas, with taxa restricted to rural areas being the least threatened. Since most major development and urban expansion is expected in Johannesburg and Pretoria, populations occurring in these areas are considered to be at a higher risk than those occurring in the minor urban areas of Gauteng.

H. Utilisation data (Newton and Chan 1998) were incorporated into eighth-level sorting. A taxon collected from the wild for either its medicinal, food or for other values (Mander et al. 1997, Van Wyk et al. 1997, Van Wyk and Gericke 2000) or advertised for sale on nursery catalogues on Internet sites was considered to be a higher priority than those taxa not collected at all. Taxa related to, i.e. belonging to the same genera as, known medicinals or plants collected and/or traded were assumed to be at a higher risk, due to possible future utilisation related to potential genetic and/or collector value of the taxa.

Results

The top five Red Data plant taxa in Gauteng are (in decreasing order of importance) *Khadia beswickii*, *Delosperma macellum*, *Ceropegia decidua* subsp. *pretoriensis*, *Delosperma purpureum* and *Delosperma gautengense* (Table 2). For detailed discussions on these taxa see Pfab and Victor (2002). The Red Data plant species with the lowest priority ranking in Gauteng is *Eulophia leachii*.

In order to facilitate the use of this ranking scheme, the Red Data taxa were grouped together in priority groupings based on their distribution within southern Africa (B criterion). Fifty-six percent of the Gauteng Red Data plant taxa are endemic to the province of Gauteng (A1 taxa, Table 2), while 25% are endemic to Gauteng and one other province/country (A2 taxa, Table 2). The highest priority Red Data species belonging to the latter group is *Encephalartos middelburgensis*. Similarly, almost 10% of the Red Data plant taxa are endemic to Gauteng and two or more (A3 taxa, Table 2) other provinces/countries. The highest ranked A3 species is *Cleome conrathii* (Table 2). Species not endemic to southern Africa comprise almost 10% of the Gauteng Red Data plant taxa (B taxa, Table 2), the highest priority of which is *Holothrix randii*.

Taxa endemic to southern Africa dominate the Gauteng Red Data plant list (Criterion A, Table 3). In terms of distribution, many of the Gauteng Red Data plant taxa are narrowly distributed within southern Africa (Criterion B), within the northern provinces of South Africa (Criterion D) and within Gauteng itself (Criterion E), although taxa characterised by wider distributions are also represented (Table 3). Thirty-four percent of Gauteng threatened and Data Deficient plant taxa are currently unprotected in conservation areas within the province (Criterion F, Table 3). Eighty-seven percent of the Red Data plant taxa of Gauteng occur within the urban areas of the province, while 75% of the taxa occur either in Johannesburg or Pretoria or both of these cities (Criterion G, Table 3), currently both characterised by major urban development and industrialisation. It appears that trade does not represent as significant a factor of threat as urbanisation, with 34% of the taxa currently being traded/collected/utilised to varying degrees (Table 3).

Discussion

The scheme presented in this paper is not at all intended to replace, but rather to complement, the new IUCN Red List categories and criteria; the latter is intended to be an easily and widely understood system for classifying species objec-

Table 2: Priority ranking of Red Data plant taxa for the province of Gauteng. The priority profile for each taxon is indicated in terms of the scoring of all taxa against eight criteria, A to H. Taxa are grouped into priority groupings

TAXON	A	B	C	D	E	F	G	H	RANK	GROUPING
Khadia beswickii	1	1	1	1	2	1	3	1	1	A1
Delosperma macellum	1	1	1	1	2	2	5	1	2	A1
Ceropegia decidua subsp. *pretoriensis*	1	1	1	1	4	2	4	1	3	A1
Delosperma purpureum	1	1	2	1	2	1	4	2	4	A1
Delosperma gautengense	1	1	2	1	2	2	4	2	5	A1
Holothrix micrantha	1	1	2	1	3	2	3	2	6	A1
Cineraria longipes	1	1	2	1	4	2	3	2	7	A1
Lotononis adpressa subsp. *leptantha*	1	1	2	2	2	2	3	2	8	A1
Melolobium subspicatum	1	1	2	2	2	2	3	3	9	A1
Habenaria mossii	1	1	2	2	3	2	1	2	10	A1
Delosperma vogtsii	1	1	2	2	4	2	3	2	11	A1
Delosperma knox-daviesii	1	1	4	1	1	1	4	2	12	A1
Delosperma framesii	1	1	4	1	1	1	4	2	12	A1
Dicoma pretoriensis	1	1	4	1	1	1	4	2	12	A1
Agrostis eriantha var. *planifolia*	1	1	4	1	1	1	4	2	12	A1
Harveya anisodonta	1	1	4	1	2	1	3	3	13	A1
Lithops lesliei subsp. *lesliei* var. *rubrobrunnea*	1	1	4	1	2	2	5	1	14	A1
Delosperma davyi	1	1	4	2	3	2	3	1	15	A1
Encephalartos middelburgensis	1	2	1	1	2	2	6	1	16	A2
Eulophia coddii	1	2	2	2	3	2	1	1	17	A2
Aloe peglerae	1	2	2	2	4	2	3	1	18	A2
Frithia pulchra	1	2	3	1	1	2	6	1	19	A2
Frithia humilis	1	2	3	1	3	2	5	1	20	A2
Nerine gracilis	1	2	3	3	3	1	5	2	21	A2
Lepidium mossii	1	2	4	1	1	1	4	2	22	A2
Delosperma leendertziae	1	2	4	2	2	2	3	2	23	A2
Cleome conrathii	1	3	2	4	2	2	4	2	24	A3
Brachystelma discoideum	1	3	3	1	1	2	6	1	25	A3
Trachyandra erythrorrhiza	1	3	3	4	4	2	2	2	26	A3
Holothrix randii	2	2	3	2	4	2	2	2	27	B
Cucumis humifructus	2	3	2	1	1	1	6	2	28	B
Eulophia leachii	2	3	3	3	1	1	4	2	29	B

tively according to their extinction risk into one of three categories of threat. A threat category, however, is not necessarily sufficient to determine priorities for the conservation of threatened species (IUCN Species Survival Commission 2000). By solely using the IUCN system for Gauteng plants, for example, it is not clear which of the four Critically Endangered, 12 Endangered, seven Vulnerable and nine Data Deficient plant taxa (Pfab and Victor 2002) deserve priority conservation action.

In order to identify proximate and causal factors threatening a species and to subsequently develop management plans required to ensure the future persistence of populations, the following five steps are essential:

1. Locating all populations of the species by searching all recorded localities;
2. Recording the population size of all located populations;
3. Investigating the population biology and ecology of located populations (Witkowski *et al.* 1997);
4. Identifying threats to located populations;
5. Monitoring located populations.

It is clear that the development of management plans for and the monitoring of all 32 Red Data plant taxa in Gauteng cannot occur simultaneously, especially considering the limited resources (staff, time, budget) available to the Gauteng Directorate of Nature Conservation. However, the ranking

scheme presented in this paper will be used to distribute resources for the development of long-term monitoring programmes and extensive ecological and population studies to priority species.

In general, priority setting of threatened species is useful for indicating which species are most threatened, for setting priorities for funding and action to preserve species and for dividing large lists into groups which can be readily perceived by those using them (Given and Norton 1993). Species prioritisation provides the initial step for Dynamic Habitat and Population Analysis, a method for compiling data and knowledge that provides the basis for biodiversity management at local spatial scales (Hansen *et al.* 1999).

Priority setting may be used for drafting and eventually implementing policy and legislation on threatened species (Given and Norton 1993) and for developing well-defined and comprehensible criteria to select species for inclusion in international conventions (Schnittler and Günther 1999).

The scheme presented in this paper has been used as the basis of a departmental policy to assist with the evaluation of development applications and environmental impact assessments affecting Red Data plant taxa in Gauteng (Pfab 2000). A policy such as this is specifically vital considering the urbanisation threat to the Red Data plant taxa of Gauteng (Table 3). Essentially, the priority scheme is incorporated into

Table 3: Summary of priority ranking of Red Data plant taxa of Gauteng showing percentage of taxa receiving different scores for each criterion

CRITERION	SCORE	% OF TAXA
A	1	90.6
	2	9.4
B	1	56.3
	2	28.1
	3	15.6
C	1	12.5
	2	37.5
	3	21.9
	4	28.1
D	1	59.4
	2	28.0
	3	6.3
	4	6.3
	5	0.0
	6	0.0
E	1	28.0
	2	34.4
	3	18.8
	4	18.8
F	1	34.4
	2	65.6
G	1	6.2
	2	6.2
	3	31.3
	4	31.3
	5	12.5
	6	12.5
H	1	34.4
	2	59.4
	3	6.2

the policy as three sets of rules/guidelines. (1) Rules for searching proposed development sites that are historical localities of Red Data plant taxa or that neighbour historical localities of Red Data plant taxa, where environmental assessments require compulsory searching during the recorded flowering seasons of high priority taxa. (2) Strict guidelines for the *in situ* conservation of all Red Data plant populations, where larger buffer zones for mitigation against edge effects are required for higher priority taxa. (3) Rules for protecting suitable habitat for Red Data plant taxa, based on the priority ranking and priority profile (Table 2) of taxa.

The priority ranking scheme presented here will also be used as a factor in setting priority conservation areas for future conservation action in the Gauteng province, such as the establishment of new conservation areas, natural heritage sites and community-based conservation projects, and the development of management plans to guide future development in sensitive areas. This concept will be further developed in the Gauteng Biodiversity Gap Analysis Project, recently initiated within the Gauteng Directorate of Nature Conservation.

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Edited by L Mucina