CHAPTER 2

Floristic assessment of the remaining Afromontane grassland fragments in the escarpment region of Mpumalanga, South Africa.

ABSTRACT

The vegetation communities in 24 grassland fragments within an afforested area of the Mpumalanga escarpment is described from a phytosociological point of view. Four major plant communities were revealed using TWINSPAN based classification, and these were supported by the DECORANA analyses. The phytosociological structure of relevés within grassland fragments corresponded to those of control sites outside of the plantations. Secondly, the associations within the study sites can unambiguously be assigned to communities identified in wider-scale classifications of undisturbed grassland in the literature. Thirdly, no invader plant taxa or pioneer species were observed in large numbers within any of the grassland fragments. Taken together, these points indicate that the grassland fragments within the plantation represent largely intact plant communities that have a significant conservation importance. Conservation priorities were assigned to each of the plant communities described based on geological formation, representation of particular communities, fragment sizes as well as risk of transformation. The Wetter North and Transitional regions have higher conservation priorities than the Drier South region as a result of unique geological formations and high transformation risk.

Keywords: grassland, afforestation, conservation, endemism

Introduction

Fragmentation of habitats due to landscape transformation as a result of human activities is one of the most serious threats to the biological diversity of the planet (Thomas et al. 1997, Sotherton 1998, Turin 1988). The risk to the mountain grassland of South Africa is particularly critical as a result of extensive afforestation in the area (Foord 1997, Matthews 1991). Also, the area is exceptionally rich in endemic plant taxa (Matthews 1991, Deall 1985) and has a high plant diversity (Davis 1994). A large part of the natural vegetation in this region has been destroyed, and the remaining grassland is frequently restricted to small, isolated remnant patches.

On the central Mpumalanga escarpment, less than five percent of the area within the plantations of alien trees is still characterised by relatively undisturbed montane grassland. The native plant diversity is often also a valuable reflection of the diversity of other groups (Crisp et al. 1998) and a principal determinant of their spatial distributions (Davis 1994). Close collaboration between forestry companies and conservationists is therefore crucial to preserve and manage this valuable resource. Very little of the mountain grassland in the escarpment region between Graskop and remaining fragments, as well as sound management plans to maintain the high Ngodwana remains, (at least 80% of the study area is now covered with alien timber tree plantations) and there is a great need for the conservation prioritisation of the biodiversity in these grassland areas.

Aims

1 To determine if any marked human-induced disturbance to the plant communities in the grassland fragments has occurred. I do this in three ways:

   a) To compare the plant community composition of eighteen fragments with those of six control plots outside of the plantations where no marked disturbance to the grassland can be observed.

   b) To determine whether the plant assemblages in the fragments can be assigned to any of the natural and intact plant communities that Matthews (1993) described from a large-scale survey of undisturbed mountain areas.

   c) To determine the presence of any known intruder plant species within the fragments.

2 To assign conservation priorities to the remaining grassland fragments.

Methods

Study area

The study area is located in the escarpment region of Mpumalanga, bordered to the North by the Blyderivierspoort Nature Reserve (24° 51' S, 30° 53' E), and the most southern fragments (25° 20' S, 30° 47' E) is located near the Sudwala Caves. The eastern border of the study area is characterised by the cliffs of the great escarpment of the Drakensberg, and the most western sample plots are situated on the Long Tom Pass (25° 09' S, 30° 387' E). The area is represented by Northeastern mountain sourveld (Acocks 1988, Matthews 1991), and belongs geologically to the Transvaal sequence, and the relevant

grassland fragments are situated in two subgroups, Chuniespoort and Wolkberg, and two formations, Black Reef and Timeball Hill.
The underlying rocks of the area consist mainly of dolomite, lime, shale and quartzite. As a result of the high rainfall in the area, many of the soil types show signs of medium to high leaching as well as high acidity (an average pH of 4.7), with the soils of dolomite being the least acidic (Matthews 1991). The study area is mountainous with many peaks, deep valleys and gorges with their associated streams.

Very little remains of the natural grassland in the study area, and eighteen sample plots were chosen in isolated grassland fragments as well as six control plots chosen in large, relatively unfragmented grassland because of their accessibility, variability in geology and physiographical distribution (Figure 1). Ten of the grassland fragments chosen were smaller than 4 ha (0.5 to 3.8 ha), four between 15 and 64 ha (15, 33, 34 and 64 ha) and four between 100 and 300 ha (106, 143, 210, 267 ha). The control plots were all located in grassland areas of at least 500 ha. The twenty-four sample plots are located between 1130 and 1980 m above sea level.

Only two of the twenty-four plots are officially protected, and most of the plots are under the control of forestry companies SafCol, Sappi and Mondi, with a few under private and government ownership. Management of the plots ranged from burning and grazing to cutting and no management at all, and management is inconsistent in timing and extent. Slopes of the sample plots were measured using the 1: 50 000 topographical maps and calculating the distances between contours within each plot.

Field survey

Since most of the grassland fragments were relatively small (mean size < 50 ha), a single relevé was used within each fragment. Relevés were chosen to be representative of the vegetation in the fragment. Relevé sizes of 50x50 metres were chosen, and a step point survey conducted for each relevé. These surveys consisted of two hundred step points, recording the individual plant closest to the indicator. This yielded adequate quantitative data to assay the frequency of dominant species (Bosch & Janse van Rensburg 1987, Hoare & Bredenkamp 1998). However, this method would be unable to detect the presence of rare, often endangered or ecologically sensitive species. Therefore an inventory of all plant species encountered along with a semi-quantitative assessment of the cover-abundance of each species according to the Braun-Blanquet cover-abundance scale was compiled for each relevé (Muller-Dombois & Ellenberg 1974, Werger 1974).

Data analysis

Classification:

The relevés were classified by using Two-way Indicator Species Analysis (TWINSPAN) (Hill 1979), a multivariate polithetic, divisive clustering algorithm (Kent & Coker 1995). Refinement was done by Braun-Blanquet procedures, and the results presented in the form of a phytosociological table.

A Detrended Correspondence Analysis (DECORANA) (Hill 1979a) was performed as a quantitative way of classifying the twenty-four relevés.

Deall (1985) and Matthews (1991) did extensive work on the vegetation of the escarpment region of Mpumalanga (Matthews et al. 1992, Matthews et al. 1993, Deall et al. 1989a, Deall et al. 1989b).

Deall's work included vegetation from a restricted part in the centre of the study area, from the Mac Mac Nature Reserve to the Vertroosting Nature Reserve and included the thicket vegetation of the lowveld as far west as Hazyview.

Matthews' study area was wide ranging, covering the escarpment region of the Drakensberg from the Wolkberg (Limpopo province) in the north to Barberton in the south (Mpumalanga province).

In order to place the relevés of this study within the regional floristic description above, they were compared to the communities described by Matthews and by Deall. However, because each of the three studies mentioned (Deall, Matthews and the present study), made use of different plot sizes (10x10, 10x20 and 50x50m), quantitative statistical comparisons of these studies were not possible. As a result, the sample plots and communities were compared in a qualitative way, using geology, altitude, dominant species and characteristic species defined by Matthews and by Deall.

Results

Classification of study sites

The TWINSPAN analysis revealed four associations and six alliances, grouped hierarchically into four orders and two major classes of montane grassland (Figure 1). This community-level structuring is evident from the Braun-Blanquet ordination table

(Table 1), where the total number of plant species is divided into seventeen groups, Species Groups A to Q. The DECORANA supported these results, indicating clear differences between four communities 1.1, 1.2, 2.1 and 2.2 (Figure 2), described below:

Plant communities:

1. Helichrysum acutatum – Themeda triandra grassland of the wetter North and Transitional regions. This is a grassland community found throughout the region, and includes eighteen relevés, distributed throughout the northern part of the study area. It is found on most of the geological formations of the region, between 1130 and 1980 metres above sea level and is represented by relevés of varying sizes, slopes, elevations, aspects and geological characteristics. This community is dominated by the grasses Themeda triandra, Monocymbium ceresiiforme, Panicum natalense, Eulalia vllosa and Loudetia simplex (species group P). Species from group K such as Monopsis decipiens, Selago atherstoni and Helichrysum acutatum are characteristic of this community and differentiate it from community 2.

1.1 Eriosema salignum – Loudetia simplex grassland of the wetter North region. This is a community of grassland found throughout the region, and includes ten relevés. It is found on most of the geological formations of the region, between 1130 and 1980 metres above sea level. The grass species of Themeda triandra, Loudetia simplex, Monocymbium ceresiiforme, Eragrostis racemosa and Eulalia villosa dominate this community, and it is characterised by Eriosema salignum (Species Group D).

1.1.1 Helichrysum wilmsii – Loudetia simplex grassland. Represented by only one relevè (4), this marsh-like community is found on Black Reef quartzite at 1364 metres above sea level, and is dominated by the grasses Loudetia flavida, Loudetia simplex and Diheteropogon amplectens. It is characterised by Species Group A, including Felicia muricata, Satyrium cristatum and Helichrysum wilmsii.

1.1.2 Acalypha angustata – Loudetia simplex grassland of relatively high altitudes. This alliance is represented by nine relevés, mostly occurring on dolomite, lime and shale. Mostly found on plots with south-westerly to south-easterly facing slopes, it is dominated by the grasses Themeda triandra, Monocymbium ceresiiforme and Eragrostis racemosa. Characteristic species include Acalypha angustata, Pseudarthria hookeri and Crabbea hirsuta (Species Group D).

1.1.2.1 Rhynchosia villosa - Monocymbium ceresiiforme grassland. The four relevés representing this association have gentle slopes (less than 12°), mostly facing in a southerly direction. The main geological component is shale, and it is found over varying elevations. This community is dominated by Themeda triandra and Monocymbium ceresiiforme and characteristic species include Rhynchosia villosa and Watsonia wilmsii (Species Group B).

1.1.2.2 Pteridium aquilinum – Eulalia villosa grassland. Found on dolomite, lime and shale, this community is represented by five relevés smaller than two ha, and all with south-westerly and south-easterly facing slopes and elevations between 1170 and 1350 metres above sea level. It is dominated by Themeda triandra, Loudetia flavida, Loudetia simplex and Eulalia villosa and characterised by Species Group C, including Pteridium aquilinum, Peucedanum capense and Rhoicissus tridentata.

1.2 Lobelia erinus – Panicum natalense grassland of the Transitional region. Relevés of this community are all bigger than two ha, and found on shale and quartzite, but never on dolomite. Elevation is varied, and slopes range from gentle to steep and from south-easterly to north-westerly facing. The community is dominated by the grasses Panicum natalense, Eragrostis racemosa and Moncymbium ceresiiforme. The characteristic species are Lobelia erinus and Stiburus alopecuroides (Species Group J).

1.2.1 Helichrysum chionosphaerum – Panicum natalense grassland. Five relevés represent this alliance, and all are found on Long Tom Pass, between 1800 and 1950 metres above sea level. It is mainly found on shale, and never on dolomite. Panicum natalense, Monocymbium ceresiiforme, Eragrostis racemosa and Themeda triandra dominate this relatively wet grassland of high altitudes, and it is characterised by Helichrysum chionosphaerum and Sutera neglecta (Species Group G).

1.2.1.1 Berkheya echinacea – Rendlia altera grassland. This grassland association is represented by two control plots larger than 500 ha, with elevations between 1860 and 1950 metres above sea level. Both have steep, easterly facing slopes (> 12 degrees), and occur on shale. The grass species Rendlia altera, Panicum natalense and Monocymbium ceresiiforme dominate this community, and the characteristic species are Berkheya echinacea, Trachyandra asperata and Dierama medium (Species Group E).

1.2.1.2 Hemizygia pretoriae – Sporobolus pyramidalis grassland. Three relevés constitute this community, all between 1800 and 1860 metres above sea level, with moderately steep slopes with varying aspects. Plot sizes range from 2.1 to 34 ha, and is found on shale and quartzite, but never on dolomite. It is dominated by Sporobolus pyramidalis, Loudetia simplex, Eragrostis racemosa and Themeda triandra. Characteristic species are those of Species Group F in Table 1, and include Hemizygia pretoriae and Conostomium natalense.

1.2.2 Eragrostis sclerantha – Panicum natalense grassland. This grassland community of large plots (> 200 ha) is only found on quartzite, and between 1260 and 1590 metres above sea level. It is gentle sloping grassland (< 10°), with westerly and north-westerly aspects. Dominant species include Panicum natalense, Loudetia flavida and Trachypogon spicatus. Species Group H contains the characteristic species for this alliance, and includes Eragrostis sclerantha, Crassula compacta and Oldenlandia herbacea.

2. Barleria ovata – Eragrostis racemosa grassland of the Drier South region. This grassland is found to the south of Long Tom Pass, in an area of relatively low altitude (1200 – 1530 metres above sea level) and with a slightly drier climate. The relevés representing this community have moderately steep to very steep slopes with varying aspects, and are seldom found on quartzite. The grassland of this area is visibly

different from the typical mountain grassland of the area (Matthews 1991) and as a result classified as a different class in Figure 1. Grasses such as Eragrostis racemosa, Andropogon schirensis and Bulbostylis burchelli dominate the vegetation of this area.

2.1 Parinari capensis – Eragrostis racemosa grassland. This grassland of relatively low altitude (< 1530 metres above sea level) occurs on various geological formations, mostly on dolomite, lime and shale. The fragments represented by this community have varying sizes and slopes, but never with a southerly aspect. Dominating this grassland is Eragrostis racemosa and Bulbostylis burchelli and characteristic species are Barleria ovata, Tephrosia glomeruliflora, Eragrostis curvula and Parinari capensis (Species Group N).

2.1.1 Senecio glaberrimus – Andropogon schirensis grassland. The three relevés representing this alliance have contrasting sizes and are found on various geological formations. All have moderately steep to steep slopes, facing north-westerly to north-easterly. It is dominated by the grasses Eragrostis racemosa, Andropogon schirensis and Loudetia simplex, and characterised by Species Group L, including Elionurus muticus, Senecio glaberrimus and Melinus repens.

2.1.2 Linum thunbergii – Loudetia flavida grassland. This alliance is found between 1220 and 1380 metres above sea level and on dolomite, lime and shale, but never on quartzite. Slopes of the representing fragments are relatively gentle (7.4 – 9.9°), and sizes differ greatly (0.9 – 267 ha). Grass species Eragrostis racemosa, Loudetia flavida and Themeda triandra dominate the vegetation, and the characteristic species of this community (Species Group M) include Acalypha villicaulis, Hypochaeris radicata, Panicum dregeanum and Linum thunbergii.

2.2 Helichrysum rugulosum – Eragrostis racemosa grassland. One relevè (14) represents this grassland community, and is found at 1200 metres above sea level, on shale, and has a gentle north-easterly facing slope. The grasses Eragrostis racemosa and Loudetia flavida dominate this grassland fragment and it is characterised by two species, Callilepis leptophylla and Helichrysum rugulosum (Species Group O).

Although the fragments and control plots were selected to be similar physiographic traits and climatic conditions and in vegetation (homogenic floristic units), differences in floristic composition of relevés is inescapable in such a large study area. Communities occurring closely together have similar geological characteristics and experience similar weather conditions, and as a result have similar plant communities (Table 2). The four major communities (1.1, 1.2, 2.1 and 2.2) were distinct in both the TWINSPAN-based classification, (Fig.1) as well as the DECORANA ordination (Fig. 2).

Comparability of grassland fragments with the control plots

Relevés from isolated grassland fragments and those of large unfragmented areas compare well with each other. The species richness of experimental and control plots do not differ significantly (Table 3). Furthermore, the species composition of plots from the

Wetter North, Transitional and Drier South region show more variation than is evident between experimental and control plots (Figure 1).

Qualitative comparisons with existing communities, in terms of dominant and characteristic species as well as geomorphology

The relevés compared well to the communities described by Deall and Matthews, and each of the twenty-four sample plots was comparable to one of Matthews' communities, and some to Deall's communities (Table 2).

Matthews (1991) described the vegetation of a large area in Mpumalanga, including a large part of the study area of this study. Three of his important community groups were found to be comparable to relevés of this study – The Grasslands of Drier Dolomitic Regions, Hygrophilous Grasslands of High Altitude and Grasslands of Relatively Low Altitude. Seven, nine and eight relevés were respectively comparable to these community groups, however, these relevés did not correspond with the three regions described in this study, and there is no clear link between the Wetter North, Transitional and Drier South Regions with those described by Matthews.

Invasive plant species within the grassland fragments.

The most obvious of invader species in the twenty-four plots studied, was *Pteridium aquilinum*. It was, however, very localised in its distribution, and restricted to community 1.1.2.2 (Table 1). No other obviously invasive or pioneer species in the context of the natural grassland communities of Matthews or in the abundances of such species within the twenty-four relevés of this study were found.

Discussion

The twenty-four sample plots are situated along a fifty kilometre North-South gradient, and the floristic differences between the Wetter North and Drier South regions are therefore hardly surprising. The average rainfall of plots in the Drier South region is about 210 mm less (on average) than that of their Wetter North counterparts, and the Drier South plots are located, on average, 179 metres closer to sea level than the plots of the Wetter North and Transitional regions. Furthermore, the geology between the three regions differs significantly, with most of the Black Reef quartzite plots located within the Wetter North and Transitional regions. These factors clearly contribute towards the plant community differences between the three regions.

Three lines of evidence suggests that the extensive afforestation in the study area has not had a clearly measurable effect on the floral species composition of the isolated grassland fragments within plantations, and their isolation and restriction did not result in significant differences from their unfragmented equivalents (Fig 1, Table 3).

Firstly, both the control sites and grassland fragments were classified into both the wetter northern associations as well as the transitional associations of community no. 1 (Table1, Fig. 1). Unfortunately, suitable control sites could not be identified in the drier southern community (no. 2; Table 1, Fig. 1), because no suitable, unfragmented grassland areas remain in the southern part of the study area.

In addition, the species richness values of relevés within the fragments did not differ from those at the control sites (Table 3), indicating that fragmentation has not visibly influenced the number of plant species found in small, isolated grassland fragments.

Secondly, all the relevés analysed here could be classified into plant communities identified in the large-scale study of Matthews (1993) (Table 2 of this thesis). Since Matthews' study largely concentrated on intact and natural montane plant communities, the inference is that the communities identified here have not been subject to systematic changes in community structure. I conclude that fragmentation of the montane grassland of the study area has not influenced the plant communities of the remaining fragments within plantations significantly, and the presence of invader and pioneer species have not yet changed the nature of these communities.

The lack of representation of several of Matthews' and Deall's grassland communities by the sample plots of this study may reflect the extent and extent of habitat destruction in the afforested areas of the region.

Thirdly, no major invasive plant species were observed within the grassland fragments. The only recognised invader plant species found within the grassland fragments of the study area, *Pteridium aquilinum*, were restricted to community 1.1.2.2 and had very little impact on the study area as a whole. No other plant species found is obviously invasive in the context of the study area, the natural grassland communities described by Matthews and their relative abundances in the twenty-four relevés of this study.

The fact that fragmentation has had no obviously significant effects on the plant communities of the isolated grassland fragments of the study has important conservation implications. Although the possibility exists that Matthews' communities may represent stages in a successional gradient (therefore influencing the conservation status of some of the isolated fragments of this study), the fact that Matthews' study focused on relatively undisturbed communities renders that possibility remote.

<u>Conservation of the grassland fragments identified during this study.</u>

Within the study area, and indeed throughout the region, the quartzite of the Black Reef Formation (Geological Survey 1986) is restricted to a few isolated areas, and is associated with unique and rare plant communities, both as far as grassland and forests are concerned (Matthews 1993).

Very few of the current sample plots of afromontane grassland are found on Black Reef Quartzite, and are restricted to two communities – communities 1.1 and 1.2.2 are therefore of great conservation importance, not only in regards to the study area, but on a much larger scale– it includes many endemic and rare species (Matthews 1991) and reflects the rarity of Black Reef Quartzite as an underlying geological basis for montane grassland in general.

Community 1.2.2 is represented by three relevés, two of which are under official protection (experimental plot 6 – Mac Mac Pools, and control plot 21 – in the Blyderivierspoort Nature Reserve), but the two plots in community 1.1 found on Black Reef Quartzite are small isolated patches (relevés 2 and 4), and at great risk of being transformed to the surrounding afforested landscape. It is critical that the importance of these unique plots are realised, and that the appropriate steps are taken to ensure the continued survival of this unique plant community.

In order to arrive at an objective but useful recommendation about the relative conservation priorities of the remaining grassland fragments, a conservation importance index is proposed that depends on four factors: a) Geological formation, b) degree of representation within the study area, c) fragment size and d) degree of risk of habitat transformation. Risk of transformation was estimated in three categories: high risk assigned to fragments totally surrounded by plantations and without any form of protection, moderate risk to fragments with some form of protection and not completely isolated and low risk to fragments within protected areas and with a very low level of isolation.

The following scoring system was used, with the resulting total score used to assign conservation rank (Table 5):

1. Geology

All relevés on Black Reef Quartzite – 10 points

All but one on Black Reef Quartzite – 8

All but two on Black Reef Quartzite – 6

Various Geology with one relevè on Black Reef Quartzite – 4

All relevés on Shale – 2

Various Geology – 0

2. Level of representation

One relevè – 3 points

Two relevés – 2

More than two relevés – 1

3. Fragment sizes

All relevés smaller than 10 ha – 5 points

All but one smaller than 10 ha – 4

All but one larger than 10 ha – 3

All between 10 and 100 ha – 2

All but one larger than 100 ha – 1

All larger than 100 ha – 0

4. Risk of transformation

All relevés high risk – 5 points

All but one high risk – 4

All relevés moderate risk – 3

All but one moderate risk – 2

All relevés low risk – 1

Communities 1.1 and 1.2.2 are of particular conservation importance (Table 4), because of their rare geological (Black Reef Quartzite) and floristic characteristics, and their uniqueness within the area and region. As a general geographical trend, the communities have less conservation importance the further south it is found, with the northern communities 1.1 and 1.2.2 the most important, and the southern communities 2.1 and 2.2 the least important for conservation (Table 4).

The diversity, high levels of endemism and variation within the mountain grassland of the study area emphasise the importance of the escarpment region of the Drakensberg in Mpumalanga as a conservation area. The fact that no clear changes were detectable in the plant community structure and the plant diversity within the existing fragments (including even the fragments smaller than 5 ha in extent) emphasises the conservation importance of these fragments. They need to be included in any conservation plan for these fragments.

Management of the grassland fragments

The grassland fragments of the study area were subjected to chemical weed control, and burning on a two-year cycle. Grazing and cutting occurred sporadically, and never with any regularity. Unfortunately, no specific and accurate historical information on the management of any individual grassland fragment is available, because of a large number of owners.

In order too quantify the effects of management of the remaining grassland patches, precise experimental planning involving grazing, mechanical cutting, grazing and burning is needed to decide on the optimal management regime for each fragment if biodiversity is to be conserved properly. Furthermore, grassland patches within plantations may change in structure and characteristics when the surrounding plantations are sawn, especially since management of these patches often is neglected, as is the case with relevè 5 where large amounts of moribund grass have accumulated.

Conclusion

Many of the grassland fragments surrounded by plantations are still easily identifiable as natural communities, described by Matthews and Deall in broader-scale surveys in the past. They are not discernible as obvious invader – or disturbed plant communities, even though some of them have been isolated for as long as 40 years. If it is assumed that other influences such as management (natural or human-induced) did not differ significantly between fragments since the onset of afforestation in the area, it stands to reason that afforestation and habitat fragmentation have not significantly impacted on the floristics of the montane grassland of the study area.

The plant communities of conservation importance described by Matthews coincide with the important communities recognized in this study. Rare and endangered plant species, as well as species endemic to the region, are more often than not found on the scarce Black Reef quartzite of the region, which is more evident to the Northern part of the study area. Communities 1.1 and 1.2.2 are therefore of particular conservation importance, not only as a result of their scare geological base, but also because of the high risk associated with the few grassland examples left of these communities.

The importance of the small, isolated fragments is evident from the results of this study. They do not differ significantly in species composition from the large, unfragmented grassland areas, and are often the only representation left of specific grassland variants. The management of these grassland areas are critical, and serious consideration should be given to the different management options (burning, grazing, etc.) by plantation managers and relevant officials, to ensure the continued survival of all grassland communities in the area.

The latitudinal and moisture gradient within the study area, best explains the plant communities described for the twenty-four sample plots. This indication will be used fundamentally in the next two chapters where, amongst other, the faunal component of the sample plots of the study will be investigated.

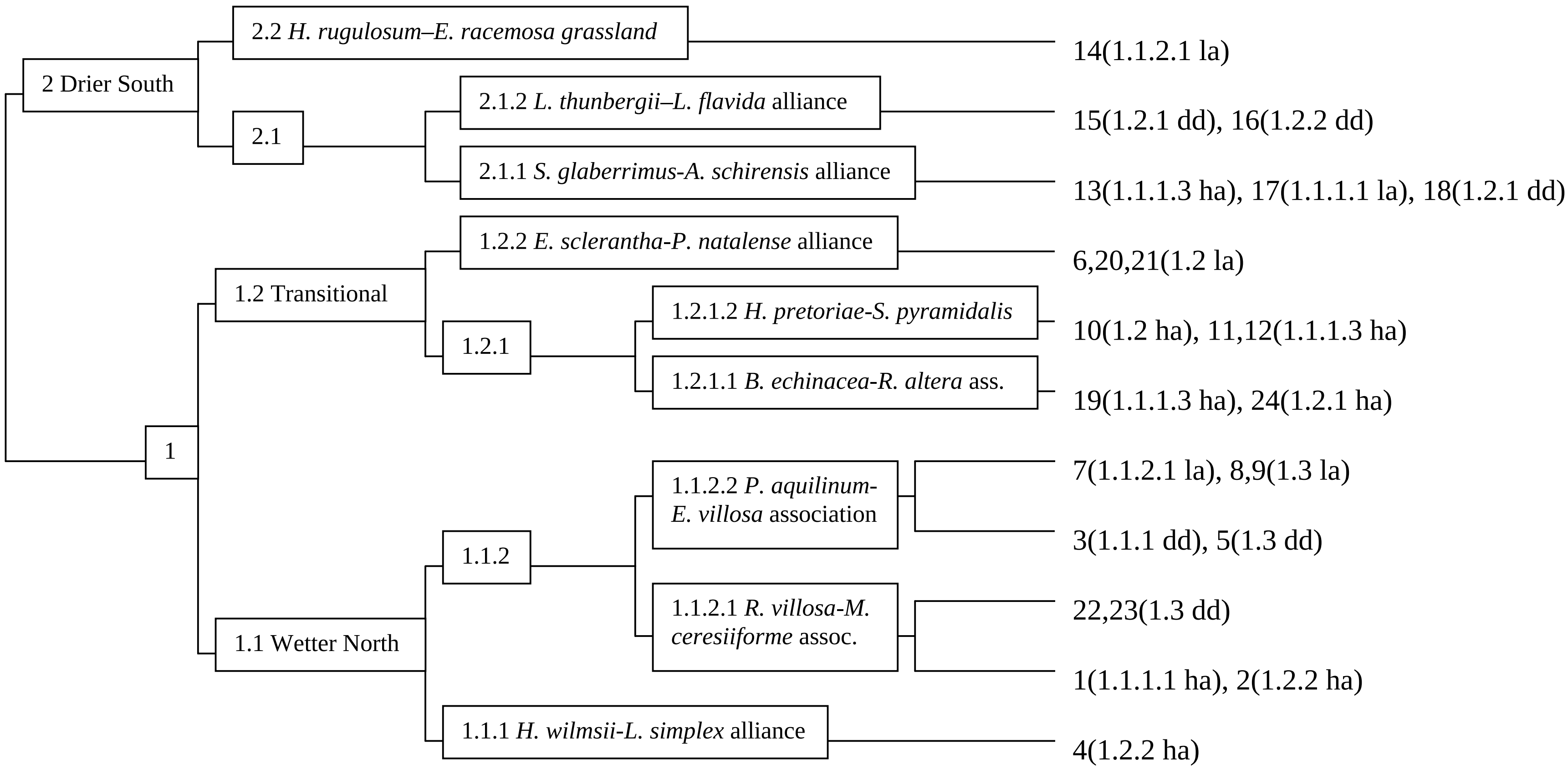

Figure 1. A TWINSPAN-based classification of the vegetation of the twenty-four relevés. The column on the right gives the identification of plot within an association, the identification of the association within then text, and the broad region within which an association was located. Control plots are numbered 19-24, and Matthews' relevant communities are given for each relevè (dd – drier dolomitic, ha – high altitude, la – relatively low altitude – Table 2).

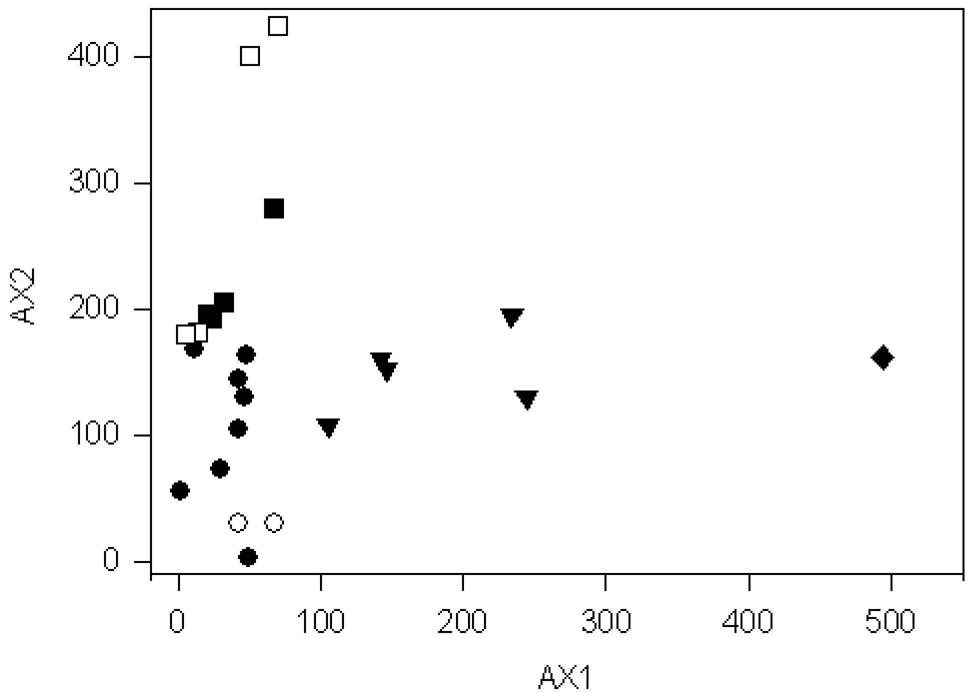

Figure 2. Decorana of the twenty-four relevés. Circles represent community 1.1 (Wetter North), squares community 1.2 (Transitional), triangles community 2.1 (Drier South) and diamonds community 2.2 (Drier South). The six open symbols represent the six control relevés, and the eighteen closed symbols the experimental relevés. The four communities are distinct within the ordination, but the experimental and control relevés show no obvious separation.

Table 1. A Braun-Blanquet phytosociological interpretation of the plant species identified in the twenty-four relevés in the Drakensberg Escarpment region of Mpumalanga. Decimal numbers at the top of the table indicate TWINSPAN-based communities corresponding to those indicated in Fig. 1.

Community number	1																		2					
	1.1										1.2								2.1					2.2
	1.1.1	1.1.2									1.2.1					1.2.2			2.1.1			2.1.2		
		1.1.2.1				1.1.2.2					1.2.1.1		1.2.1.2											
Sample plot number	4	1	2	22	23	3	5	7	8	9	19	24	10	11	12	6	20	21	13	17	18	15	16	14
Floristic data																								
Species Group A	+																							
Felicia muricata	+																							
Satyrium cristatum	+																							
Helichrysum wilmsii	+																							
Schizochilus cecilii	+																							
Sopubia mannii																								
Species Group B		B	3										+				1							
Heteropogon contortus		+	+					1																
Cyphia assimilis			2	A	1																			
Rhynchosia villosa		+		+	+																			
Watsonia wilmsii																								
Species Group C																						+		
Diospyros lycioides						+	+																	
Agapanthus nutans						+	+																	
Gomphocarpus fruticosus						+	+																	
Rhus discolor				1		+	+	+																
Rhoicissus tridentata							+	1																
Pteridium aquilinum						1	+	1	A	A														
Peucedanum capense						+		+	+	+														
Species Group D																								
Acalypha angustata	+	1	+	1			+	+																
Eriosema salignum		+			+		+			+														
Hypericum lalandii		+							+															
Pseudarthria hookeri		+				+																		
Crabbea hirsuta			+					+																
Species Group E																								
Trachyandra asperata							1				1	+												
Berkheya echinacea											1	+												
Dierama medium											+	+												
Species Group F																								
Conostomium natalense													+	+										
Hemizygia pretoriae													+	+										
Gazania krebsiana											+			+	+									
Species Group G																								
Helichrysum chionosphaerum												+			+									
Sutera neglecta												+	+											

Table 1 -cont-

Species Group H																									
Eragrostis sclerantha									+								+	A	+						
Chlorophytum fasciculatum		+																+	+						
Buchnera longespicata			+															+	+						
Crassula compacta																		+	+						
Oldenlandia herbacea																		+	+						
Species Group I																									
Digitaria monodactyla																1	+								
Gladiolus longicollis																+	+								
Wahlenbergia undulata															+		+								
Species Group J																									
Lobelia erinus		+											+	+			+								
Stiburus alopecuroides													+					+							
Species Group K																									
Erica drakensbergensis		+	+			+				+		+													
Commelina africana		+	+					+					+												
Scilla natalensis		+						+				+		+											
Helichrysum spiralepis		+										+	+												
Helichrysum platypterum				+		+	+				+		+												
Alepidea longifolia	1								1		+	+													
Crassula vaginata	+						+				+		1												
Satyrium longicauda							+		+			+	+		+	+									
Silene burchellii			+				+		+							+									
Craterocapsa tarsodes		+	+												+	+									
Tristachya leucothrix	+	A	+			+	+					+		1											
Chlorophytum cooperi	+	+					+	+							+	+									
Koeleria capensis	1	+										1			+	1									
Helichrysum umbraculigerum				+					1		+					+									
Rabdosiella calycina							+	+			+			+											
Sporobolus pectinatus	1	1												+											
Ledebouria revoluta			1									+			+										
Drosera madagascariensis	+												+			+									
Helichrysum acutatum	+	+	+				+	+	1						+		+								
Senecio oxyriifolius	+	+					+		+		+		+				1								
Monopsis decipiens	+	A											+	+			+	+							
Selago atherstonei	+									+		+	+				1	+	+						
Sebaea grandis	+	+							+							+	1		+						
Thesium utile	1	+										1			+				+						
Species Group L																									
Elionurus muticus		A																			A	+			
Senecio glaberrimus																				+		+			
Melinis repens																					+	+			
Species Group M																									
Acalypha villicaulis							1																1	1	
Hypochaeris radicata																							+	+	+
Panicum dregeanum																	+						+	+	
Helichrysum glomeratum		+																					+	+	
Berkheya densifolia																							+	+	
Linum thunbergii																							+	+	

Table 1 -cont-

Species Group N																								
Barleria ovata																				1	1		1	
Tephrosia glomeruliflora																				+		+		
Eragrostis curvula																				+			+	
Parinari capensis																					1		+	
Species Group O																								
Callilepis leptophylla																								+
Helichrysum rugulosum																								+
Species Group P																								
Themeda triandra		B	B	B	A	B	3	B	1	A	3	1	3	4	A	+	+			A	A	1	A	A
Eragrostis racemosa		A	1	A		1		1	1	1	B	1	1	B	B		1	1	B	B	1	3	A	3
Monocymbium ceresiiforme	1	B	+	A	1	+		1	+	+	A	1		1	A	A	1	+	+	+				1
Panicum natalense	+		+				+	1	3	A	A	1	+	A	A	A	1	1	A	A	A	1		+
Eulalia villosa	1		A	1	1	1	1	1	A	A		+				1	+	+		1	1	1	+	1
Bulbostylis burchellii		B	1	1	+	+		1		+	1	1		A			+	1	A	1	1	B		+
Loudetia flavida	A			1		1	A	A	+	A				1	A	3	3	1	1	1		A	A	B
Aristea galpinii	+		+			+	+	+	+	+	+	+	+		+				+	+		+		1
Scabiosa columbaria	1	+	+		+	+	+	+	1	+	+	+							+			+	+	+
Inulanthera calva			+				+			+				1		+	1	1				+	1	+
Gladiolus exiguus	+		+			+	+				+	+							+		+	+	+	+
Cymbopogon excavatus				1		1	1		+	+	1			1	A					+		1		1
Ctenium concinnum																			A	A				
Pentanisia angustifolia		+	+	1		1		+						1	+						+			
Dicoma anomala		+	+									+							+					
Gnidia capitata		+	+			1													+	+				
Clutia species				+	+								+					+	+					
Loudetia simplex	B	A	A	B		A	3	A	3	B	1	+	B	1	A	3		B	A	A	A			
Helichrysum cephaloideum		1	A			1			+	1	1	+		+						+				
Andropogon chinensis			+	1						+					+	+					+			
Pearsonia obovata												1			A				+	1	1		A	
Rhynchosia caribaea								1								1		B	A		1	1	B	
Hemizygia subvelutina								1			+				1				1				+	
Buchnera reducta						+			+						+							1	1	
Chamaecrista comosa				A		B		1	+							+	+	B				+		
Helichrysum pallidum				+	1						+	+			+			+	+	+	+		+	
Gnidia kraussiana				1				+			1			+	+			+					+	
Helichrysum pilosellum		1	+	+	1	+		+	1		+	1		+	+	+			+	+	+	+	+	
Trachypogon spicatus		B		1	1		1						+	+		A	3	+		1	1	+		
Cyperus obtusiflorus		+	+	+							1	+	+	1	+			+	1			+		
Alloteropsis semialata		1	1						+		+		+	+	1				1				+	
Clerodendrum triphyllum			+	1		1		1	+											+	+	+	+	
Zornia linearis		+		+	+	+		+													+	+	+	
Pearsonia sessilifolia		+	+									+				1			+				+	
Zaluzianskya katharinae		+			+			+				+			+								1	
Polygala hottentotta		+									+			+				+		+			+	
Lotononis foliosa		+		1								+		+									+	
Lippia javanica			+			+										+					+		+	
Sebaea leiostyla		+				+											+	+				+		
Senecio venosus		+													1					+		+		

Table 1 -cont-

Diheteropogon amplectens	A	A	A	1		A		+	+	+		A	1		+	1	+		+	1	A	1	1	
Helichrysum aureonitens	A	A	1	+		1	1		1	1		1	1	+	1	1	+	+		+			A	
Haplocarpha scaposa		+	1	1	1	+		+	+	+	1	1		+		+			+	+	+		1	
Rendlia altera	1			A	A	3	B	3			1	A			A			+	A		1	A	1	
Andropogon schirensis	1		A		A	+	1				1	1			A	+		+	B	A	A		A	
Sopubia cana		+	1	+		1	+	+	1	+	+	+		+	+			+					+	
Cyanotis speciosa	+		+		+	+			1	+	+	1			+	+		+					+	
Inezia integrifolia					+				+	1	+	+	+	+					+	+		+		
Crassula alba	+		+	+	+		+		+		+								+				+	
Schizachyrium sanguineum										+						+				+		+	1	
Clutia pulchella		+		+			1	1		1									+	1	A		+	
Cliffortia linearifolia								+	+	+		+								+		+	+	
Senecio gerrardii													+	+						1		+	+	+
Helichrysum nudifolium											+						+					+	+	+
Eriosema cordatum		+	+	1		+			+		+				+	+	1	+					A	+
Indigofera rostrata		+		+	+	+			+							+		+	+	A		A	+	1
Sporobolus pyramidalis		A	+	1	1	+						+	A	1	1			+	+	+	+		1	1
Euryops pedunculatus		1	+	1		+							A		+	1							A	+
Vernonia natalensis		+	1			A	1	1	1		+		1	+					1	1				1
Hermannia coccocarpa		+		+		+	+	+					+						+			+	+	1
Pentanisia prunelloides		+			+	+	+	+					+			+		+	+	1			1	+
Kyllinga alba		+	+						+				+	+		+	+	+		+			+	+
Raphionacme hirsuta		+	+	+				+			+	+		+										+
Aristida junciformis		+	1		1							+	3	1			+				+			+
Eucommis montana				+	+			+	1				1											+
Oxalis depressa		+	+															+						+
Anthospermum rigidum		+	+																					A
Vernonia galpinii	+		+		+			+						+										+
Hyparrhenia hirta										+												1		B
Eragrostis capensis	1															1				+	1		A	+
Trichoneura grandiglum							+	+		1										+			+	
Desmodium setigerum									+	+												+		1
Melinis nerviglumis															+									+
Berheya setifera								+		+									+					
Xyris capensis	1						1									+				+				
Schistostephium crataegifolium								+		1														
Tetradenia riparia													+	+										
Setaria nigrirostris							+	+												+				
Dipcadi viride		+		+																	+			+
Helichrysum mimetes										+											+	+		
Stachys natalensis											1			+							+			+
Hypoxis rigidula									+															
Ammocharis coranica	1												1											
Eriosema transvaalense				+												+								
Hypoxis iridifolia						A									+									
Aster peglerae			+											+										
Harpochloa falx		+										1												
Disa patula			+								+													
Helichrysum miconiifolium		+																						
Monsonia attenuata															+					+				
Myrica brevifolia										+											+			
Striga asiatica				+															+			+		
Chaetacanthus costatus				+																				+

Table 1 -cont-

Species Group Q									
Crepis hypochoeridea		+							
Festuca scabra		+							
Senecio erubescens		+							
Solanum retroflexum		+							
Sonchus wilmsii		+							
Vigna unguiculata		+							
Gomphocarpus tomentosus		+							
Indigofera hedyantha		+							
Indigofera hilaris		+							
Disa patula		+							
Habenaria lithophila		+							
Eucomis autumnalis			+						
Helichrysum uninervium			1						
Kalanchoe thyrsiflora			+						
Maytenus heterophylla			+						
Talinum caffrum			+						
Dimorphotheca spectabilis			+						
Cyathea dregei			+						
Cyphostemma lanigerum			+						
Hypericum revolutum			+						
Senecio inaequidens			+						
Digitaria diagonalis			1						
Helichrysum mixtum			1						
Costularia natalensis			+						
Calpurnia aurea			+						
Gladiolus dalenii			+						
Paspalum scrobiculatum			+						
Vernonia oligocephala			1						
Conyza podocephala				+					
Wahlenbergia huttonii				+					
Alepidea setifera				+					
Aristea angolensis				+					
Hypoxis galpinii				+					
Cyphia assimilis				+					
Clutia monticola					+				
Helichrysum splendidum					+				
Cyphia elata					+				
Paspalum urvillei					+				
Cheilanthes viridis					+				
Psammotropha myriantha					+				
Cotula hispida						1			
Craterostigma wilmsii						1			
Kohautia amatymbica						1			
Ledebouria cooperi						+			
Cyperus rupestris						+			
Alectra sessiliflora							+		
Otholobium polystictum							+		
Senecio affinis							+		
Aloe simii								+	
Elephantorrhiza elephantina								+	
Faurea speciosa								1	
Geigeria burkei								+	
Hypericum aethiopicum								+	
Tephrosia longipes								+	

Table 1 -cont-

Vernonia schlechteri								+	
Convolvulus sagittatus								+	

Table 2. Qualitative comparison of the twenty-four study sample plots to the grassland communities of the escarpment region of Mpumalanga described by the wide-scale studies of the wide-scale studies of Matthews (1991) and Deall (1985).

Matthews' Grassland Communities	Geology	Altitude	Shared Dominant Species	Shared Characteristic Species	Shared communities Deall	Kamffer
Grasslands of the Drier Dolomitic Regions					Comm.	Relevés
1.1.1 The Eragrosto curvulae – Hyparrhenietum filipendulae - hyparrhenietosum tambae grassland	Dolomite	1100 – 1400 m.a.s.	*Themeda triandra*	*Pseudarthria hookeri*	51a&b 52a&b	3
1.2.1 The Hemizygio transvaalensis – Loudetietum simplex – barlerietosum ovatae grassland	Dolomite	1100 – 1500 m.a.s.	*Panicum natalense* *Trachypogon spicatus*	*Barleria ovata*		15, 18
1.2.2The Hemizygio tranvaalensis – Loudetietum simplex – indigoferetosum oxalidea grassland	Dolomite	1100 – 1400 m.a.s.	*Eragrostis racemosa* *Diheteropogon amplectens*	*Polygala hottentotta* *Scabiosa columbaria*	49a 49b	16
1.3 The Rhoicisso tridentatae – Rhynchosietum nitentis grassland	Dolomite	1100-1400 m.a.s.	*Themeda triandra*	*Aristida junciformis Rhus discolor Scilla natalensis Rhoicissus tridentata*		5, 22, 23
Hygrophilous Grasslands of High Altitude Regions						
1.1.1.1 The Festuco costatae – Proteetum gaguedi grassland	Shale	Above 1600 m.a.s.	*Monocymbium ceresiiforme*	*Helichrysum acutatum* *Sporobolus pectinatus*		1
1.1.1.3 The Gnidio kraussianae – Festucetum costatae grassland	Shale	1600 – 2000 m.a.s.	*Monocymbium ceresiiforme* *Helichrysum pilosellum*	*Polygala hottentotta Gnidia kraussiana* *Schizachyrium sanguineum Helichrysum nudifolium*		11,12, 13, 19
1.2 The Helichryso aureonitentis – Monopsion decipientis grassland	Quartzite	1600 – 2000 m.a.s.	*Loudetia simplex*	*Monopsis decipiens* *Aristida junciformis*		10
1.2.1 The Helichryso aureonitentis – Sopubietum canae grassland	Quartzite Dolomite	1100 – 1600 m.a.s.	*Monocymbium ceresiiforme* *Loudetia simplex*	*Microchloa caffra* *Sopubia cana*	47 48	24
1.2.2 The Helichryso aurreonitentis – Stiburetum alopecuroidis grassland	Quartzite	1100 – 1450 m.a.s.	*Eragrostis racemosa* *Helichrysum aureonitens*	*Drosera madagascariensis* *Koeleria capensis*		4, 2
Grasslands of Relatively Low Altitude						
1.1.1.1 The Diheteropogono amplectentis – Proteetum gaguedi – Hemizygietosum transvaalensis grassland	Quartzite	Around 1250 m.a.s.	*Loudetia simplex* *Diheteropogon amplectens*	*Melinus repens*		17
1.1.2.1 The Panico natalensis – Andropogonetum schirensis – Bulbostyletosum oritrephes grassland	Shale	1200 – 1600 m.a.s.	*Eragrostis racemosa* *Diheteropogon amplectens*	*Kyllinga alba* *Pentanisia prunelloides*		14, 7
1.2 The Eragrostido scleranthae – Monocymbietum ceresiiformis grassland	Quartzite	1450 – 1850 m.a.s.	*Loudetia simplex* *Rendlia altera*	*Eragrostis sclerantha*		20, 21, 6
1.3 The Diheteropogono filifolii – Scilletum nervosae grassland	Dolomite	1300 – 1800 m.a.s.	*Eragrostis racemosa* *Monocymbium ceresiiforme*	*Pteridium aquilinum Cyanotis speciosa Helichrysum cephaloideum*		8, 9

Table 3. Statistical comparisons (t-tests) of species richness of control plots with that of experimental plots also showed no significant differences for the Wetter North (community 1.1), the Transitional (community1.2), or overall (including the Drier South region which unfortunately has no control plots).

COMPARISON Exp vs. control	*t*	df	*P*
Overall: (Exp = 1-18) (Control = 19-24)	1.308	22	0.2041
Community 1 (WN & T) (Exp. = 1-12) (Control = 19-24)	1.3914	16	0.1831
Community 1.1(WN) (Exp. = 1-5,7-9) (Control = 22-23)	1.143	8	0.286
Community 1.2 (T) (Exp. = 6,10-12) (Control = 19-21,24)	0.294	6	0.778

Table 4. Conservation rank priorities of the twenty-four sample plots within their nine respective plant communities. Scores are assigned for geology, level of representation, fragment sizes and risk of transformation, which contribute towards a total score used to assign conservation priorities. The Wetter North (WN) and Transitional (T) regions receive conservation priority above the Drier South (DS) region.

Community	Geology: score	# relevés: score	Size: score	Risk: score	Total score	**Rank**
1.1.1(WN)	10	3	5	5	23	**1**
1.2.2(T)	10	1	0	2	13	**2**
1.1.2.1(WN)	4	1	3	4	12	**3**
1.1.2.2(WN)	0	1	5	5	11	**4**
1.2.1.2(T)	4	1	4	2	11	**5**
2.2(DS)	2	3	2	3	10	**6**
2.1.1(DS)	4	1	2	3	10	**7**
1.2.1.1(T)	2	2	0	3	7	**8**
2.1.2(DS)	0	2	1	3	6	**9**

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