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Wetland vegetation in the North-eastern Sandy Highveld, Mpumalanga, South Africa

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Keywords: conservation, endangered habitats, Mpumalanga, phytosociology, plant communities, South Africa

ABSTRACT

The wetland vegetation of the high mountain grasslands of Mpumalanga was sampled by using stratification based on geology and land types. Floristic data were classified by TWINSPAN procedures and refined by using the Braun-Blanquet method. This resulted in the recognition of four major wetland plant communities which are subdivided into eleven minor plant communities. The major communities include the *Phragmites australis* Wetland occurring in relatively deep water, the *Miscanthus junceus* Wetland from moist river banks and wet drainage lines, the *Eragrostis biflora–Stiburus allopecuroides* Moist Grassland restricted to moist, poorly drained soils with a high water table, and *Arundinella nepalensis* Moist Grasslands on black vertic soils.

INTRODUCTION

South Africa is rapidly approaching the position of maximum exploitation of it's natural water resources (Walmsley 1988). Due to the increased demands that people place on the natural habitat for the basic requirements of life, the natural resources are slowly but surely being depleted and will not be able to provide for the needs of the people (Bayer 1970; Allen 1972; Scheepers 1975; Asibey 1977; Mentis & Huntley 1982). Many wetlands have been destroyed beyond rehabilitation (Cowan 1991), making them one of the most endangered ecosystem types in South Africa (Walmsley 1988). The Sabie, Elands and Crocodile Rivers are fed by smaller rivers originating from wetlands in and around the study area. These wetlands are therefore important for maintaining the flow of the rivers. Wetlands are therefore considered as a scarce resource which should enjoy high conservation priority (Eckhardt *et al.* 1993; Smit *et al.* 1995). It is vital that these natural wetland resources be maintained, if not improved, to be able to cope with future pressures being placed upon them.

The degradation of wetlands in this area affects the continued health of these river systems (Walmsley 1988). This degradation is often caused by dessication of the soil by pine forests in the catchment areas. An estimated 30–35% of this study area is currently under cultivation, with forestry being the most abundant practice (Matthews *et al.* 1993). Apart from the exotic plantations there is also a considerable problem with black wattle (*Acacia mearnsii*) and silver wattle (*Acacia dealbata*) in these drainage systems. The removal of these trees will enable the natural vegetation to re-establish itself (Mueller-Dombois & Ellenberg 1974).

An important conclusion of Myburgh *et al.* (1995) is that individual wetlands in the Grootvlei area, Mpumalanga, are poor in plant species, but that the different wetlands are floristically and ecologically quite distinct. Bloem *et al.* (1993) similarly recognized a large variety of wetland communities, each with unique species composition but with low plant species richness, from the Verlorenvallei Nature Reserve in the North-eastern Sandy Highveld (Acocks 1988). This implies that a variety of wetland community types will have to be included in a conservation programme in order to preserve wetland biodiversity.

The phytosociological study of the wetlands of this study area will not only contribute to the knowledge of South African wetland vegetation and diversity, but can be incorporated into the Grassland Biome Classification Project (Du Preez & Bredenkamp 1991). Other comparable vegetation surveys of the area include those of Deall (1985), Deall *et al.* (1989), Bloem (1988), Turner (1989) and Matthews (1991).

An important site rich in wetland communities is the Lakenvalei, north of Belfast. A recommendation to preserve this site is made, thus preserving many of the wetland communities of this study.

STUDY AREA

Physiography

The study area comprises two parts (Figure 1), both situated at high altitudes in Mpumalanga, the average being above 1 800 m. The area is mountainous and rugged with deep ravines and steep cliffs in places and gently sloping plains in others. This area has the highest rainfall in the northern provinces, resulting in an unique flora (Stevens 1989). The altitude ranges from 900–2 331 m (Die Berg), which is the highest mountain in Mpumalanga. Mount Anderson (2 284 m) lies just outside the bounds, to the north of the smaller study area. Gradients of up to 57° are not uncommon, and many vertical cliffs are to be found.

The geology of the study area was described in detail (Burgoyne 1995) and only a brief summary is given here.

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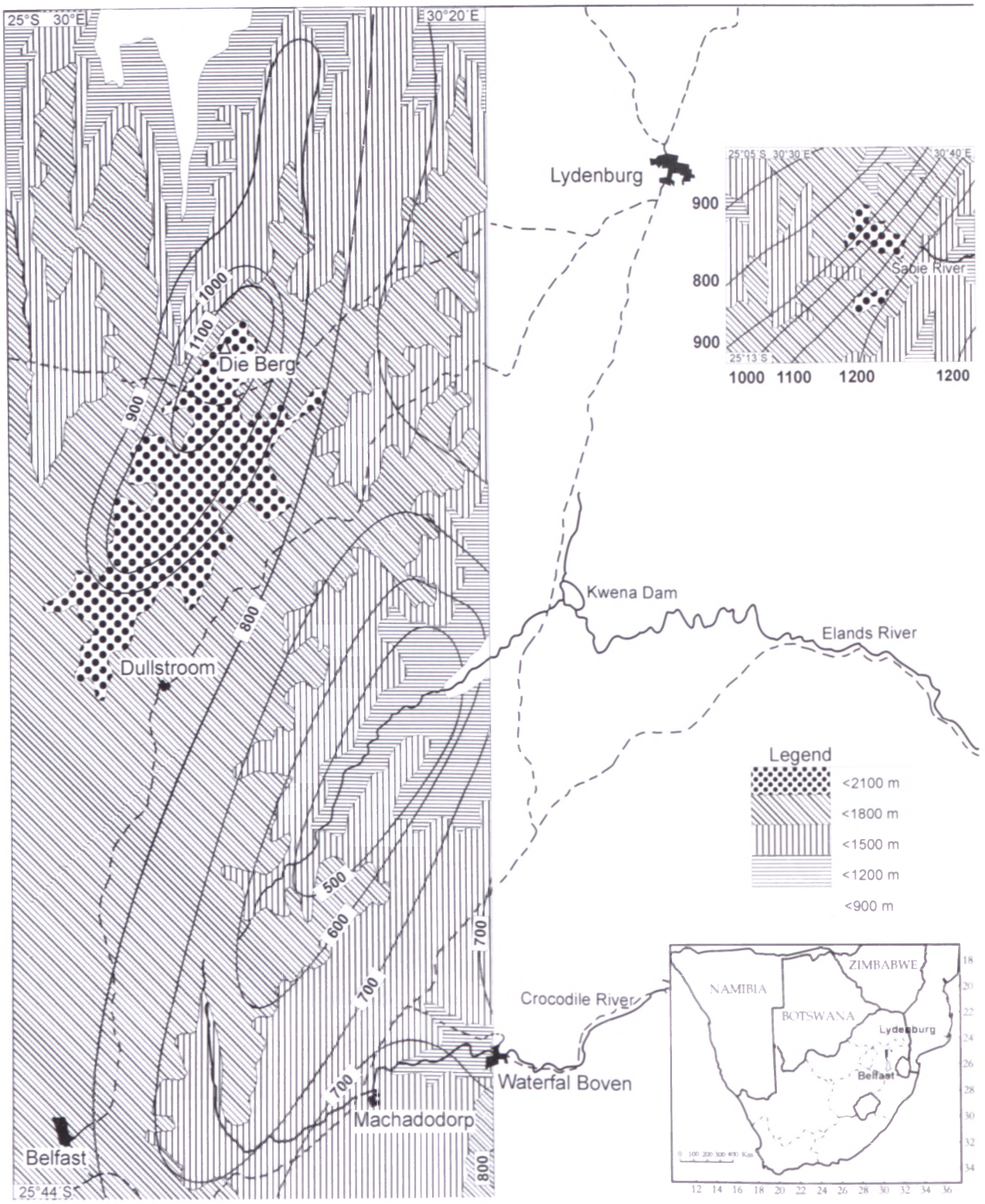

FIGURE 1.—Locality, rainfall in mm and topography of the study area.

Nomenclature follows the South African Committee for Stratigraphy (SACS 1980).

The Pretoria Group is dominated by quartzite and shale, combined with some conglomerate and also some chemical members. Volcanic eruptions occurred intermittently and were normally localized. The soils derived from sedimentary rocks are generally very shallow and poor in nutrients, whereas the soils derived from the lavas are richer in nutrients and are generally deeper (SACS 1980). Fine-grained hornfels together with silt and sandstone, with minor layers of carbonaceous (dolomite) and siliceous (chert) rocks, are to be found throughout the study area in a broken, broad band from the north to the south. These rock types give rise to soils that are rich in minerals but the soils themselves are not deep. Diabase sills and dykes can be found at intervals all over the study area. These sills and dykes can sometimes be noted from aerial photographs by the difference in the vegetation growing on them.

The Ecca Series of the Karoo Supergroup consists of sediments that were laid down in a freshwater basin (Truswell 1970). Vegetation growing in the swamps gave rise to the formation of coal which is extracted by means of open cast mining. This is detrimental to the ecology of the area because much of the topsoil is lost or ruined, while seepage from open casts and waste dumps threatens wetland systems.

Recent Quarternary Deposits (Pleistocene) occur in the study area in most of the riverbeds where the products of many years of erosion have been deposited (SACS 1980). Some wetland communities occur specifically on these deposits along the rivers.

The Fa and Ac land types were studied in this area (Land Type Survey Staff 1984). These two land types constitute the land covered by grassland in the escarpment area. Other land types were not studied for the reason that they are not grassland, but forest or savanna, as well as the fact that they are considered as lowlands. The Fa and Ac land types differ from each other in terms of microclimate, terrain form and geology (Land Type Survey Staff 1979). The Ac land type represents the high altitude plateau of the escarpment and occurs on sediments of various geological groups. Slopes are generally shallow and may reach considerable lengths, forming systems of catenas, creating a gently undulating plateau landscape. The soils are defined as red-yellow and apedal, with free drainage, and are dystrophic or mesotrophic. Soil forms Hutton, Griffin, Clovely and Inanda are frequent, although others may be present to a lesser extent (Land Type Survey Staff 1979). The Fa land type represents the rugged slopes with deep gorges and valleys of the escarpment, linking the grassland plateau with the low-lying bushveld vegetation (Figure 1). It is principally found on Vermont sandstone, Magaliesberg shale and Steenkampsberg quartzite where the main soil-forming process is weathering of the parent material, resulting in the formation of relatively young soils with orthic topsoils. The B horizons are formed by clay illuviation. Although Glenrosa and Mispah Forms are the most common soil forms, other forms make up 7% of this land type.

Climate

The climate of this region, according to the classification of Koppen (Schulze 1947), is a temperate, rainy climate with a dry winter season (summer rainfall). There is a C-type humidity province (subhumid), with grassland as the characteristic vegetation, together with a precipitation (P)/evaporation (E) index of 32 to 63 (Schultze 1947; Schulze & McGee 1978). The area is also classified as a w-type, which indicates a moisture deficiency in the winter.

Lydenburg (1 439 m) and Waterval Boven (1 430 m) have similar temperature ranges. Lydenburg records an extreme minimum of –7,8°C and Waterval Boven records the highest maximum temperature of 38,8°C (Weather Bureau 1968). Sabie, however, has a maximum average of 30,2°C, which is higher than the other towns in the area. The temperatures recorded for Belfast are lower due to its situation on an open, exposed, high-altitude plain where free airflow occurs. Dullstroom (2 100 m) is expected to be colder than the other towns in the area.

Frost occurs generally in the winter months in this area and is common on all slopes, crests, as well as in the valleys. It has been known to persist into the months of September and October in the southern parts of the study area. Frost causes teracettes on slopes in this region (Van Zinderen Bakker & Werger 1974) by the daily frost-thaw process. These terracettes are often colonized by pioneers because they are basically disturbed areas. During rainy seasons the teracettes can be eroded, thus losing valuable topsoil. The formation of frost-heaved tussocks is also an important process in this region (Sigafoos & Hopkins 1951; Hopkins & Sigafoos 1954).

The higher parts of the Steenkampsberg receive more rainfall than surrounding areas (Figure 1). This is partly due to the higher elevation coupled to the fact that these mountains act as a barrier against which the rain falls. The same can be observed in the northeastern part of the Escarpment which receives a higher rainfall than the areas surrounding it. The high rainfall in the area might have contributed to the higher species diversity than in most other parts of the country (MacArthur 1972; Huston 1979; Stevens 1989; Matthews *et al.* 1993).

From the Walter Climate Diagrams (Figure 2) it can be seen that Sabie has a considerably higher rainfall than the other towns in the area. Precipitation from mist and fog supplements the rainfall rather significantly. Mist is a common occurrence especially during the months of October to February. From the data (Figure 3) it can be seen that the most mist occurs in Belfast, but other areas that do not have ample weather stations for recording this phenomenon, may have much higher occurrences of mist. Areas above 2 000 m in altitude are shrouded in mist for most of the summer months, and mist can cover the entire escarpment area for three weeks at a time.

Snowfalls are uncommon in this area, the last falls at Dullstroom were recorded in 1974. The Steenkampsberg Range is well above 2 000 m and it forms the tail-end of the Drakensberg Range, thus any extreme weather conditions caused by cold fronts moving northwards during winter months would cause snow on these mountains (Weather Bureau 1986).

METHODS

The geological and land type maps, 2530 Barberton (scale 1:250 000) were used as units of statification.

Within each stratification unit, wetland sites were chosen subjectively, as originally postulated in the Braun-Blanquet approach (Braun-Blanquet 1932). This was done to enable a survey of the limited and scattered wetlands throughout the area. Thus a thorough reconnaissance of the study area had to be done to choose the wetland sites so that all wetland communities represented in the area were sampled. Within a particular wetland, samples were placed randomly. Relevés were compiled in 39 sample plots.

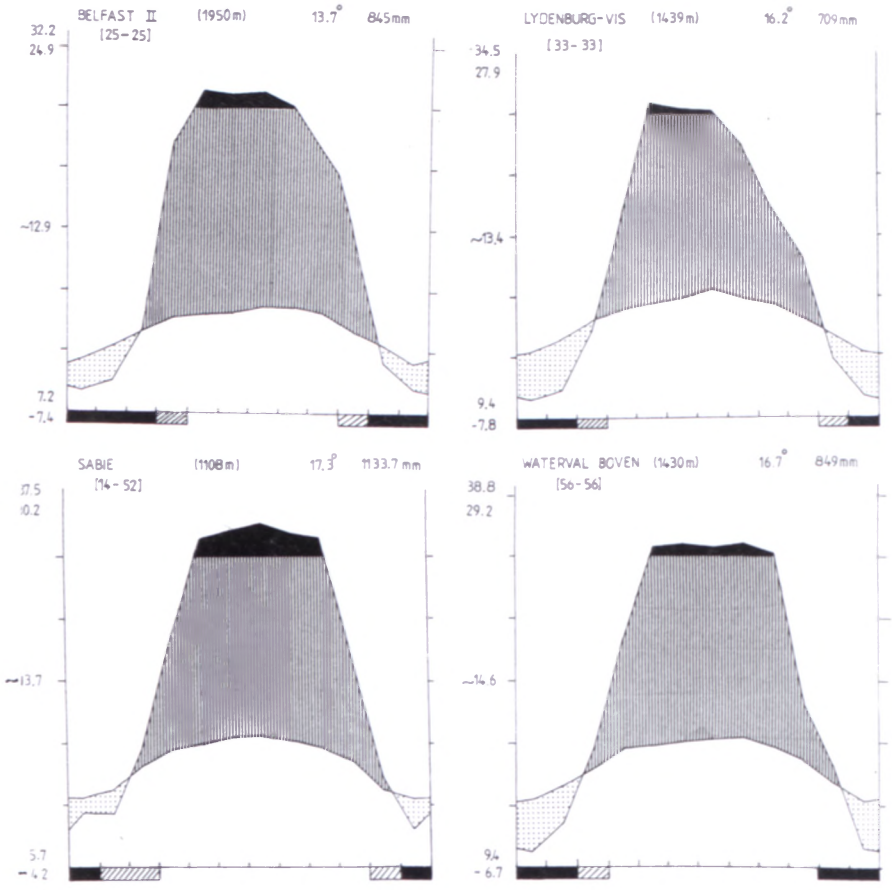

FIGURE 2.—Walter Climate Diagrams for four towns in the study area (Walter 1991).

Based on a species-area curve of the vegetation of the Verlorenvalei Nature Reserve (Bloem 1988), a sample site of 200 m^2 was used, due to the low species diversity of wetlands in high mountain grassland. This is also the same size quadrat as recommended by Deall (1985).

For each quadrat the following data were recorded:

- location by farm name or nearest beacons and stand co-ordinates (Land type series, 2530 Barberton 1979, e.g. 2530 AA)
- altitude in metres was noted from the nearest contour on the topocadastral map (Land type series, 2530 Barberton 1979)
- geology
- land type
- geomorphology position (Munnik *et al.* 1984)
- degree of disturbance, including disturbance due to road construction, exotic invaders, soil erosion, overburning, trampling and power line construction, using the following scale: 0, no visible erosion; 1, sheet erosion; 2, donga erosion; 3, sheet and donga erosion
- degree of grazing, using the following scale: 0, no recent grazing; 1, selectively grazed; 2, evenly grazed; 3, heavily grazed
- soil depth (cm)
- soil texture was noted using the method as prescribed by the FSSA (1980)
- soil form and soil series were noted following MacVicar *et al.* (1977)
- water depth and permanency were noted
- Braun-Blanquet cover-abundance values for every species present (Westhoff & Van der Maarel 1978); taxon names in accordance with Arnold & De Wet (1993)
- height of vegetation

Classification of the floristic data was accomplished by using a default TWINSPAN (Two-way INdicator SPecies ANalysis, Hill 1979). Both the relevés and the species are grouped into a specific order (Noy-Meir 1973; Gauch & Whittaker 1981). TWINSPAN produced

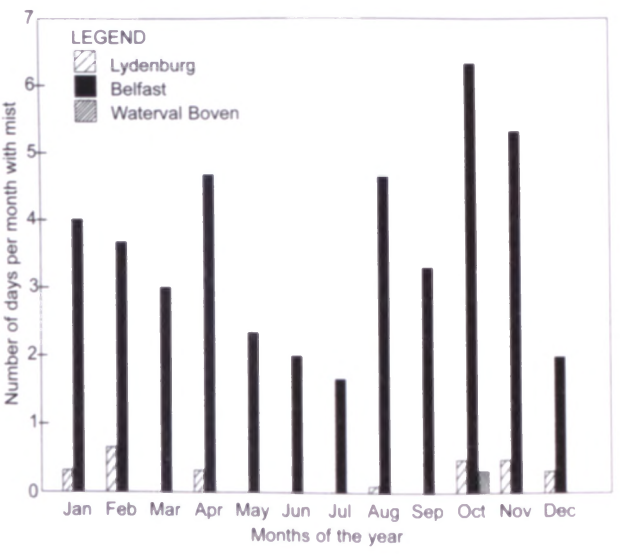

FIGURE 3.—The occurrence of mist at three stations in the study area.

a table that was then refined by Braun-Blanquet procedures (Werger 1974) as was proposed by Bredenkamp & Bezuidenhout (1995). Type relevés were chosen as the most representative relevé for a community by comparing relevés from the Braun-Blanquet tables (Table 1).

RESULTS

The floristic composition of the wetland plant communities is given in Table 1. General characteristic species for the wetlands (species group T) were identified by comparing this table with phytosociological tables from other plant communities of the area (Burgoyne 1995). Species which occur throughout all wetland communities include the grasses *Arundinella nepalensis*, *Alloteropsis* sp., *Aristida aquiglumis*, *Pennisetum thunbergii*, *Agrostis lachnantha*, *Hemarthria altissima* and *Setaria pallide-fusca*, the sedges *Fuirena pubescens*, *Mariscus congestus*, *M. sumatrensis*, *Eleocharis palustris*, *Pycreus nitidus*, and *Kyllinga erecta*, the forbs *Pycnostachys reticulata*, *Sebaea sedoides*, *Mentha aquatica*, *Lobelia flaccida*, *Helichrysum difficile* and *H. mundtii*, and the monocot *Eriocaulon dregei*.

The species with the highest constancy values are *Fuirena pubescens* (66%) and *Arundinella nepalensis* (66%), followed by *Mariscus congestus* (39%) and *Schoenoplectus corymbosus* (32%).

The analysis of the wetland vegetation resulted in the recognition of four communities and 11 subcommunities, which are classified as follows:

1. *Phragmites australis* Deep Wetland Community
   - 1.1. *Phragmites australis–Ficinia acuminata* Deep Wetland Subcommunity
   - 1.2. *Phragmites australis–Senecio microglossus* Deep Wetland Subcommunity
2. *Miscanthus junceus* Wetland Community
   - 2.1. *Alepidea amatymbica–Miscanthus junceus* Moist River Bank Subcommunity
   - 2.2. *Agrostis gigantea–Miscanthus junceus* Moist Grassland Subcommunity
   - 2.3. *Panicum schinzii–Miscanthus junceus* Shallow Wetland Subcommunity
   - 2.4. *Carex cognata–Miscanthus junceus* Wetland Subcommunity
   - 2.5. *Ischaemum fasciculatum–Miscanthus junceus* Wetland Subcommunity
3. *Eragrostis biflora–Stiburus allopecuroides* Moist Grassland Community
   - 3.1. *Helichrysum aureonitens–Eragrostis biflora–Stiburus allopecuroides* Moist Grassland Subcommunity
   - 3.2. *Disa patula–Eragrostis biflora–Stiburus allopecuroides* Moist Grassland Subcommunity
4. *Arundinella nepalensis* Moist Turf Grassland Community
   - 4.1. *Hypericum aethiopicum–Arundinella nepalensis* Moist Turf Grassland Subcommunity
   - 4.2. *Imperata cylindrica–Arundinella nepalensis* Moist Turf Grassland Subcommunity

1. The *Phragmites australis* Deep Wetland Community

Species group: C (Table 1).
Diagnostic species: the tall-growing reed, *Phragmites australis* and bulrush *Typha capensis*.
Dominant species: hygrophylic forbs such as *Zantedeschia albomaculata*, *Berkheya speciosa* and the fern *Thelypteris confluens* which can grow in almost pure stands.

This community occurs predominantly in deep water, mostly deeper than 0.2 m and often deeper than 1.1 m. The soils are high in organic matter, representing the Champagne Form.

This community is divided into two subcommunities namely the *Phragmites australis–Ficinia acuminata* Deep Wetland Subcommunity in water 0.2–0.7 m deep, mostly at altitudes of 2 000 m and lower, and the *Phragmites australis–Senecio microglossus* Deep Wetland Subcommunity in water deeper than 1.1 m, mostly at altitudes higher than 2 000 m above sea level.

1.1. *Phragmites australis–Ficinia acuminata* Deep Wetland Subcommunity

Type relevé: 307.
Av. no. spp. per relevé: 32.
Max. no. spp. per relevé: 47.
Min. no. spp. per relevé: 10.
Altitude: 980–2 000 m.
Geology: predominantly from the Magaliesberg and the Steenkampsberg Formations although some shale from the Strubenkop and Lakenvalei Formations is also present.
Soil form: Champagne and deep alluvial soils high in organic matter.
Height of vegetation: 2.6 m.
Species group: A (Table 1).
Diagnostic species: the sedge *Ficinia acuminata*, the geophytes *Dierama pendulum*, *Ornithogalum monophyllum* and *Brunsvigia radulosa*, the forbs *Wahlenbergia* sp., *Cycnium racemosum*, *Cyphia stenopetala*, *Asclepias dissona*, *Vigna vexillata*, *Vernonia hirsuta*, *V. sutherlandii* and *Helichrysum pilosellum*.
Dominant species: the reed *Phragmites australis*; the reedbeds form important bird breeding sites (Figure 4).

Stands of these deep wetlands may cover a surface area of up to 5 ha. This community is found where seasonal fluctuation of the water level occurs. Only in the most dry of seasons (as in the spring of 1992) is relatively deep surface water not present.

TABLE 1.—Phytosociological table showing wetland communities

	1				2					3		4	
	1.1	1.2	2.1	2.2	2.3	2.4	2.5	3.1	3.2	4.1	4.2		
	33111	2321222	130	03	32	130	3113	01321	23221	30	2		
	00453	4052480	725	41	00	716	1311	59139	41454	11	1		
	75651	3941740	206	19	87	301	3792	24591	48950	19	5		
Species Group A													
Ficinia acuminata	++ +												
Dierama pendulum	+++				R								
Wahlenbergia sp.	+++												
Cycnium racemosum	++ +												
Cyphia stenopetala	++				+								
Brunsvigia radulosa	+ +				R								
Asclepias dissona	+ +												
Vigna vexillata	+ +				R								
Ornithogalum monophyllum	+		+										
Vernonia hirsuta	+ +												
Vernonia sutherlandii	+ +												
Helichrysum pilosellum	+ +												
Species Group B													
Senecio microglossus		+ 1 +											
Polygonum meisnerianum		++											
Kniphofia multiflora		+ +											
Polygonum sp.		A											
Eragrostis cylindriflora		+	+					1					
Species Group C													
Phragmites australis	1B 1B	3A1+1											
Zantedeschia albomaculata	++ +	++ R		++									
Typha capensis	R R	+ 1R	R			R							
Thelypteris confluens	+ +	++											
Berkheya speciosa	R R	+		RR									
Species Group D													
Geranium multisectum			+++										+
Alepidea amatymbica		+	+++										
Pelargonium alchemilloides			++		RR								
Diclis rotundifolia			++					+					
Kyllinga pauciflora		+	++				++						
Adiantum capillis-veneris			++										
Diheteropogon amplectens			++										
Aeschynomene rehmannii			++										
Asclepias cultriformis			++						+				
Cephalaria attenuata			++										
Species Group E													
Scleria dieterlenii		+	+	11				1					
Agrostis gigantea				11									
Sphagnum truncatum				++				+ +					
Senecio striatifolius		+	+	++		+		+					
Rorippa nasturtium-aquaticum				++				+					
Aristea sp.				++									
Disperis cooperi				++		+		+					
Koeleria capensis				++			++	+					
Commelina africana				++				+					+
Hypoxis rigidula			+	++					+				
Alepidea setifera				++									
Aloe ecklonis				++									
Tulbachia nutans	+		++	++									
Helichrysum subglomeratum			+	++		1							
Peucedanum sp.	+		+	++									
Species Group F													
Panicum schinzii		+			11			+		+			
Aponogeton junceus		+	+	++	++								
Crassula pellucida			+		R+								
Lolium multiflorum	+				++								
Habenaria sp.					++								
Species Group G													
Epilobium salignum	+ +	+++ 1	+++	++	++								
Sium repandum	+ +	+ +	+++	++	++								
Kniphofia linearifolia	R	++	++		RR	+							
Holcus lanatus	1 1	1	1		11				+				1
Eucomus comosa	+	+ 1			RR								

TABLE 1.—Phytosociological table showing wetland communities (cont.)

	1		2					3		4	
	1.1	1.2	2.1	2.2	2.3	2.4	2.5	3.1	3.2	4.1	4.2
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	00453	4052480	725	41	00	716	1311	59139	41454	11	1
	75651	3941740	206	19	87	301	3792	24591	48950	19	5
Species Group H											
Nerine angustifolia			+			+R					
Carex cognata						A					
Disa cooperi						+					
Eulophia ovalis						+					
Bulbine abyssinica						+					
Eulophia leontoglossa						+					
Species Group I											
Carex austro-africana	+ +	A1AAB1	+	++	AA	1 A			+		+
Rumex lanceolatus	+++++	+ +1++	+++			+					
Gunnera perpensa	11 11	+1 A+BB	A		11	1					
Festuca caprina	+ +	+	+ +	++	++	++		A			
Satyrium hallackii	+ +	+R+R +			RR	R			+		
Senecio serratuliodes	1 1		+ +	11	++	+1					B
Kniphofia fluviatilis	+ +	+ +	+		++	++					
Leersia hexandra	+ +	1 +	1	++				+			
Species Group J											
Ischaemum fasciculatum							BB11			+	
Dolichos falciformis							++++				
Conyza pinnata	+ +		+				++++	+			
Digitaria eylesii							11				
Pennisetum macrourum			+			+	++				
Digitaria flaccida							++			+	
Pycreus sp.							++			+	
Alysicarpus rugosus							++				
Satyrium parviflorum		+					++		+		
Helichrysum opacum							++				
Habenaria lithophila							RR			+	
Eragrostis curvula							RR				
Berkheya echinacea											
Species Group K											
Miscanthus junceus	B+BB+	4	4 B		AA	44	11	+			
Ranunculus meyeri	+ +	+ +	1	++	++	+	11				
Ranunculus multifidus	+ +		++			+	++	+			+
Juncus exsertus			+	++	++		++				
Species Group L											
Helichrysum aureonitens							11	+AA A	+		
Hypoxis filiformis	1							+++++	++	1	
Agrostis eriantha			+ 1		++	+		1 A A	B		1
Asclepias multicaulis						+		R + +			
Sebaea leiostyla								++ +			
Juncus dregeanus				++				++ +			
Oxalis obliquifolia								+ +			+
Anthericum cooperi								R R			
Ficinia sp.								1			
Species Group M											
Buchnera glabrata							++++	+ + +			
Habenaria clavata							RR	RR R			
Disa aconitoides		+		++			RR	+R R			
Andropogon eucomis			+			+	BB	+ +			
Chironia purpurescens	+ +	+					++	R	+		
Species Group N											
Disa patula									+++ +		
Helictotrichon turgidulum									++ +		
Ornithogalum tenuifolium							++	+	++R		
Eragrostis capensis							++		+		
Bulbostylis sp.									++		
Plectranthus sp.									++		
Alepidea gracilis									++		
									11		

TABLE 1.—Phytosociological table showing wetland communities (cont.)

	1							2							3				4	
	1.1		1.2					2.1	2.2	2.3	2.4	2.5			3.1		3.2		4.1	4.2
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	00453		4052480					725	41	00	716	1311			59139		41454		11	1
	75651		3941740					206	19	87	301	3792			24591		48950		19	5
Species Group O																				
Drosera madagascariensis																				
Eragrostis biflora								+	++		+				++	+	111+		R	
Ascolepis capensis								++							1B	B	++	B		
Dierama sp.									+						1	1	1111		+	+
Polygala uncinata												AA			+++	+				
Utricularia prehensilis															+	+	++	+		
Justicia petiolaris			+						R						+	+		R+		
															+	B		A		
Species Group P																				
Schoenoplectus corymbosus																				
Mariscus keniensis			1	1				+	+	++	11	+1	++		A	A		+		+
Juncus oxycarpus			A+A	1						++		A	+	++	+		BB	A		
Bulbostylis burchellii			+	+					+				+	++++	1+1			++		
Ledebouria cooperi			1					1	+			11+	++		+	+		1		+
Gladiolus longicollis								+++	++			+			+		++	+		
Denekia capensis			R							++	RR	+			R+	+				
Satyrium longicauda									+		++			++	+		++			
Oldenlandia herbacea			+		R					++		+				+				
			+												R	R				
Species Group Q																				
Hypericum aethiopicum																			33	
Crassula sarcocaulis										++									11	
Gladiolis ecklonis		+																	++	
Ledebouria sp.																			++	
Species Group R																				
Pycreus macranthus																				+
Imperata cylindrica																				+
Senecio latifolius																				+
Species Group S																				
Stiburus alopecuroides	+	+							A	BB			A	44	B1	B	B		BR	
Monopsis decipiens	+									++				++	+++	+	+++	1+	1	
Wahlenbergia virgata									+	++				++	+	+			++	+
Xyris capensis														AA	1R	1	111			
Paspalum urvillei								++			++			11				+	11	
Hypericum lalandii	+									++				++	+			+	+	
Helictotrichon hirtelum									+	++					+			+	+	
Cephalaria zeyheriana										++		+			+					
Species Group T																				
Arundinella nepalensis	1	1A	11	1	++		1		A	11	11	+	1	11	41	+++		1	11	A
Fuirena pubescens	3A	3A	+		B	3	113		AA	BB		3	BB		B+3	3	33B	3		3
Mariscus congestus	+	+	1						++	11	1			++	+			1		+
Pycnostachys reticulata	+1	+1		+	+		1		++			1			+	+		+		
Sebaea sedoides		++	+						++			+		++			+++		++	
Alloteropsis sp.		+	+	+		+		+	++			+			+	+		1+		
Eleocharis palustris	+	++	+	+				+	++						1+	1				
Pycreus nitidus		+	+					+	++	11		+		++						A
Mentha aquatica		1	1				+			++	+					+		+		+
Eriocaulon dregei	+	+							++				AA		++					+
Lobelia flaccida							+	+				++	++					1	++	
Aristida aequiglumis	+	+					++					+			+3			+		
Helichrysum difficile	+	+					+++					+			+					1
Helichrysum mundtii	+	+					+		++			+			+					+
Pennisetum thunbergii				1				+	++			+			+	+				+
Agrostis lachnantha	A	A			+					++						+	+			
Mariscus sumatrensis			1		1			1				+			1	4				
Kyllinga erecta	+	+								++					+					+
Hemarthria altissima	+	+	B													+++				
Setaria pallide-fusca	+	+							++				++							
Ranunculus baurii					+		++					+			+					

FIGURE 4.—The *Phragmites australis* deep wetlands, showing the dominance of the reed *Phragmites australis*.

1.2. *Phragmites australis–Senecio microglossus* Deep Wetland Subcommunity

Type relevé: 243.
Av. no. spp. per relevé: 36.
Max. no. spp. per relevé: 36.
Min. no. spp. per relevé: 32.
Altitude: above 2 000 m.
Geology: quartzite of Steenkampsberg and Lakenvalei Formations.
Soil form: Champagne.
Height of vegetation: 2.6 m.
Species group: B (Table 1).
Diagnostic species: the forbs *Senecio microglossus, Polygonum meisnerianum, Polygonum* sp. and the grass *Eragrostis cylindriflora*, together with the characteristic and conspicuous monocot *Kniphofia multiflora*, which can be seen from afar when flowering.
Dominant species: the tall-growing reed *Phragmites australis*.

This high altitude community occurs in the central parts of the deep wetlands and the surface area covered may be up to 15 ha. Lakenvalei between Belfast and Dullstroom is a good example of this community. These wetlands are periodically burned and according to some of the farmers in the region this is beneficial to the breeding of birds like the wattled crane, who prefer open areas where they can clearly see any foes approaching (Tarboton 1981).

2. *Miscanthus junceus* Wetland Community

Species group: K (Table 1).
Diagnostic species: the robust grass *Miscanthus junceus* dominant, and the forbs *Ranunculus meyeri* and *Ranunculus multifidus*, together with the sedge *Juncus exertus*. A shrinking of the *Miscanthus junceus* wetlands was observed over a period of two years, possibly aggravated by low rainfall.

These wetlands are represented by moist river bank communities to wet drainage lines. No trees occur and rockiness is confined to the presence of small pebbles in the sediments. The moisture regime varies from moist soil which releases free water when trodden on, to surface water of a depth of 0.7 m. The area covered by these wetlands is generally shrinking, due to management practices.

2.1. *Alepidea amatymbica–Miscanthus junceus* Moist River Bank Subcommunity

Type relevé: 172.
Av. no. spp. per relevé: 18.
Max. no. spp. per relevé: 30.
Min. no. spp. per relevé: 9.
Altitude: 1 200–2 000 m.
Geology: mainly from quartzites and shales of the Pretoria group.
Soil form: Champagne, deep, dark and rich in organic content, Arcadia may also be present.
Height of vegetation: 0.15–0.65 m.
Species group: D (Table 1).
Diagnostic species: the forbs *Geranium multisectum, Alepidea amatymbica, Pelargonium alchemilloides, Diclis rotundifolium, Aeschynomene rehmannii, Asclepias dissona* and *Cephalaria attenuata*, together with the sedge *Kyllinga paucifolia*, the fern *Adiantum capillis-veneris* and the grass *Diheteropogon amplectens*.
Dominant species: the tall grass *Miscanthus junceus*.

This subcommunity is found on wet soils. The moisture status is such that when trodden on, water is released to the surface.

2.2 *Agrostis gigantea–Miscanthus junceus* Moist Grassland Subcommunity

Type relevé: 41.
Av. no. spp. per relevé: 45.
Max. no. spp. per relevé: 53.
Min. no. spp. per relevé: 29.
Altitude: 1 400–2 200 m.
Geology: shale and diabase from various geological formations.

Soil form: Champagne, deep, rich dark loam, high in organic matter.
Height of vegetation: 0.4 m.
Species group: E (Table 1).
Diagnostic species: the moss *Sphagnum africanum*, which grows in mats, the remains of which may form a peat bog, and the forbs *Senecio striatifolius*, *Rorippa nasturtium-aquaticum* (much eaten by cattle), *Commelina africana*, *Alepidea setifera* and *Peucedanum* sp. Also the geophytes *Aristea* sp. *Hypoxis rigidula*, *Aloe ecklonis*, and *Tulbaghia nutans* together with the orchid *Disperis cooperii*, the grass *Koeleria capensis* and the asteraceous forb *Helichrysum subglomeratum*.
Dominant species: the grasses *Scleria dieterlenii* and *Agrostis gigantea*.

This community is represented by numerous small patches of shallow wetlands that are a result of a raised water table caused by the lithological formations in the area. This wetland type may also be formed by the drying up of larger wetlands through destructive practises.

The moisture status is such that visible water is present on the soil surface but never deeper than 0.05 m. The vegetation is extensively grazed especially in the dry season when it is still green, as compared to the adjacent drier grassland vegetation.

The species richness (53) in this community is higher than in any other wetland community and should therefore be considered important to conserve.

2.3 *Panicum schinzii–Miscanthus junceus* Shallow Wetland Subcommunity

Type relevé: 207.
Av. no. spp. per relevé: 22.
Max. no. spp. per relevé: 34.
Min. no. spp. per relevé: 9.
Altitude: 1 200–2 000 m.
Geology: varies greatly but quarternary deposits are dominant.
Soil form: Champagne, deep, rich dark loam, high in organic matter.
Height of vegetation: 0.7 m.
Species group: F (Table 1).
Diagnostic species: the grasses *Panicum schinzii* and *Lolium multiflorum*, the semisucculent forb *Crassula pellucida*, which may form mats of pure stands in patches, possibly due to it's seed dispersal mechanism, the orchid *Habenaria* sp. and the water plant *Aponogeton junceus*.
Dominant species: *Miscanthus junceus*.

This subcommunity covers a larger area than the *Agrostis gigantea–Miscanthus junceus* Moist Grasslands Subcommunity (2.2) and is also found along the periphery of the larger wetlands, where the water depth is up to 0.8 m. Moisture levels in these wetlands vary greatly and can become quite dry, especially in the winter when rainfall is low.

General species occurring in all the above-mentioned *Miscanthus* communities (1.1. to 2.3.) are: the forbs *Epilobium salignum*, *Sium repandum*, the geophytes *Eucomis comosa*, *Kniphofia linearifolia* and the grass *Holcus lanatus*.

2.4 *Carex cognata–Miscanthus junceus* Wetland Community

Type relevé: 61.
Av. no. spp. per relevé: 26.
Max. no. spp. per relevé: 34.
Min. no. spp. per relevé: 17.
Altitude: 1 600–1 900 m.
Geology: loose Quarternary deposits.
Soil form: Champagne, deep, rich dark loam, high in organic matter.
Height of vegetation: 0.6 m.
Species group: H (Table 1).
Diagnostic species: the sedge *Carex cognata*, the geophytic orchids *Disa cooperii*, *Eulophia leontoglossa*, *E. ovalis* and the geophytes *Nerine angustifolia* and *Bulbine abyssinica*.
Dominant species: *Miscanthus junceus*.

Large and perennial, these wetlands contain ± 0.7 m water all year and are fed by fountains forming the beginnings of the river systems of Mpumalanga. The only time when they may have little or no water in them is during severe drought.

Species group I represents general species occurring in communities 1.1 to 2.4 and include the sedge *Carex austro-africana*, the forbs *Rumex lanceolatus*, the conspicuous *Gunnera perpensa* with its large round leaves, *Senecio serrulatuloides*, the orchid *Satyrium hallackii*, the monocot *Kniphofia fluviatilis* and the grasses *Festuca caprina* and *Leersia hexandra*.

2.5 *Ischaemum fasciculatum–Miscanthus junceus* Wetland Community

Type relevé: 137.
Av. no. spp. per relevé: 19.
Max. no. spp. per relevé: 36.
Min. no. spp. per relevé: 9.
Altitude: 1 200–2 000 m.
Geology: Quartzites of the Pretoria Group.
Soil form: vertic soils of the Arcadia soil form.
Height of vegetation: 0.7 m.
Species group: J (Table 1).
Diagnostic species: the grasses *Ischaemum fasciculatum*, *Digitaria flacida*, *D. eyelsii*, *Pennisetum macrourum* and *Eragrostis curvula*, the orchid *Satyrium parviflorum*, and the sedge *Pycreus* sp.
Dominant species: *Stiburus alopecuroides* and *Ischaemum fasciculatum*.

These communities cover an area of less than three hectares and are subjected to periods of drying out. The water is also never as deep as the wetlands of the previous community (2.4) and is only ± 0.4 m deep. The slopes occupied by these wetlands are also steep (± 12°) as opposed to the wetlands in the previous community where a gradient of 3° is the steepest noted. Running water is therefore a feature of this community.

Forbs in this community include *Dolichos falciformis*, *Conyza pinnata*, *Berkheya echinacea*, *Alysicarpus rugosus* and *Helichrysum opacum*. Species group K (Table 1) are found throughout the previously mentioned communities (1.1 to 2.5) and include the sedges *Miscanthus junceus* and *Juncus exsertus*, together with the forbs *Ranunculus meyeri* and *R. multifidus*.

It is interesting to note that the robust grass *Miscanthus junceus* is relatively absent in the *Senecio microglossus–Phragmites australis* Community, whereas it is most dominant in all the other communities. The explanation for this may be that *Phragmites australis* and *Carex austro-africana* out-compete this species to such an extent that it cannot survive.

3. *Eragrostis biflora–Stiburus alopecuroides* Moist Grassland Community

Species group: O (Table 1).
Diagnostic species: the insect trapping plants *Drosera madagascariensis* and *Utricularia prehensilis*, the forbs *Polygala uncinata* and *Justicia petiolaris*, the sedge *Ascolepis capensis*, the geophyte *Dierama* sp. and the grass *Eragrostis biflora*. This grass is also visibly prominent due to its fine leaves and light pink, fluffy inflorescence.

These wetlands are found in poorly drained soils. In most cases the lithology is impenetrable, resulting in a raised water table. Palatable grasses are predominant, affording much grazing.

This community is divided into two subcommunities: *Helichrysum aureonitens–Eragrostis biflora–Stiburus alopecuroides* Moist Grassland Subcommunity which is found on soils of diabase origin, and *Disa patula–Eragrostis alopecuroides* Moist Grassland Subcommunity, found on soils of sedimentary origin.

3.1. *Helichrysum aureonitens–Eragrostis biflora–Stiburus alopecuroides* Moist Grassland Subcommunity

Type relevé: 194.
Av. no. spp. per relevé: 31.
Max. no. spp. per relevé: 37.
Min. no. spp. per relevé: 23.
Altitude: 950–2 200 m.
Geology: igneous rock, particularly Transvaal diabase.
Soil form: Champagne, 0.3 m deep, relatively rich in organic matter, stones may occur in this community but their size never exceeds 0.05 m diam.
Height of vegetation: 0.4 m.
Species group: L (Table 1).
Diagnostic species: the geophytes *Hypoxis filiformis* and *Oxalis obliquifolia*, the forbs *Helichrysum aureonitens*, *Sebaea leiostyla*, *Asclepias multicaulis* and *Anthericum cooperii* and the sedges *Juncus dregeanus* and *Ficinia* sp. together with the grass *Agrostis eriantha*.
Dominant species: *Stiburus alopecuroides*, *Fuirena pubescens* and *Eragrostis biflora*.

This community is found on all aspects and slopes, and the area covered by stands of this community never exceeds 1.5 ha. There are thus small areas where the water is trapped by the geological strata. No visible water is present but, during the rainy season, water may seep out when trodden on. Grazing is moderate to heavy due to the presence of palatable grasses in this community.

Species group M represents a group of species common to the *Ischaemum fasciculatum–Miscanthus junceus* Wetland Subcommunity (2.5) and the *Helichrysum aureonitens–Eragrostis biflora–Stiburus alopecuroides* (3.1) Wetland Subcommunity. These include the forbs *Buchnera glabrata* and *Chironia purpurescens*, the orchids *Habenaria clavata* and *Disa aconitodes* together with the grass *Andropogon eucomis*.

3.2. *Disa patula–Eragrostis biflora–Stiburus alopecuroides* Moist Grassland Subcommunity

Type relevé: 244.
Av. no. spp. per relevé: 19.
Max. no. spp. per relevé: 36.
Min. no. spp. per relevé: 9.
Altitude: 1 200–2 000 m.
Geology: quartzites of the Pretoria Group.
Soil form: Champagne or Mispah.
Height of vegetation: 0.4 m.
Species group: N (Table 1).
Diagnostic species: the orchid *Disa patula*, the forbs *Plectranthus* sp. and *Alepidea gracilis*, the geophyte *Ornithogalum tenuifolium*, the sedge *Bulbostylis* sp. and the grasses *Helictotrichon turgidulum* and *Eragrostis capensis*.
Dominant species: the grass *Stiburus alopecuroides* dominates the vegetation and especially in the months when it flowers, the light purple heads are prominently visible. Also when mist is present this community stands out visibly from those next to it due to the dew drops that are caught in the hairs of the leaves of this plant.

In this community depressions with poor drainage are periodically flooded in the wet season, thus forming wetlands, which dry out if further rainfall ceases or is insufficient. The sandy loam soil is dark, rich in organic material and is not deeper than 0.4 m, having a rock base which is normally not penetrable to water, thus the water table is raised, resulting in moist conditions. Rocks may be found in this community but are not larger than 0.05 m diam.

An affinity exists between community number 3.1 and 3.2 through the common species shared in species group M. Species group P, present in communities 1.2–3.2 represents species common to these communities and include the following: the sedges *Schoenoplectus corymbosus*, *Mariscus keniensis*, *Juncus oxycarpus* and *Bulbostylis burchellii*, the forbs *Denekia capensis* and *Oldenlandia herbacea*, the geophytes *Ledebouria cooperi* and *Gladiolus longicollis* and the orchid *Satyrium longicauda*. The presence of species in more than one community shows environmental affinities which exist between the communities. These environmental factors have yet to be ascertained and a combination of factors may be responsible for the distribution of species.

4. *Arundinella nepalensis* Moist Turf Grassland Community

This major community is fairly poor in species composition, is often dominated by the widespread *Arundinella nepalensis* (species group T, Table 1). No diagnostic species group could be recognized.

It is divided into two subcommunities namely the *Hypericum aethiopicum–Arundinella nepalensis* Moist Turf Grassland Subcommunity and the *Imperata cylindrica–Arundinella nepalensis* Moist Turf Grassland Subcommunity. Both these subcommunities have the vertic Arcadia soil form in common, though the origins of the soil differ.

4.1. *Hypericum aethiopicum–Arundinella nepalensis* Moist Turf Grassland

Type relevé: 311.
Av. no. spp. per relevé: 20.
Max. no. spp. per relevé: 30.
Min. no. spp. per relevé: 10.
Altitude: 900–2 100 m.
Geology: mainly Transvaal diabase.
Soil form: vertic, clay rich loams of the Arcadia soil form.
Height of vegetation: 0.8 m or higher due mainly to the presence of the robust grass *Arundinella nepalensis*.
Species group: Q (Table 1).
Diagnostic species: the succulent *Crassula sarcocaulis*, the forbs *Hypericum aethiopicum* and *Senecio latifolius* and the geophytes *Ledebouria* sp. and *Gladiolus ecklonis*.
Dominant species: *Hypericum aethiopicum* and *Arundinella nepalensis*.

This community is found on all aspects and on slopes of moderate inclination (15°–30°). There are rock sheets present which may lie exposed at the surface or are covered by a thin (± 0.30 m) layer of soil. Because the soil is not deep, the roots of the plants grow so closely together that a mat is formed. The moisture status gives rise to a semipermanent soggy layer of soil underlain by an impenetrable layer of solid or weathered rock. During the dry season the soil may dry out completely.

4.2. *Imperata cylindrica–Arundinella nepalensis* Moist Turf Grassland Subcommunity

Type relevé: 215.
Av. no. spp. per relevé: 30.
Max. no. spp. per relevé: 30.
Min. no. spp. per relevé: 30.
Altitude: 900–1 900 m.
Geology: alluvial deposits of Quarternary origin.
Soil form: vertic soils of the Arcadia soil form.
Height of vegetation: 0.6 m.
Species group: R (Table 1).
Diagnostic species: the grass *Imperata cylindrica* which may grow in nearly pure stands, the sedge *Pycreus macranthus* and the forb *Senecio latifolius*.
Dominant species: the grass *Imperata cylindrica*.

This community is found on very gentle slopes, normally in shallow valleys. During wet periods much water is held in the soil and during dry seasons the soil may be cracked and dry.

Species Group S present in communities 2.1–4.2 but absent entirely in community 2.2, represents species that are flexible in their habitat requirements, thus inhabiting a wide variety of environmental conditions within the parameters of the wetland. These include the grasses *Stiburus alopecuroides*, *Helictotrichon hirtellum* and *Paspalum urvillei*, the forbs *Monopsis decipiens*, *Wahlenbergia virgata*, *Hypericum lalandii* and *Cephalaria zeyheriana* and the sedge *Xyris capensis*.

DISCUSSION

Wetlands are fragile ecosystems and mismanaging them can result in a shrinkage of the area covered by the wetland or a total disappearance of some species in the wetland (Walmsley 1988; Eckhardt *et al.* 1993), for example, the *Miscanthus junceus* wetlands (2.1 to 2.5) are intensively grazed by cattle and sheep, as they contain plant species that are highly desireable in the winter months when greens are scarce for grazing animals. Burning takes place at intervals of between one and five years and this, accompanied by grazing of the green shoots and trampling by livestock, may cause a serious depletion of the water. With continued grazing and trampling and increased evaporation, the surface area of the wetland shrinks until only moist grassland is left.

The wattled crane (*Grus carunculata*), which has its breeding grounds in this area, is an endangered bird species (Batchelor *et al.* 1982). The Verlorenvalei Nature Reserve has been set aside specifically as a breeding ground for wattled cranes. According to some local farmers, they breed only in wetlands that have been burned the previous season. Under-burning can have as serious an effect on the condition of the wetland and grassland as can over-burning (Trollope 1989). Thus if wetlands are left unburned, the cranes will either move to a more suitable site or would simply not breed that year due to unfavourable conditions. Most cranes, however, return to their territories each year to breed. Not burning the wetlands may be a possible explanation for their low numbers. According to Heyns (1985), wetlands of the Verlorenvalei Nature Reserve should be burned every third year to remove dead plant material.

Grasslands found in the Belfast, Lydenburg and Dullstroom Districts are of fire climax vegetation as opposed to climatic climax vegetation (Tainton 1981). Here it can be seen that fire, together with grazing, maintains the grass cover (Burkhart 1975), and prevents the establishment of shrubs and trees. Thus fire started naturally (lightning) or by man, together with grazing, have created pressures with which the grasslands of Africa have co-evolved (Daubenmire 1974; Grubb 1977; Owen & Wiegert 1981; Tainton 1981; Mentis & Huntley 1982). Fire has always been used by pasturalists for the management of the vegetation, but abuse of this tool can result in deterioration in the vegetation (Trollope 1989). Such misuse of fire is to be found in the study area where sheep

farmers burn the veld out of season to obtain green growth for grazing. This causes a reduction of canopy cover, basal cover and a reduction of vigour (Tainton 1981; Trollope 1989) as well as an increased run-off area for rain which in turn causes soil erosion (Trollope 1989).

The great variety of wetland plant communities identified in this study, most of them being relatively poor in species richness, emphasizes the results of Myburgh *et al.* (1995) and Bloem (1986). Therefore a variety of wetland communities should be conserved in order to preserve the wetland biodiversity in Mpumalanga.

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