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Flora of the Zuurberg National Park. 1. Characterization of major vegetation units

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ABSTRACT

The distribution of major vegetation units or veld types in the Zuurberg National Park, situated on the eastern limits of the Fynbos Biome, is presented. Structural and floristic criteria are used to describe and map five basic units, namely Afromontane Forest, Subtropical Thicket, Mountain Fynbos, Grassy Fynbos and Grassland.

UITTREKSEL

Die verspreiding van die hoofplantegroei-eenhede of veldtipes in die Zuurberg Nasionale Park, geleë aan die oostelike grens van die Fynbosbioom, word aangebied. Strukturele en floristiese maatstawwe word gebruik om vyf basiese eenhede te beskryf en te karteer, naamlik Afromontane Woud, Subtropiese Ruigtes, Bergfynbos, Grasryke Fynbos en Grasveld.

INTRODUCTION

The Zuurberg National Park represents one of the largest conservation areas incorporating Grassy Fynbos, a vegetation type characteristic of the eastern limits of the Fynbos Biome. An intricate mosaic of vegetation types is present, reflecting the rugged topography, variety of aspects and different microclimates. The biogeographical complexity of the eastern Cape is well known and is a result of the convergence of four major phytochoria (Goldblatt 1978; Gibbs Russell & Robinson 1981; Cowling 1983a, 1983b, 1984; Lubke *et al.* 1986). This diversity represents a major challenge in terms of conservation, since management measures taken for one plant community may not be suitable for another.

No comprehensive account of the vegetation of the Park is available. Existing knowledge is fragmentary and limited to unpublished official reports and management plans (Stehle 1979; Charlton 1982; Breytenbach & Vlok 1985; Geldenhuys 1985). A research project to provide basic floristic data and to explore the vegetational diversity was started in 1985. The results of a preliminary survey aimed at describing and mapping the major vegetation units is presented in this paper.

STUDY AREA

The study area is situated in the Zuurberg mountain range, approximately 70 km due north of Port Elizabeth (Figure 1). The Park comprises three separate parts with a total area of more than 20 000 ha. The Zuurberg forms part of the Cape Folded Belt and consists mainly of hard quartzitic rock of the Witteberg Group with numerous narrow bands of shale. Most of the area is characterized by a series of mountain plateaus separated by deep valleys with an east-west orientation.

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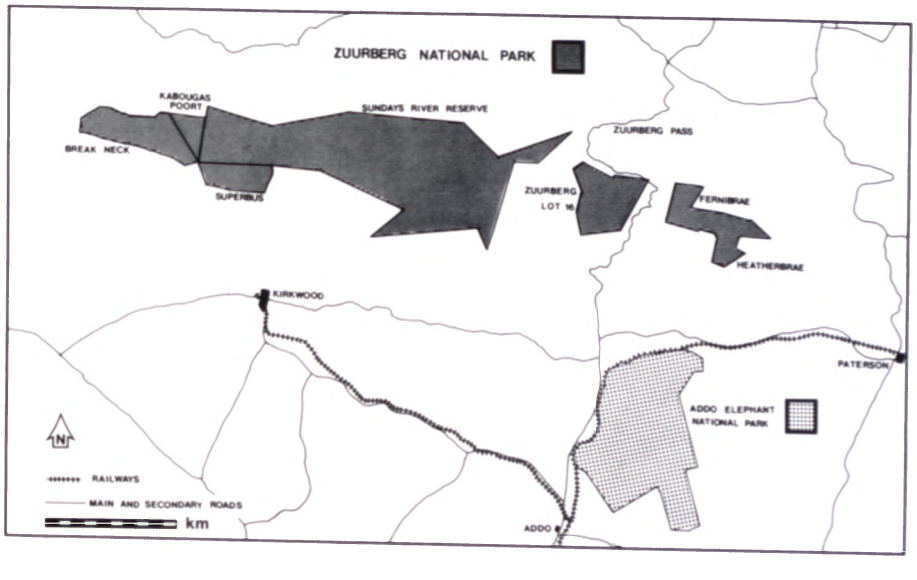

FIGURE 1.—Locality of the study area showing the different parts of the Zuurberg National Park.

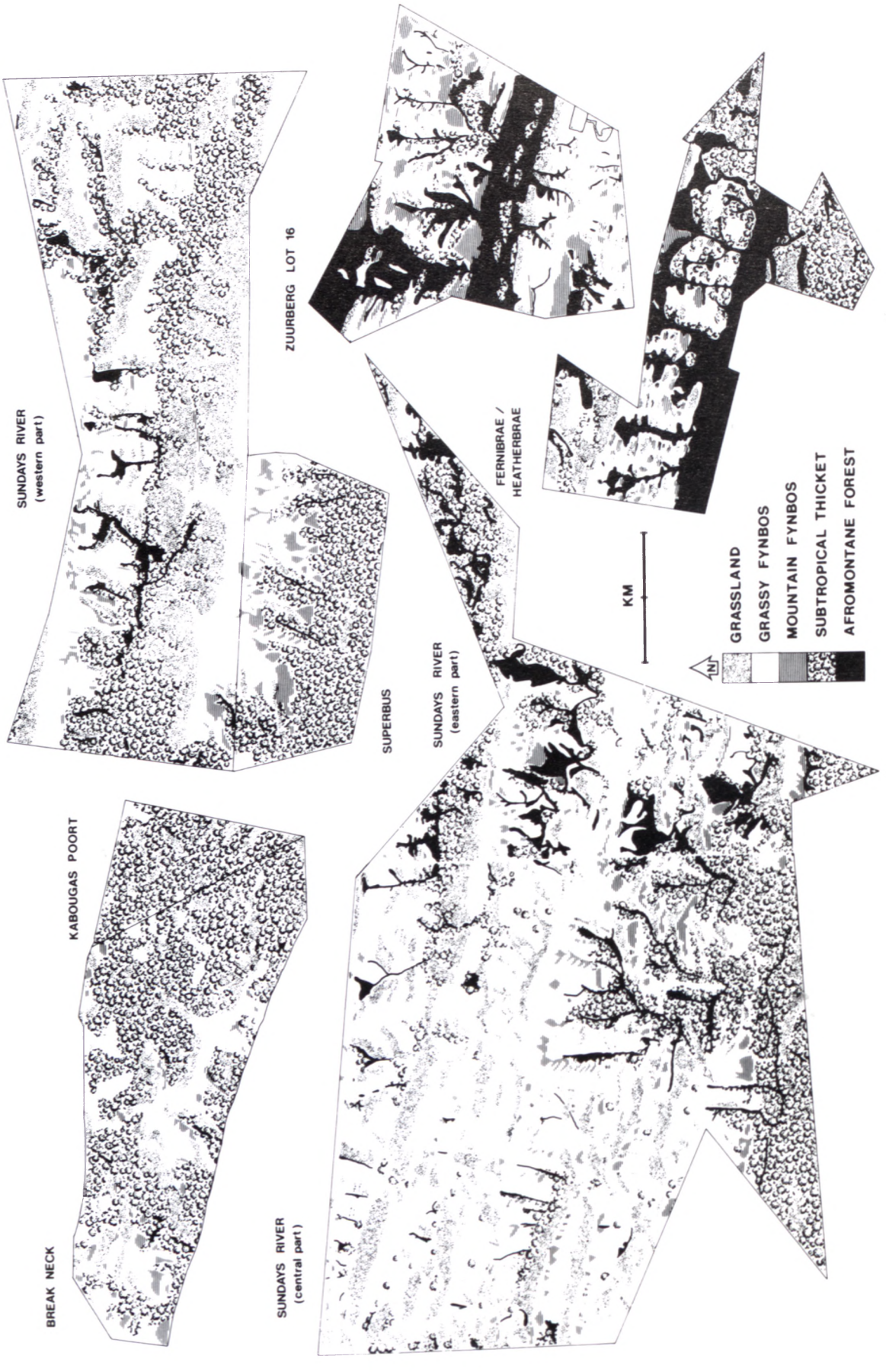

FIGURE 2.—Distribution of major vegetation units in the Zuurberg National Park.

TABLE 1.—Mean monthly rainfall (mm) at Zuurberg Lot 16 for the period 1931 to 1962 (Geldenhuys 1985)

J	F	M	A	M	J	J	A	S	O	N	D	Total
66,8	63,8	95,0	53,3	43,0	25,5	38,3	35,7	77,0	79,7	78,9	64,7	721,7

The topography is very rugged due to the erosion of softer shale bands from between alternating layers of quartzites, but there are no peaks or steep cliffs. Height above sea level varies between 250 and 970 m. The climate is temperate with a mean annual rainfall of ± 722 mm. Table 1 shows rainfall figures recorded at the office (Lot 16) between 1931 and 1962. The mean monthly figures clearly show that spring and autumn maxima are experienced. Unlike other fynbos areas, winter months are the driest. Thunderstorms commonly occur during the summer months, when lightning fires may also be expected. Soil texture and soil depth vary considerably as a result of the geological and topographical diversity. The soils of the Zuurberg are generally more fertile and finer textured than soils of the Cape Folded Belt to the west (Campbell 1983; Cowling 1984).

METHODS

Ground patrols and an aerial reconnaissance by helicopter were undertaken to interpret aerial photographs and to become familiar with the terrain, vegetation and plant species. Herbarium specimens were collected on several visits during 1985, 1986 and 1987. A checklist of all the plant species recorded, complete with their author names, is presented in part 2 of this series (Van Wyk *et al.* 1988).

Vegetation units of the study area were visually identified according to vegetation structure and they correspond roughly with the 'veld type' concept of Acocks (1953) or the rank of class (Cowling 1984). A map (Figure 2) was drawn from 1:50 000 aerial photographs. A series of colour slides taken by helicopter from different angles at low altitude was used to verify the boundaries between vegetation units. The area covered by each unit (Table 3) was estimated from the 1:50 000 map by a randomly positioned 2 mm grid. Descriptive data for each of the five major vegetation units were obtained from 64 sample quadrats distributed as shown in Table 2. All the quadrats were permanently marked by 1,2 m iron fencing standards in each corner (5 × 10 m plots), one at the centre of each short end (4 × 25 m plots) or one at the centre (400 m² circular plots). Localities were selected so as to include most of the variation in each vegetation type. Plot size varied between 50 and 400 m² (Table 2).

The following information was recorded in each plot: all identifiable species present, Braun-Blanquet cover values for each species (r = <1% projected canopy cover; 1 = <5%; 2 = 6–25%; 3 = 26–50%; 4 = 51–75%; 5 = >75%), total projected canopy cover of all species, height of different strata (grass layer, shrub layer, canopy height and height of emergents) and, for Forest and Thicket plots, also diameter at breast height of all individual trees (if more than 100 mm). In view of the tremendous variability of the vegetation, the sample size was inadequate for a detailed phytosociological classification. It does, however, provide sufficient information to characterize the major vegetation units. For descriptive purposes, species were classed into growth forms as shown in Tables 5–14. Dominant and characteristic species of each vegetation unit were chosen as follows:

Characteristic (diagnostic) species: species with a fidelity value of 80% or more.

Dominant species: species with a mean Braun-Blanquet cover value of at least 0,80.

In these calculations, single occurrences (species present in only one plot) were excluded. Forest and Thicket plots were considered separately from the Mountain Fynbos, Grassy Fynbos and Grassland plots. This seemed reasonable as only a few species were common to both subdivisions, and of these very few qualified as characteristic or dominant.

RESULTS

The dominant vegetation types in the study area were Grassy Fynbos (33%) and Subtropical Thicket (32%) (Figure 2, Table 3). Grassland (18%), Afromontane Forest (12%) and Mountain Fynbos (5%) had more limited distributions.

A summary of floristic and structural characteristics of the major vegetation units as recorded in 64 sample plots is given in Table 4. Species richness (expressed as species per m² of plot area) varied between 0,13 (Forest) to 0,92 (Mountain Fynbos). These values are dependent on quadrat area, so that only the figures for Grassland, Grassy Fynbos and Mountain Fynbos are directly comparable. The high figure for Thickets compared to Forest agrees with previous findings that Afromontane Forests are poorer in species than Thickets in the eastern Cape (Cowling 1983b). When distinct differences in structure (Table 4) are considered in conjunction with diagnostic and dominant species (Tables 5 to 14), each of the major units is clearly distinguishable.

1. *Afromontane Forest*

Forests comprising tall evergreen trees with canopy heights of 10 to 14 m and emergents of up to 21 m occur on south-facing slopes and in some valley bottoms. Forest types on northern slopes and in alluvial valley bottoms with canopy heights of 2–9 m and emergents of up to 12 m are grouped with the next unit (Subtropical Thicket). The distinction was not made on the basis of structure only. We also used the almost total absence of a herbaceous ground layer and the presence of typical Afromontane species (White 1978) such as *Podocarpus falcatus* and *Diospyros whyteana*. Despite a strong Tongoland-Pondoland influence, there are pronounced floristic differences between Afromontane Forest and Subtropical Thicket in the eastern Cape (Cowling 1984). In the results of our survey, 24 tree species have fidelity values of more than 80% (present in less than

TABLE 2.—Number of sample quadrats. All were permanently marked to double as long term monitoring plots

	Forest 400 m² (circular)	Thicket 4 × 25 m	Mountain Fynbos 5 × 10 m	Grassy Fynbos 5 × 10 m	Grassland 5 × 10 m
Fernibrae	2	3	3	3	3
Zuurberg Lot 16	2	3	3	3	3
Sunday's River, Skurwenek			3	3	3
Superbus	1	5	3	3	3
Break Neck	1	2	3	3	3
Total (64)	6	13	15	15	15

TABLE 3.—Distribution of major vegetation units in different parts of the Zuurberg National Park. Areas were estimated from the maps in Figure 2

		Forest	Thicket	Grassland	Grassy Fynbos	Mountain Fynbos
Fernibrae/Heatherbrae						
area (ha)	1 755	681	521	212	277	64
% of total	8,5	39	30	12	16	3
Zuurberg Lot 16						
area (ha)	1 940	720	196	128	656	240
% of total	9,3	37	10	7	34	12
Sunday's River Reserve						
area (ha)	13 464	1 138	3 564	3 064	5 194	504
% of total	64,8	8	26	23	39	4
Superbus						
area (ha)	978	22	596	48	188	124
% of total	4,7	2	61	5	19	13
Kabougas Poort						
area (ha)	457	–	396	35	24	2
% of total	2,2	–	87	8	5	–
Break Neck						
area (ha)	2 184	12	1 320	268	480	104
% of total	10,5	1	60	12	22	5
Zuurberg National Park						
area (ha)	20 778	2 573	6 593	3 755	6 819	1 038
% of total	100	12	32	18	33	5

TABLE 4.—Floristic and structural characteristics of the major vegetation units of the Zuurberg National Park

	Forest	Thicket	Grassland	Grassy Fynbos	Mountain Fynbos
No. of plots	6	13	15	15	15
Plot size (m²)	400	100	50	50	50
No. of spp. recorded	109	140	151	136	176
No. of spp. per plot					
max.	67	51	42	46	60
min.	39	25	22	24	31
mean	53	37	31	35	46
Mean no. of spp. per m² plot	0,13	0,37	0,62	0,70	0,92
Canopy height (m)					
max.	14	9	0,5	0,9	2,0
min.	10	2	0,3	0,5	0,5
mean	12	5	0,4	0,7	1,2
Maximum height of emergents (m)	21	12	2,5	1,5	3,5

20% of non-Forest plots) and 18 of these were recorded only in Forest. Shrubs are rare, succulents are virtually absent, and eight of the 10 fern species recorded occur exclusively in Forest. Diagnostic and dominant species are listed in Tables 5 and 6.

2. *Subtropical Thicket*

Thicket as defined here comprises a variable assemblage of communities dominated by thorny and/or succulent shrubs. They occur on dry north-facing slopes in higher parts and on all aspects in lower-lying southern parts of the study area. Most of them comprise what Lubke *et al.* (1986) describe as Valley Bushveld. This term was used by Acocks (1953) but is no longer useful because it incorporates too wide a range of types (Cowling 1984). At least three basic types were included in our sample:

TABLE 5.—Diagnostic species of Afromontane Forest grouped by growth form. Single occurrences are excluded

	Presence (no. of plots)	Dominance (mean BB cover value)*	Fidelity (%)
Trees			
Podocarpus falcatus	6	1,50	86
Canthium inerme	6	0,58	86
Rhus chirindensis	5	0,60	100
Celtis africana	5	0,50	83
Hyperacanthus amoenus	5	0,80	83
Olea capensis subsp. *macrocarpa*	5	0,60	83
Calodendrum capense	4	0,88	80
Pterocelastrus tricuspidatus	3	1,00	100
Podocarpus latifolius	3	0,50	100
Scolopia mundii	3	0,50	100
Sideroxylon inerme	3	0,67	100
Ficus sur	3	1,00	100
Olinia ventosa	3	1,00	100
Apodytes dimidiata	3	0,83	100
Trimeria trinervis	2	0,50	100
Eugenia capensis	2	1,25	100
Gonioma kamassi	2	0,50	100
Maytenus acuminata	2	0,50	100
Shrubs			
Dovyalis rhamnoides	6	0,50	86
Clutia pulchella	2	0,50	100
Vines			
Rhoicissus tomentosa	4	1,25	100
Herbs & graminoids			
Ehrharta erecta	3	0,67	100
Peperomia tetraphylla	3	0,50	100
Oplismenus sp. cf. *O. hirtelus*	2	1,25	100
Galopina circaeoides	2	0,50	100
Haemanthus albiflos	2	0,50	100
Streptocarpus rexii	2	0,50	100
Succulents			
Crassula nemorosa	2	0,50	100
Ferns			
Rumohra adiantiformis	4	0,50	100
Asplenium rutifolium	2	0,50	100

* Sum of Braun-Blanquet cover estimates divided by presence; for Forest and Thicket plots a cover of less than 5% was recorded as 0,50.

Kaffrarian Thicket

Closed, non-succulent shrubland to low forest communities dominated by evergreen, sclerophyllous trees and shrubs with a high cover of stem spines and vines (Cowling 1984; Everard 1987). Campbell (1985) would classify much of the taller thicket of this type as Eastern Forest & Thicket.

Kaffrarian Succulent Thicket

This type occurs in dry areas and is characterized by a high proportion of succulents, a great diversity in growth form and a strong Karoo-Namib floristic influence (Cowling 1984; Campbell 1985; Everard 1987). A variation of this type, similar to Addo Bush and Sundays River Scrub (Acocks 1953), occurs in southern parts such as the northern slopes at Superbus (see Figure 2). The latter has a canopy height of no more than 2–3 m and is dominated by *Schotia afra, Putterlickia pyracantha, Phyllanthus verrucosus* and *Euphorbia ledienii. Portulacaria afra* dominates in some parts, particularly on steep slopes in the western parts of the Park.

Combretum caffrum–Acacia caffra Thicket

This type has a very limited distribution along river beds. Since the dominant species (*Combretum caffrum* and *Acacia caffra*) are deciduous, it is not included in the Subtropical Thicket concept and we group it here provisionally. It shows similarity to the tropical thickets found in the valleys of Natal and Transvaal.

Diagnostic and dominant species of Subtropical Thicket are listed in Tables 7 and 8.

3. *Mountain Fynbos*

Mountain Fynbos has the highest species richness (Table 4) and covers only an estimated 5% of the Park

TABLE 6.—Dominant species of Afromontane Forest grouped by growth form. Single occurrences are excluded

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Trees			
Trichocladus ellipticus	3	2,17	75
Podocarpus falcatus	6	1,50	86
Eugenia capensis	2	1,25	100
Vepris lanceolata	5	1,10	71
Pterocelastrus tricuspidatus	3	1,00	100
Ficus sur	3	1,00	100
Olinia ventosa	3	1,00	100
Diospyros whyteana	6	1,00	60
Calodendrum capense	4	0,88	80
Apodytes dimidiata	3	0,83	100
Hyperacanthus amoenus	5	0,80	83
Shrubs			
Carissa bispinosa	6	0,83	75
Vines			
Rhoicissus tomentosa	4	1,25	100
Rhoicissus digitata	4	1,00	27
Herbs & graminoids			
Oplismenus sp. cf. *O. hirtellus*	2	1,25	100
Behnia reticulata	4	1,25	29
Chlorophytum comosum	4	0,88	57
Cyperus albostriatus	4	0,88	50

TABLE 7.—Diagnostic species of Thicket communities grouped by growth form. Single occurrences are excluded

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Trees			
Brachylaena ilicifolia	7	0,79	88
Pappea capensis	7	0,71	88
Rhus refracta	7	0,50	88
Euclea undulata	6	1,00	100
Ptaeroxylon obliquum	5	0,80	83
Schotia afra	4	1,25	100
Olea europaea subsp. *africana*	4	0,50	100
Combretum caffrum	2	1,25	100
Acacia caffra	2	0,50	100
Psydrax obovata	2	0,50	100
Shrubs			
Ehretia rigida	9	0,50	90
Putterlickia pyracantha	8	1,94	100
Plumbago auriculata	8	1,00	89
Abutilon sonneratium	7	0,50	100
Portulacaria afra	5	1,30	100
Croton rivularis	4	0,50	80
Xeromphis rudis	4	0,50	80
Jatropha hastata	3	0,67	100
Grewia robusta	2	1,50	100
Rhigozum obovatum	2	1,25	100
Euphorbia ledienii	2	0,75	100
Tecomaria capensis	2	0,50	100
Phyllanthus verrucosus	2	0,50	100
Euphorbia mauritanica	2	0,50	100
Vines			
Sarcostemma viminale	7	0,50	100
Jasminum spp.	6	0,75	100
Kedrostis nana	6	0,50	100
Herbs & graminoids			
Sansevieria hyacinthoides	10	0,90	91
Commelina spp.	10	0,50	91
Panicum maximum	9	0,83	100
Protasparagus aethiopicus	9	0,50	100
Panicum deustum	8	0,50	89
Protasparagus multiflorus	7	0,50	88
Protasparagus crassicladus	5	0,50	100
Protasparagus striatus	4	0,50	100
Peristrophe cernua	3	1,50	100
Protasparagus virgatus	3	0,67	100
Protasparagus subulatus	3	0,50	100
Succulents			
*Opuntia ficus-indica**	7	0,50	100
Crassula perforata	4	0,50	100
Cotyledon velutina	4	0,50	100
Crassula expansa	3	0,50	100

* Invasive exotic

TABLE 8.—Dominant species of Thicket communities grouped by growth form

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Trees			
Hippobromus pauciflorus	2	2,00	50
Schotia afra	4	1,25	100
Combretum caffrum	2	1,25	100
Euclea undulata	6	1,00	100
Schotia latifolia	3	1,00	50
Ochna arborea	3	0,83	33
Ptaeroxylon obliquum	5	0,80	83
Maytenus nemorosa	5	0,80	50
Shrubs			
Putterlickia pyracantha	8	1,94	100
Grewia robusta	2	1,50	100
Portulacaria afra	5	1,30	100
Rhigozum obovatum	2	1,25	100
Azima tetracantha	6	1,17	67
Plumbago auriculata	8	1,00	89
Vines			
Rhoicissus digitata	11	1,05	73
Rhoicissus tridentata	3	1,00	50
Capparis sepiaria	12	0,96	75
Herbs & graminoids			
Hypoestis forskaolii	9	1,61	75
Peristrophe cernua	3	1,50	100
Cyperus albostriatus	4	1,25	50
Protasparagus setaceus	6	1,00	60
Sansevieria hyacinthoides	10	0,90	91
Panicum maximum	9	0,83	100

(Table 3). It is most common on wet southern slopes, but also occurs on sandy soils in protected low-lying areas. Mountain Fynbos as defined here is largely synonymous to the Mountain Fynbos of Taylor (1978), and Kruger (1979) and the Mesotrophic Proteoid Fynbos of Campbell (1985), but it also includes some communities that may represent later seral stages of the next unit (Grassy Fynbos). The Mountain Fynbos represented in our sampling has a relatively low total grass cover and a high proportion of C_3 grasses (*Festuca*, *Pentaschistis* and *Merxmuellera* species) and Restionaceae. Mature stands of *Protea lorifolia* and *P. repens* are very localized and occur mostly in inaccessible areas. Campbell (1985) did not include mature fynbos of the Zuurberg in his sample, presumably because it was thought to be absent (Campbell *op. cit.*, page 7).

Widdringtonia nodiflora did not occur in any of our fynbos plots, but it is highly characteristic of our concept of Mountain Fynbos and should be added to the lengthy list of diagnostic species in Table 9. A large number of species are locally dominant. The list of dominant species (Table 10) has therefore been limited to those with a mean cover value of 1,00 or more and, except for species with very high cover values, a presence of more than 50% (present in at least eight of the 15 Mountain Fynbos plots).

4. *Grassy Fynbos*

Grassy Fynbos covers the largest proportion of the surface area of the Park (Table 3) and occurs on all plateau tops and also on gentle southern and northern slopes in higher-lying areas. Diagnostic and dominant species of Grassy Fynbos are listed in Tables 11 and 12.

Campbell (1985) distinguished between three subseries of Grassy Fynbos, namely Dry, Mesic and Mesotrophic. He classified the dominant vegetation of the Zuurberg as Sundays Mesic Grassy Fynbos but also mentioned the lack of good differential characters. The presence of proteoids over 1 m tall, the less than 40% cover of Ericaceae, the 10–50% cover of restioids and the 30–90% cover of grasses are used as differentiating features by Campbell. Two types of his Mesotrophic sub-

TABLE 9.—Diagnostic species of Mountain Fynbos communities grouped by growth form. Single occurrences are excluded

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Shrubs			
Clutia alaternoides	8	1,13	100
Montinia caryophyllacea	8	1,13	100
Anthospermum spathulatum	8	1,00	80
Erica cerinthoides	7	0,86	88
Othonna quinquedentata	6	1,17	100
Cliffortia ilicifolia	5	1,40	100
Erica chamissonis	5	2,00	100
Penaea cneorum	5	1,20	100
Protea cynaroides	5	0,80	100
Struthiola argentea	5	0,80	100
Ursinia anethoides	5	0,80	100
Erica copiosa	5	1,00	83
Metalasia gnaphalodes	4	0,75	100
Cliffortia paucistaminea	3	1,00	100
Coleonema pulchellum	3	1,00	100
Hermannia sp. cf. *H. odorata*	3	1,00	100
Myrica kraussiana	3	1,00	100
Passerina obtusifolia	3	1,00	100
Thesium strictum	3	1,00	100
Agathosma ovata	2	1,00	100
Cliffortia burchellii	2	2,50	100
Euclea polyandra	2	0,50	100
Euryops latifolius	2	2,00	100
Myrsine africana	2	1,00	100
Polygala fruticosa	2	1,00	100
Protea lorifolia	2	1,00	100
Senecio lineatus	2	1,00	100
Grasses			
Festuca costata	6	1,83	100
Merxmuellera disticha	6	1,00	100
Ehrharta ramosa	4	1,00	100
Merxmuellera stricta	3	1,67	100
Pentaschistis eriostoma	3	1,67	100
Miscanthus erectus	2	2,00	100
Restioids			
Rhodocoma capensis	11	1,36	100
Cannomois virgata	6	2,00	100
Restio sejunctus	4	1,00	100
Hypodiscus synchrolepis	3	1,00	100
Herbs & suffrutices			
Senecio oxyriifolius	14	0,86	100
Knowltonia cordata	11	1,00	100
Pelargonium reniforme	9	1,00	100
Streptocarpus meyeri	7	1,00	100
Scabiosa columbaria	7	0,86	88
Rhyticarpus difformis	6	0,50	100
Stachys scabrida	6	1,00	100
Pelargonium zeyheri	5	0,80	100
Schizaea pectinata	5	0,80	100
Aristea schizolaena	5	0,80	83
Cephalaria humilis	4	0,75	100
Psoralea asarina	4	1,00	100
Rhynchosia cooperi	4	1,00	100
Argyrolobium tuberosum	4	0,50	80
Chironia melampyrifolia	3	0,33	100
Helichrysum cymosum	3	1,00	100
Pteridium aquilinum	3	1,33	100
Senecio crenatus	3	1,00	100
Pimpinella caffra	3	0,33	100
Succulents			
Crassula obovata	7	1,00	88
Crassula nemorosa	2	0,50	100
Geophytes			
Eriospermum spp.	9	0,89	90
Empodium sp.	3	0,67	100
Agapanthus praecox	2	0,50	100
Cyrtanthus sp.	2	1,00	100

TABLE 10.—Dominant species of Mountain Fynbos communities grouped by growth form. Criteria for entry are specified in the text

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Shrubs			
Erica deliciosa	2	3,00	50
Cliffortia burchellii	2	2,50	100
Erica simulans	10	2,10	56
Erica chamissonis	5	2,00	100
Euryops latifolius	2	2,00	100
Pteronia teretifolia	2	2,00	40
Thesium strictum	3	1,67	100
Cliffortia ilicifolia	5	1,40	100
Myrica kraussiana	3	1,33	100
Penaea cneorum	5	1,20	100
Othonna quinquedentata	6	1,17	100
Clutia alaternoides	8	1,13	100
Montinia caryophyllacea	8	1,13	100
Phylica axillaris	11	1,09	46
Indigofera stenophylla	13	1,08	46
Leucadendron salignum	11	1,00	42
Anthospermum spathulatum	8	1,00	80
Gnidia coriacea	8	1,00	35
Protea foliosa	8	1,00	62
Grasses			
Festuca costata	6	1,83	100
Merxmuellera stricta	3	1,67	100
Pentaschistis eriostoma	3	1,67	100
Pentaschistis angustifolia	6	1,17	75
Tristachya leucothrix	6	1,17	22
Themeda triandra	7	1,14	19
Restioids			
Cannomois virgata	6	2,00	100
Restio triticeus	11	1,55	55
Rhodocoma capensis	11	1,36	100
Sedges			
Tetraria cuspidata	8	1,00	42
Herbs & shrublets			
Helichrysum odoratissimum	2	2,00	40
Pteridium aquilinum	3	1,33	100
Helichrysum felinum	13	1,08	68
Helichrysum nudifolium	13	1,00	52
Mohria caffrorum	13	1,00	72
Knowltonia cordata	11	1,00	100
Aster bakerianus	10	1,00	50
Alepidea capensis	9	1,00	75
Berkeya sphaerocephala	9	1,00	75
Pelargonium reniforme	9	1,00	100
Geophytes			
Oxalis spp.	15	1,00	79
Hypoxis hemerocallidea	9	1,00	53

series also occur in the Zuurberg, namely Mannetjiesberg Mesotrophic Grassy Fynbos and Grahamstown Mesotrophic Grassy Fynbos. In the study area, these two types have a much more limited distribution than Sundays Mesic Grassy Fynbos.

Our concept of Grassy Fynbos is much wider than that of Campbell. We also include Suurberg Grassland and much of Hankey Grassland, both of which approach Acocks's (1953) Dohne Sourveld (Campbell *op. cit.*). Hankey Grassveld shows two extremes. A sourveld with *Tristachya leucothrix*, *Merxmuellera stricta* and numerous fynbos elements and a sweetveld with grasses such

TABLE 11.—Diagnostic species of Grassy Fynbos grouped by growth form. Single occurrences are excluded

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Shrubs			
Erica adunca	6	1,67	100
Erica demissa	4	1,50	80
Erica pectinifolia	3	2,33	100
Gnidia anthylloides	3	0,67	100
Oedera imbricata	2	0,50	100
Metalasia muricata	2	1,00	100
Podalyria burchellii	2	–	100
Grasses			
Sporobolus mauritianus	3	0,67	100
Sedges			
Tetraria sp. nov.	3	0,67	100
Tetraria secans	2	0,50	100
Herbs & suffrutices			
Linum thunbergii	4	1,00	100
Polygala hispida	3	1,00	100
Corymbium africanum	2	1,00	100

TABLE 12.—Dominant species of Grassy Fynbos grouped by growth form

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Shrubs			
Erica pectinifolia	3	2,33	100
Phylica axillaris	12	1,83	50
Leucadendron salignum	15	1,67	58
Erica adunca	6	1,67	100
Erica demissa	4	1,50	80
Agathosma capensis	3	1,33	50
Pteronia teretifolia	3	1,33	60
Leucospermum cuneiforme	4	1,25	36
Aspalathus chortophila	6	1,17	33
Anthospermum paniculatum	8	1,13	38
Erica simulans	8	1,13	44
Gnidia coriacea	12	1,00	52
Grasses			
Themeda triandra	15	2,47	41
Diheteropogon filifolius	3	2,00	43
Tristachya leucothrix	11	1,82	41
Eragrostis curvula	3	1,67	50
Trachypogon spicatus	8	1,38	42
Sporobolus centrifugus	3	1,33	43
Alloteropsis semialata	12	1,25	43
Eragrostis capensis	8	1,00	36
Restioids			
Restio triticeus	9	2,00	45
Sedges			
Tetraria cuspidata	9	1,11	47
Ficinia spp.	11	1,00	46
Herbs & suffrutices			
Bobartia orientalis	9	1,78	45
Vernonia capensis	2	1,50	25
Thesium sp. cf. *T. corymbuligerum*	3	1,33	75
Hermannia flammula	6	1,17	38
Helichrysum albanense	13	1,15	68
Tephrosia capensis	14	1,00	54
Aster bakerianus	8	1,00	40

as *Themeda triandra* and *Heteropogon contortus* without fynbos elements (Campbell *op. cit.*). The sourveld is here included under Grassy Fynbos and the sweetveld under Grassland. In the study area, there is a much greater discontinuity in the distribution of fynbos elements than in those characters used by Campbell to distinguish between Grassy Fynbos and Grassland. For practical reasons, we have therefore used the presence of fynbos elements to differentiate between Grassy Fynbos and Grassland.

5. Grassland

R.A. Lubke (unpublished data) recognized, in the northern part of the Sundays River area (Figure 1), two major grassland communities, namely *Festuca costata* Tussock Grassland and *Themeda triandra–Tristachya leucothrix* Grassland. The latter was provisionally subdivided by him into *Bobartia orientalis* Grassland and *Trachypogon spicatus* Grassland, further subdivided into a, *Heteropogon contortus* Grassland and b, *Setaria sphacelata* Grassland.

We have taken a much narrower view and the Grasslands of the study area are here considered to include only those areas where Restionaceae, Ericaceae and Proteaceae are totally absent. Campbell's (1985) criteria for recognizing Grassland are difficult to use because of the gradual decrease of fynbos elements along the transition from Grassy Fynbos to Grassland. Our concept therefore includes only part of Campbell's Hankey Grassland and seems to be identical to Lubke's *Setaria sphacelata* Grassland. As such it is perhaps the most uniform vegetation unit of all and occurs mostly on steep northern and western slopes. What variation there is, appears to be the result of soil depth and rockiness. Some species (*Acacia karroo, Diospyros lycioides* and *Aloe ferox* for example) are restricted to deep soils on lower northern slopes, while succulents such as *Euphorbia polygona* are locally dominant only in very rocky areas.

Diagnostic and dominant species are listed in Tables 13 and 14. Very few of the dominant species have high fidelity values, so that most of the diagnostic species are forbs or succulents and not grasses. *Elionurus muticus* and *Brachiaria serrata* are very common but only *Setaria sphacelata* var. *torta* and *Aristida diffusa* subsp. *burkei* appear to be characteristic of Grassland as defined here. The dominant grasses are also present in Grassy Fynbos, where their cover values are scarcely lower.

DISCUSSION

The forests of the Zuurberg have floristic elements in common with both the Amatola and Alexandria Forests and are similar in species composition to forests in the Watersmeeting Nature Reserve (Bathurst), the Fort Grey Nature Reserve (East London) and the Groendal Wilderness Area north of Uitenhage (Geldenhuys 1985). They differ from the Knysna and Tsitsikamma Forests in species composition, notably the absence of *Ocotea bullata* and *Trichocladus crinitus* and the presence of species of Pondoland-Tongaland affinity. Trees such as *Smellophyllum capense, Atalaya capensis, Homalium dentatum, H. rufescens* and *Chionanthus peglerae* are rare or have limited

TABLE 13.—Diagnostic species of Grassland grouped by growth form. Single occurrences are excluded

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Trees			
Diospyros lycioides	4	1,50	80
Acacia karroo	3	1,00	100
Shrubs			
Sutera albiflora	7	1,00	88
Diospyros scabrida	2	0,50	80
Leonotis oxymifolia	2	1,00	100
Grasses			
Setaria sphacelata var. *torta*	8	1,00	80
Aristida diffusa subsp. *burkei*	4	1,00	100
Herbs & suffrutices			
Ruellia sp. cf. *R. pilosa*	7	1,00	80
Cyanotis speciosa	6	0,50	100
Thesium junceum	5	1,00	100
Eriosema saligna	4	0,75	100
Heliophila rigidiuscula	4	0,50	80
Thesium sp. cf. *flexuosum*	3	0,67	100
Euphorbia striata	2	1,00	100
Indigofera hedyantha	2	1,00	100
Monsonia emarginata	2	1,00	100
Pachycarpus dealbatus	2	1,00	100
Senecio puberulus	2	1,00	100
Succulents			
Crassula nudicaulis	5	0,40	83
Crassula mesembryanthemoides	4	0,75	100
Crassula perfoliata	3	0,33	100
Aloe ferox	2	–	100
Bulbine frutescens	2	1,00	100
Haworthia reinwardtii	2	0,50	100
Ruschia orientalis	2	–	100

TABLE 14.—Dominant species of Grassland grouped by growth form

	Presence (no. of plots)	Dominance (mean BB cover value)	Fidelity (%)
Trees			
Diospyros lycioides	4	1,50	80
Shrubs			
Aspalathus chortophila	12	1,75	67
Anthospermum paniculatum	10	1,20	48
Grasses			
Themeda triandra	15	2,20	41
Tristachya leucothrix	10	2,00	37
Eragrostis curvula	3	2,00	50
Alloteropsis semialata	7	1,43	25
Elionurus muticus	12	1,42	75
Heteropogon contortus	12	1,25	67
Cymbopogon validus	5	1,20	50
Trachypogon spicatus	11	1,09	58
Brachiaria serrata	14	1,00	70
Eragrostis capensis	14	1,00	64
Setaria sphacelata var. *torta*	8	1,00	80
Sedges			
Tetraria cuspidata	2	1,50	11
Ficinia spp.	9	1,00	38
Herbs & suffrutices			
Crabbea nana	10	1,10	56
Hermannia flammula	10	1,10	63
Tephrosia capensis	10	1,00	38
Chaetacanthus sp. nov.	9	1,00	56

distributions in the eastern Cape. The Zuurberg Forests are relatively isolated and therefore represent an important biogeographical link in the distribution of Afromontane Forest in the eastern Cape and also between the eastern and southern Cape (Geldenhuys 1985).

Thicket communities of the Zuurberg are very variable, probably as a result of topographic, rainfall and edaphic gradients. In terms of structure and species composition, most of the thicket agrees with Everard's (1987) Xeric Kaffrarian Thicket. Only a very small part of the Kaffrarian Succulent Thicket of the study area is similar to Addo Bush (Acocks 1953) or Spekboomveld (Archibald 1955), the dominant vegetation of the Addo Elephant National Park. Everard (1987) classified the latter as one of two suborders of Kaffrarian Succulent Thicket, namely Xeric Succulent Thicket. His other suborder, Mesic Succulent Thicket, seems floristically similar to some of the thickets of the Zuurberg.

The Mountain Fynbos of the study area was not included in the classification of Campbell (1985) but it has the differentiating features of his Mesotrophic Proteoid Fynbos. *Protea lorifolia* and *P. repens* are the dominant canopy species and Grassy Fynbos is present as understorey. In view of the limited and localized distribution and the high species richness, this vegetation unit should receive special attention when management policies are formulated. The effects of fire on succession (under local conditions) need to be studied in detail. The absence of seed-regenerating *Protea* species (*P. lorifolia* and *P. repens*) from the plateau areas may be partly due to frequent fires in the past (see the successional model of Cowling 1984), but shallower and more fertile soils could also be limiting factors. Mature stands of *Protea lorifolia* are almost exclusively found on sandy soils.

Judged by diagnostic species, our concept of Grassy Fynbos appears to be similar to that of Cowling (1984), who argued that it is not a recently derived vegetation type as Acocks (1953) proposed. The presence of regional endemics (*Erica demissa, E. pectinifolia, Podalyria burchellii* and *Protea foliosa* for example) and the resprouting ability of virtually all the species found in Grassy Fynbos indicate that it should be recognized as a distinct vegetation type. Campbell (1985) proposed that the Grassy Fynbos (Eastern Fynbos) of the Zuurberg and Grahamstown areas should be included in the Fynbos Biome and perhaps also in the Cape Floristic Region.

The abundance of grasses was discussed by Cowling (1984). He suggested that high temperatures during the growing season (the high proportion of summer rain) increase the competitive advantage of C_4 grasses, although the more fertile and finer-textured soils (Campbell 1983) also need to be considered. Too frequent fires may lead to an increase in grassiness by removing the shading effect of the overstorey. It is possible that longer intervals between fires will result in an increase of Mountain Fynbos in certain areas.

CONCLUSIONS

In the Zuurberg National Park several totally different and unrelated vegetation types occur in close proximity. The dynamics of the boundaries between the types and between communities need to be studied in more detail to explain the intricate mosaic of vegetation. Community boundaries may be determined at least partly by an equally intricate mosaic of soil types. Campbell (1983) has reported distinct edaphic gradients in the mountains of the Fynbos Biome. Another major ecological factor seems to be the natural fire cycle, in which the warmer, drier northern slopes tend to burn at more frequent intervals than the wet southern slopes. Fire is considered to be the major disturbance factor in fynbos biome communities (Cowling *et al.* 1987).

If the present-day patchy distribution of plant communities has been shaped by edaphic factors and a natural fire regime, little seems to be gained by interfering with the natural cycle. It is indeed impractical to divide such complex communities into conventional 'burning blocks' and burn them according to a rigid schedule. Instead, management should try to allow lightning fires to run their natural course, and exclude man-made fires from outside the Park. Further research is required to assess this policy, focusing on post-fire succession and the effects of fire on the characteristic and dominant species in each vegetation unit. It is also important to gain information on the extent to which edaphic factors are responsible for community boundaries.

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