9.4. COMPARISON OF VEGETATION STATES WITHIN AND BETWEEN PLANT ASSOCIATIONS

One of the main aims of the envisaged updated Namibian Vegetation Map (Strohbach 2001), to which this study contributes, is to serve as a tool for monitoring and managing of rangelands. This requires some indication of the conditional states of the veld, rather than just a characterization of the plant associations found within the study area.

Various methods have been developed to assess veld condition and/or grazing capacity in southern Africa. Data collected are either in the form of Braun-Blanquet surveys, point-surveys or line-transects (Eckhardt *et al.* 1993, Du Toit 1998, Smit 2000). One of the most widely used methods is the Ecological Index Method, described by Vorster (1982). This method was originally developed for the Karoo vegetation and has also been successfully applied to the grassland biome of South Africa (Eckhardt *et al.* 1993). It relies on the classification of grasses into grazing-response groups, being described as either decreaser or increaser species (definitions according to Van Oudtshoorn 1999 below Table 21), which is then used to calculate a veld-condition-index value for each relevé. A different approach is the Grazing Index Method, which is based on a species rating, developed following specific agronomic variables (Du Toit 1995, Du Toit 1998, Du Toit 2002). Despite of the relative ease and efficiency of these techniques, their application in Namibia, especially in the Savanna, has been limited. The primary reason is that not enough data is available to classify all species (especially grasses) found into either an ecological response-group (Van Oudtshoorn 1999) or assign them a grazing-index value. In addition, ecological characteristics of species may vary given the complexity of the savanna-ecosystem, a fact which has been emphasized by Stuart-Hill and Tainton (1999). Expected discrepancies in values of species can be found in the literature - e.g. Van Oudtshoorn (1999) lists the low-growing *Enneapogon desvauxii* as a good indicator of overgrazing when occurring in high numbers. However, Müller (1985) relates the occurrence of this species to more arid habitats, e.g. climax on lime-enriched plains. Observations during the study rather support Müller (1985) than Van Oudtshoorn (1999).

Namibian rangelands are most commonly evaluated (and managed) looking at key grass species (Bester *et al.* 1984) or "indicator criteria", the latter being density of plant cover, botanical composition, plant vigour, condition of soil surface as well as damage by insects

or rodents (Bester 1988). Although this is a very subjective and crude method, it does allow the detection of trends if repeated regularly. Given the above pro's and cons of various techniques, it was decided to define different "vegetation states" which could be identified from the data collected during the survey. Criteria for these vegetation states were developed to be suitable either for the rapid appraisal of a rangeland management unit (farm camp or farm) or as a baseline for vegetation monitoring by physical inspections, studies in vegetation dymanics over time or "change detection" techniques with satellite imagery - a technique currently receiving increased attention (Vogel 2002, personal communication).

"Mismanagement" of Namibian rangelands has a long history: bush encroachment was already perceived as a problem in the 1920's (Schlettwein 1994). The Grootfontein, Otjiwarongo and Okahandja districts, in which the study area is located, were then and are still considered the regions most seriously affected by increasing bush densities. Logging operations active around Tsumeb (providing construction materials for mine-shafts in Tsumeb) were already considered in the 1900's to affect grazing by removing the majority of tall trees found on the plains (Schlettwein 1994). This was followed by high stocking rates and drought periods, which further severely stressed the savanna ecosystem (Volk 1966, Schlettwein 1994). Giess (1971) and the Homogenous Farming Areas Report (1979) re-emphasize the bush-encroachment issue as being serious in Central Namibia.

In the 1970's farmers in the Otjiwarongo and Okahandja districts observed extensive dieback of *Acacia mellifera*. By the mid 1980's, this had reached "epidemic proportions", affecting the entire area previously affected by bush-encroachment. The disease is caused by a fungus, which kills the heartwood of the shrubs (Holz and Schreuder 1989). Not much is clear on how this effected the total bush encroachment issue then, but today signs of such massive dieback *of Acacia mellifera* are not evident - rather bush encroachment.

Several attempts and studies have been undertaken to understand the dynamics of bush-encroachment in savannas (Walter 1954, Knoop and Walker 1985, Skarpe 1992, O'Connor 1995 and Roques *et al.* 2001). The conclusion reached by Ward (in prep) is that these dynamics are still poorly understood, and are in general a response to a combination of causal factors, each of which have direct and indirect effects on the system. For example - heavy grazing reduces the fuel load which reduces the heat and/or frequency of fires

(O'Connor 1995) or too light grazing causes grasses adapted to short-term heavy grazing to become moribund, thus loosing their competitive ability (Illius and O'Connor 1999). This all re-emphasizes the need for an opportunistic management approach in savanna ecosystems (Westoby *et al.* 1989). Illius and O'Connor (1999) sum this up very adequately in their statement: "rather than ignoring degradation, policy-makers and ecologists should seek to identify the characteristics of grazing systems that predispose some systems towards degradation, while others appear to be resistant … focus on the spatial heterogeneity in susceptibility to grazing impacts and on preserving the productive capacity of key resource areas."

In accordance with above statement, baseline criteria for defining vegetation states were based on the composition of the grass-layer of all samples within a plant association, being considered the vegetation layer most vulnerable to effects of management practices. Relying on information available on grazing response groups, grazing value as well as grasses grazed preferentially (Müller 1985, Bester 1988, Van Oudtshoorn 1999, Du Toit 2001, Du Toit 2002), grass species were classified into annual, valuable perennial- and low value perennial grasses (see Table 21). Bester (1988) found that within the thornbush savanna, annual grasses, despite some species being highly palatable, constitute a very small part of the diet of livestock, and these were accordingly regarded as less important species. A dominance of annual grasses, especially weedy species, represents generally degraded grazing (and veld) conditions (Müller 1985, O'Connor 1995, Cornelius and Schultka 1997). Valuable perennial grasses are regarded as grasses with a high leaf production, high palatability, and are often regarded as decreaser species (Van Oudtshoorn 1999). Low value perennial grasses would generally be classified as increaser species (Van Oudtshoorn 1999), being either unpalatable due to terpentines or other compounds or due to their low leaf-production or overall hardiness (Bester 1988). A large amount of such grasses generally indicates a degeneration of veld condition (Müller 1985, O'Connor 1995, Van Oudtshoorn 1999). Pending verification of grass response groups under local environmental conditions, such degeneration could be ascribed to over- or under-utilization of veld. It should be emphasised here that the vegetation states and overall condition of vegetation types should not be seen as a definite prognosis on overall rangeland condition (especially as no data on veld management practices has been collected), but this exercise does indicate possible trends in veld condition and susceptibility to degardation, which should be recognised by rangland managers and adapted to where necessary.

Table 21: Values assigned to each grass species for the definition of vegetation states. Also added are important ecological criteria derived from Müller (1985) and Van Oudtshoorn (1999), which can aid to describe vegetation states.

SPECIES NAME	GRASS VALUE (USED IN VEGETATION - STATE DEFINITION)	GRASS VALUE (MÜLLER 1985)	PERIODICITY	ECOLOGICAL INDEX (VAN OUDTSHOORN 1999)
Anthephora schinzii	unimportant	palatable pioneer	annual grass	
Aristida adscensionis	unimportant	indicates degradation	annual grass	increaser 2
Aristida effusa	unimportant	indicates degradation	annual grass	
Aristida hordeacea	unimportant	indicates degradation	annual grass	
Aristida rhiniochloa.	unimportant	indicates degradation	annual grass	increaser 2
Brachiaria deflexa	unimportant	palatable pioneer	annual grass	increaser 2
Brachiaria eruciformis	unimportant	palatable pioneer	annual grass	increaser 2
Brachiaria malacodes	unimportant	palatable pioneer	annual grass	
Brachiaria xantholeuca	unimportant	palatable pioneer	annual grass	
Chloris virgata	unimportant	pioneer	annual grass	increaser 2
Dactyloctenium aegyptium	unimportant	palatable pioneer	annual grass	increaser 2
Dactyloctenium giganteum	unimportant	palatable	annual grass	increaser 2
Digitaria velutina	unimportant		annual grass	increaser 2
Eleusine indica. ssp. *indica*	unimportant		annual grass	
Eragrostis annulata	unimportant		annual grass	
Eragrostis biflora	unimportant		annual grass	increaser 2
Eragrostis cylindriflora	unimportant	pioneer	annual grass	
Eragrostis dinteri	unimportant		annual grass	
Eragrostis omahekensis	unimportant	pioneer	annual grass	
Eragrostis pilgeriana	unimportant		annual grass	
Eragrostis porosa	unimportant	indicates degradation	annual grass	
Eragrostis viscosa	unimportant		annual grass	increaser 2
Heteropogon melanocarpus	unimportant	hard	annual grass	
Melinis kallimorpha	unimportant		annual grass	
Melinis repens ssp. *grandiflora*	unimportant	pioneer	annual grass	increaser 2
Pogonarthria fleckii	unimportant	indicates degradation	annual grass	
Schmidtia kalihariensis	unimportant	indicates degradation	annual grass	increaser 2
Setaria pumila	unimportant		annual grass	increaser 2
Setaria verticillata	unimportant	palatable pioneer	annual grass	increaser 2
Sporobolus panicoides	unimportant		annual grass	
Tragus berteronianus	unimportant		annual grass	increaser 2
Tragus racemosus	unimportant		annual grass	increaser 2
Urochloa brachyura	unimportant		annual grass	
Urochloa trichopus	unimportant		annual grass	
Brachiaria schoenfelderi	unimportant	palatable pioneer	biennial grass	
Enneapogon cenchroides	unimportant	palatable pioneer	biennial grass	increaser 2
Enneapogon desvauxii	unimportant	climax on lime	biennial grass	increaser 2
Sorghum versicolor	unimportant		biennial grass	increaser 2
Tricholaena monachne	unimportant	subclimax	biennial grass	increaser 2

SPECIES NAME	GRASS VALUE (USED IN VEGETATION - STATE DEFINITION)	GRASS VALUE (MÜLLER 1985)	PERIODICITY	ECOLOGICAL INDEX (VAN OUDTSHOORN 1999)
Andropogon chinensis	good grazing	climax	perennial grass	increaser 1
Andropogon gayanus var. *polycladus*	low value	hard climax	perennial grass	increaser 1
Anthephora pubescens	good grazing	climax	perennial grass	decreaser
Aristida congesta ssp. *congesta*	low value	recovering veld	perennial grass	increaser 2
Aristida meridionalis	low value	subclimax	perennial grass	increaser 3
Aristida pilgeri	low value	indicates degradation	perennial grass	
Aristida stipitata ssp. *stipitata*	low value		perennial grass	increaser 2
Bothriochloa radicans	low value	indicates degradation	perennial grass	increaser 2
Brachiaria nigropedata	good grazing	climax	perennial grass	decreaser
Cenchrus ciliaris	good grazing	climax	perennial grass	decreaser
Coelachyrum yemenicum	low value		perennial grass	
Craspedorhachis rhodesiana	low value		perennial grass	
Cymbopogon plurinodis	low value	aromatic climax	perennial grass	increaser 1 or 3
Cynodon dactylon	good grazing	pioneer to climax	perennial grass	increaser 2
Dichanthium annulatum var. *papillosum*	good grazing		perennial grass	decreaser
Digitaria eriantha	good grazing	subclimax	perennial grass	decreaser
Digitaria seriata	good grazing	climax	perennial grass	
Diplachne fusca	good grazing		perennial grass	decreaser
Enneapogon scoparius	good grazing	climax	perennial grass	increaser 3
Eragrostis echinochloidea	good grazing	pioneer to subclimax	perennial grass	increaser 2
Eragrostis jeffreysii	low value	hard	perennial grass	
Eragrostis lehmanniana var. *lehmanniana*	good grazing	subclimax to climax	perennial grass	increaser 2
Eragrostis nindensis	good grazing	climax	perennial grass	increaser 2
Eragrostis rigidior	low value	hard subclimax	perennial grass	increaser 2
Eragrostis rotifer	good grazing	green for long	perennial grass	
Eragrostis superba	good grazing	climax	perennial grass	increaser 2
Eragrostis trichophora	good grazing	pioneer to subclimax	perennial grass	increaser 2
Fingerhuthia africana	good grazing	climax	perennial grass	decreaser
Heteropogon contortus	good grazing	subclimax	perennial grass	increaser 2
Melinis repens ssp. *repens*	good grazing	subclimax	perennial grass	increaser 2
Microchloa caffra	low value	pioneer	perennial grass	increaser 2
Monelytrum luederitzianum	good grazing	pioneer	perennial grass	
Oropetium capense	low value		perennial grass	increaser 2
Panicum coloratum var. *coloratum*	good grazing	climax	perennial grass	decreaser
Panicum maximum	good grazing	climax	perennial grass	decreaser
Panicum stapfianum	good grazing	climax	perennial grass	
Pogonarthria squarrosa	low value	pioneer	perennial grass	increaser 2
Schmidtia pappophoroides	good grazing	subclimax	perennial grass	increaser 2/ decreaser
Sporobolus festivus	low value		perennial grass	increaser 2
Sporobolus fimbriatus	good grazing	climax	perennial grass	decreaser
Stipagrostis hirtigluma	good grazing		perennial grass	increaser 2
Stipagrostis uniplumis var. *uniplumis*	good grazing	subclimax	perennial grass	increaser 2

SPECIES NAME	GRASS VALUE (USED IN VEGETATION - STATE DEFINITION)	GRASS VALUE (MÜLLER 1985)	PERIODICITY	ECOLOGICAL INDEX (VAN OUDTSHOORN 1999)
Triraphis ramosissima	low value	hard subclimax	perennial grass	
Triraphis schinzii	low value	palatable but rare	perennial grass	
Urochloa oligotricha	good grazing	climax	perennial grass	decreaser
Willkommia sarmentosa	good grazing		perennial grass	

Definitions (according to Van Oudtshoorn 1999):

Decreaser: abundant in good veld, decreases in numbers when the veld is overgrazed.

Increaser 1: abundant in under-utilized veld, usually unpalatable and hard

Increaser 2: abundant in overgrazed veld, mostly pioneer ans subclimax grasses with a high seed-production

Increaser 3: commonly found in overgrazed veld, usually unpalatable dense climax grasses and strong competitors

Relevés of the plant associations were divided into 5 vegetation states according to following criteria:

State 1 - very poor:

- total grass cover < 15%

State 2 - poor:

- total grass cover 15 - 20%, with annual grasses often dominating

State 3 - degraded veld:

- total grass cover > 20%, with the combined cover of annual and low value perennial grasses exceeding that of valuable perennial grasses by 5%

State 4 - moderate veld:

- total grass cover > 20%, with % cover of the annual and low value perennial grasses combined not much more (maximally 5% difference) than valuable perennial grasses, or the latter most abundant, but not exceeding 30% cover

State 5 - good veld:

- total grass cover > 30%, with valuable perennial grasses significantly more than annual and low value perennial grasses combined.

Within states 1-3, there is often a strong weedy plant component present - either in the form of weedy or poisonous herbs or, in a more irreversible state, in the form of bush encroachment. As the survey was originally aimed at characterizing the vegetation in terms of its associations and not specifically at determining veld condition, it was decided that a potential State 6 - excellent - should not be defined at this stage, but may form part of future studies defining benchmark sites for different vegetation types. Further, definite conclusions about veld condition in the study area cannot be based on data available. However, considering the amount of relevés of each association, which were not sampled prior to an understanding of veld condition, which are representative of a vegetation condition, trends in or tendencies to especially degradation can be identified.

As a general overview, ranges and averages of percentage cover within the associations, as well as species diversity have been listed in Table 22 and Table 23 respectively.

Table 22: Comparison of statistics on total cover percentages of associations.

Association	Number of samples	Minimum % cover	Maximum % cover	Average % cover	Standard Deviation
1	4	14	63	39.3	22.3
2	11	17	80	41.2	19.1
3	18	18	95	71.2	21.8
4	24	13	97	77.2	23.0
5	58	22	98	65.5	24.0
6	8	64	97	81.3	13.8
7	88	24	95	70.3	18.7
8	56	15	97	74.9	21.2
9	32	33	96	76.8	22.5
10	10	50	89	70.8	13.4
11	28	45	97	73.6	16.5
12	30	33	97	77.6	17.4
13	35	26	97	66.6	18.3
14	23	46	97	89.1	12.2

Table 23: Comparison of statistics on total species recorded in associations.

Association	Number of samples	Minimum Nr of species	Maximum Nr of species	Average Nr of species	Standard Deviation
1	4	18	23	20	2.5
2	11	11	56	33	15.8
3	18	13	54	31	12.7
4	24	19	64	43	10.6
5	58	13	60	42	12.1
6	8	40	61	51	6.1
7	88	37	68	56	6.8
8	56	21	61	46	9.1
9	32	29	77	50	12.2
10	10	28	47	38	6.1
11	28	26	60	47	8.4
12	30	34	72	49	8.9
13	35	37	77	54	8.3
14	23	30	60	40	8.3

The vegetation composition of typical vegetation states within each association are given below:

9.4.1. Association 1: *Catophractes alexandri - Willkommia sarmentosa* tall sparse shrubland

This vegetation type in general has a low percentage cover (Figure 32), which can be attributed to the relatively xeric moisture regime encountered in these lime-enriched pans. A high productivity can thus not be expected from this system. A critical evaluation of vegetation states here is thus not feasible. The grasses contributing most to the overall vegetation cover are *Willkommia sarmentosa* - itself not a very vigorous grower here, as well as *Eragrostis cylindriflora*. The latter may form dense stands at the peak of the growing season, but disintegrates quickly when dry (thus commonly called "windhalmgras"). Overall, farmers regard this system as little utilised and only of value during the peak growing season.

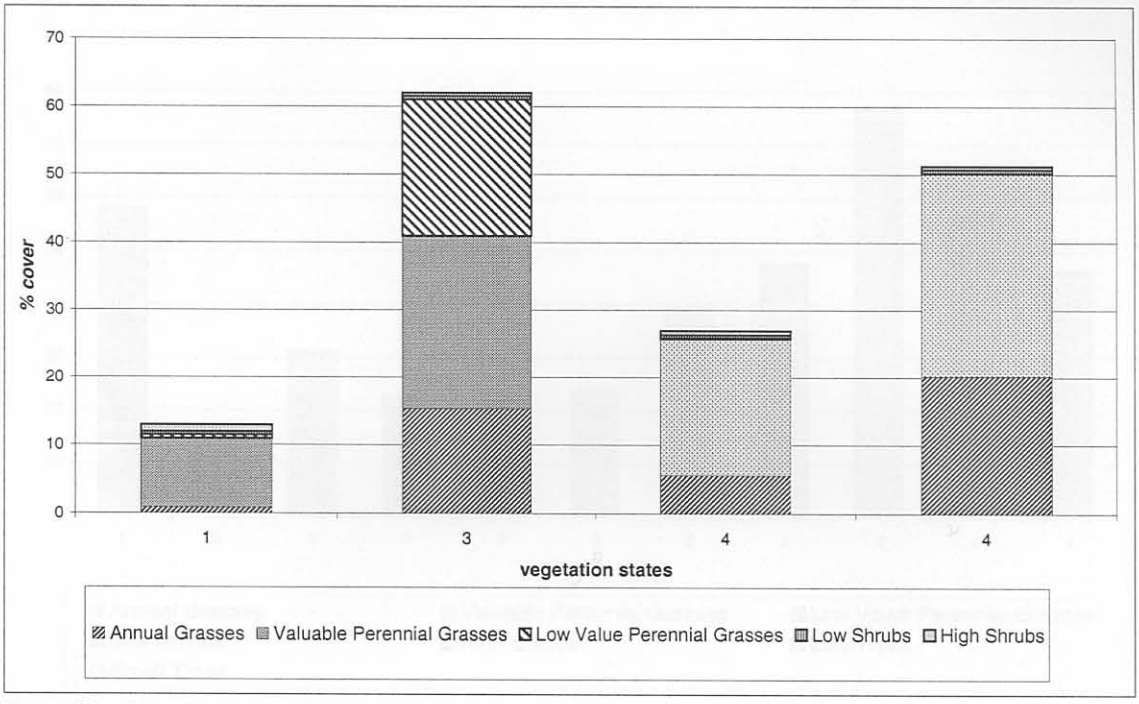

Figure 32: Samples representing the different vegetation states found in association 1.

9.4.2. Association 2: *Boscia albitrunca - Eragrostis cylindriflora* low open woodland

This vegetation type, found in the upper small omurambas (sometimes pans, sometimes part of a water-flow system, depending on amount of rains), appears to be another veld type with relatively low grass production (Figure 33). This may be attributed to the heavier soil types, combined with sheet erosion and occasional waterlogging during the rainy season. Farmers state that these areas are not easily accessible to man or beast during the peak rainy season due to the thick, sticky mud forming at this time, which makes movement difficult. Thus utilisation of grasses present at this time may also be restricted. More than 60% of all relevés of this association are, on the basis of their grass cover, considered to be in poor condition. The bulk of the grass cover is made up of *Chloris virgata* and *Eragrostis cylindriflora*, both regarded as pioneer grasses on disturbed areas or bare patches (Müller 1985). This main agent causing this disturbance is most probably sheet erosion, which may be coupled with trampling of the soil as cattle rest under the trees during dry or hot months, but this needs to be verified.

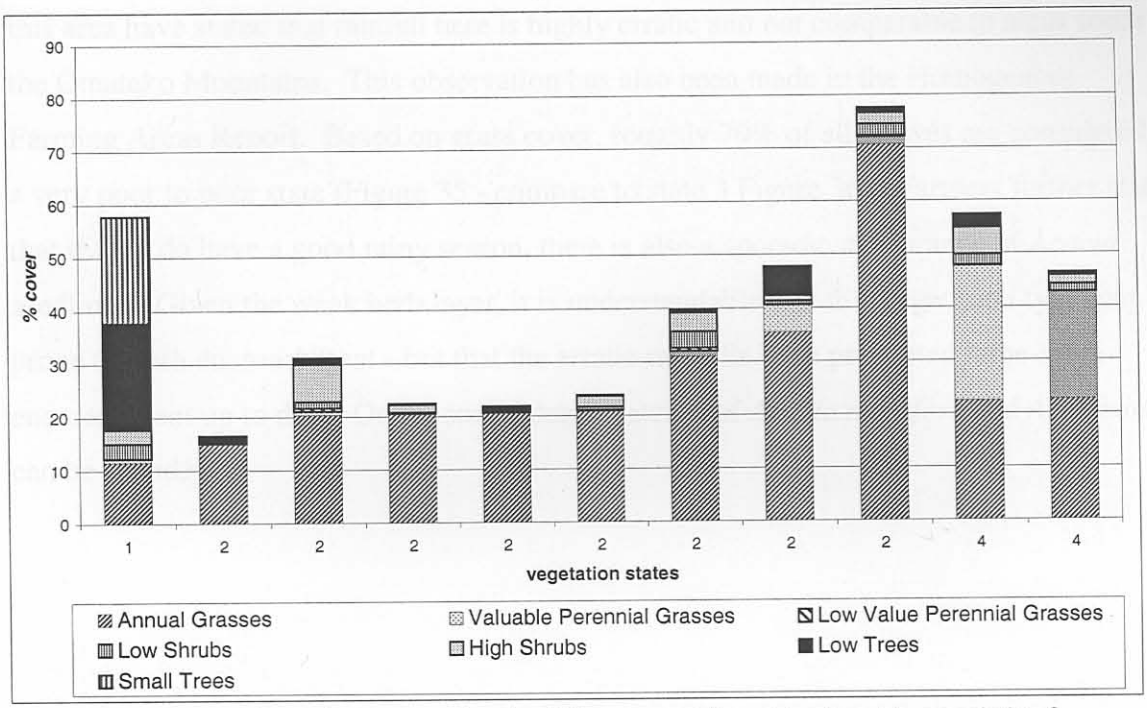

Figure 33: Selection of samples representing the different vegetation states found in association 2.

9.4.3. Association 3: *Acacia mellifera* - *Leucosphaera bainesii* low closed shrubland with patches of low open woodland

This vegetation is found mainly on the plains of the upper catchment of the Omuramba-Omatako - an area characterised by lime-enriched, crust-forming soils with frequent signs of large-scale sheet erosion. A conspicuous element of these plains is the presence of *Leucosphaera bainesii* - a shrub characteristic of a drier soil-moisture regime, which contributes to most of the low shrub layer.

Still, when considering that species such as *Aristida adscensionis, A. hordeacea, Eragrostis porosa* and *Botriochloa radicans* often contribute to a large portion of the grass layer, it can be assumed that this vegetation type overall is degraded (states in Figure 34). This is most likely due to habitat factors being less favourable to grass establishment, combined with ill-adjusted management practices. Even one of the most common and abundant valuable perennial grasses, *Eragrostis trichophora*, is considered a subclimax grass or increaser 2 (Table 21). Another common feature of this vegetation is a prominent weedy component, especially *Cyperus fulgens* and *Nidorella resedifolia*. Most farmers in

this area have stated that rainfall here is highly erratic and not comparable to areas south of the Omatako Mountains. This observation has also been made in the Homogenous Farming Areas Report. Based on grass cover, roughly 70% of all relevés are considered in a very poor to poor state (Figure 35 - compare to state 3 Figure 36). Farmers further state that if they do have a good rainy season, there is also a sporadic appearance of *Acacia* seedlings. Given the weak herb layer, it is understandable that this vegetation type may be prone to bush encroachment - but that the erratic rainfalls have prevented large-scale encroachment up to date. Occasionally dense patches of *Acacia mellifera* and *A. reficiens* can be found.

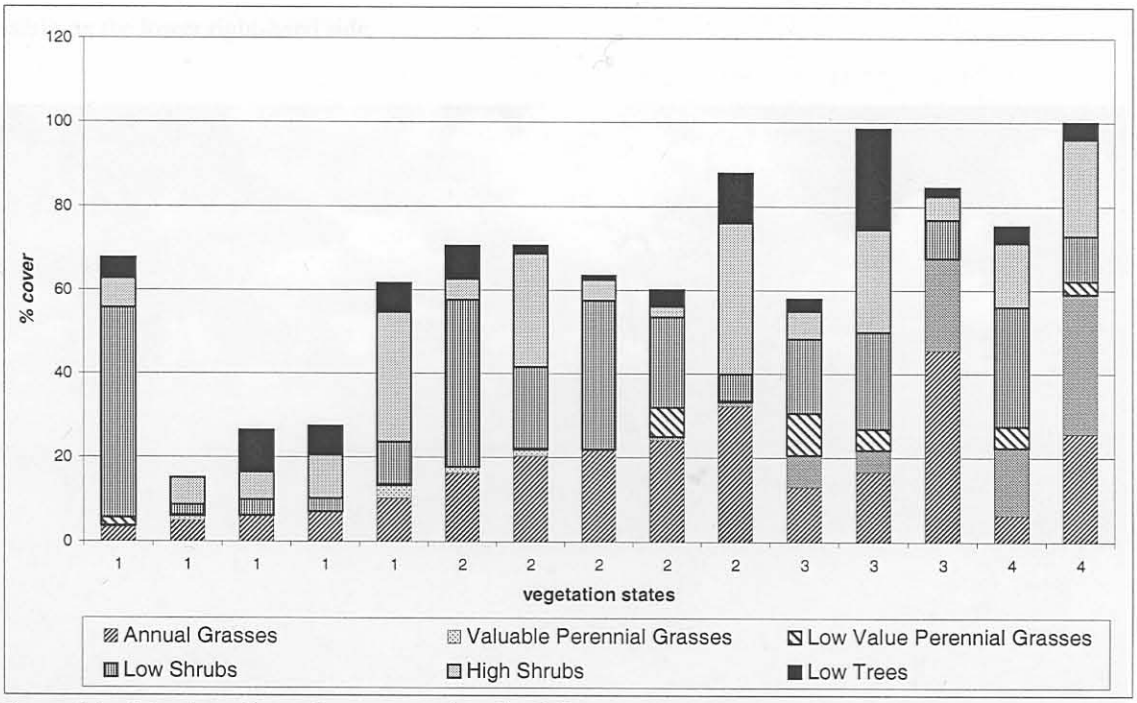

Figure 34: Selection of samples representing the different vegetation states found in association 3.

Figure 35: Example of vegetation of association 3 in state 1 (very poor). Take note of surface crusting visible on the lower right-hand side.

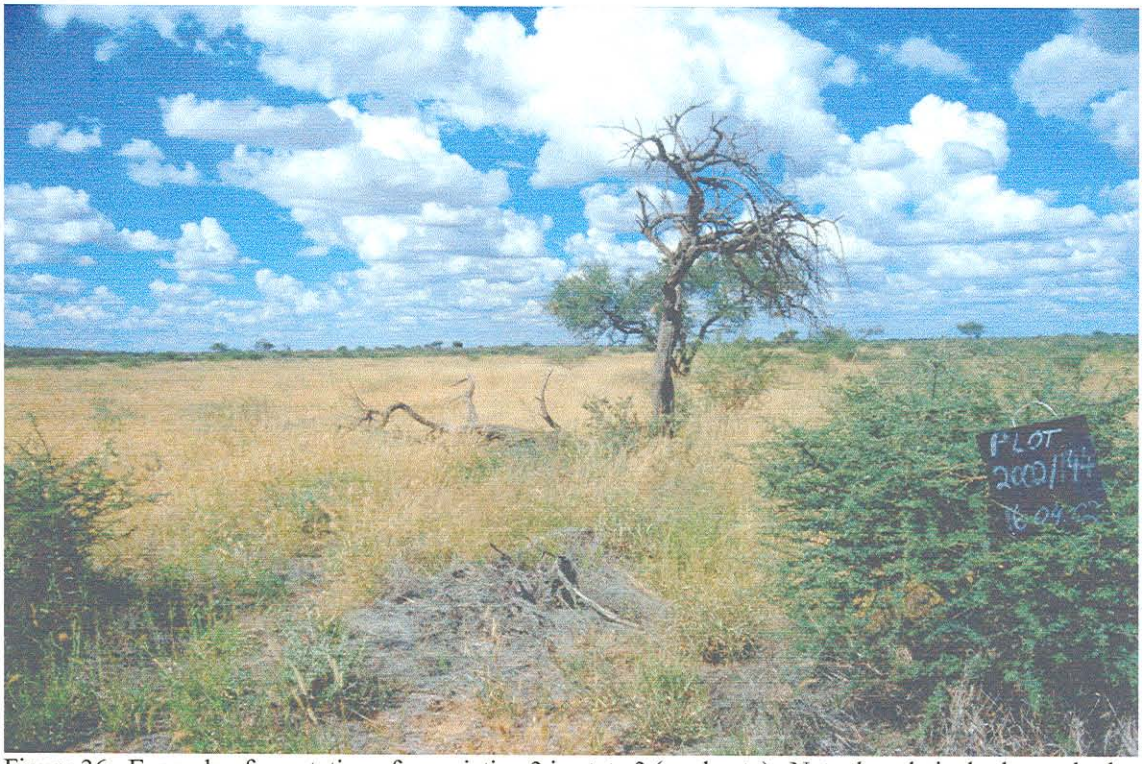

Figure 36: Example of vegetation of association 3 in state 3 (moderate). Note the relatively dense shrub cover (*Acacia mellifera*) surrounding this pan-like area.

9.4.4. Association 4: *Acacia mellifera* - *Eragrostis rotifer* low moderately closed bushland

This vegetation is found mainly on the banks of small to larger seasonal rivers (Figure 38), around farm dams as well as small pans which form in depressions in the veld (Figure 39) without necessarily being linked to a specific water drainage system. It can thus be expected that the vegetation states (Figure 37) of this vegetation will be highly variable and will also change as riverbank dynamics are influenced by rainfall events. Further, this vegetation is subject to high impact animal movement - animals coming to water or resting in the shade of the relatively large trees - which is reflected in a strong weedy component in the herb-layer, e.g. *Setaria verticillata, Achyranthes aspera* as well as varying degrees of alien species.

This vegetation cannot really be regarded as a manageable unit due to its small size as well as dynamics described above. It would be advisable though to guard against and prevent large-scale infestations by alien weeds, as seeds are further distributed by waterflow and may slowly pose an increasing problem.

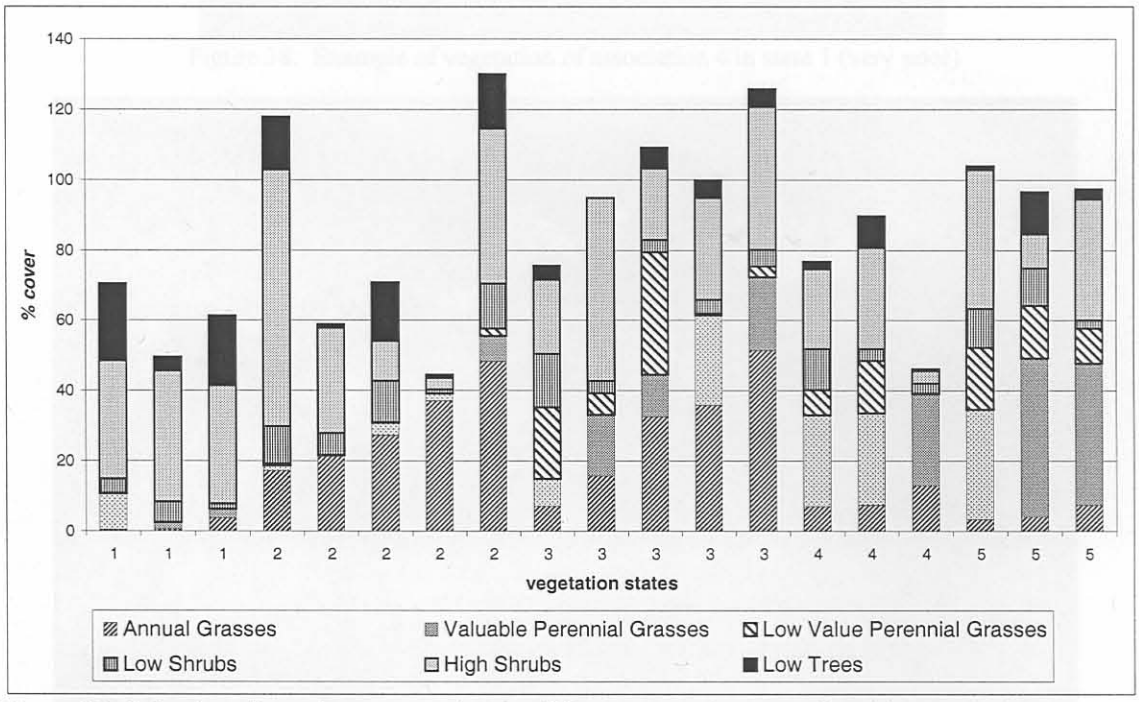

Figure 37: Selection of samples representing the different vegetation states found in association 4.

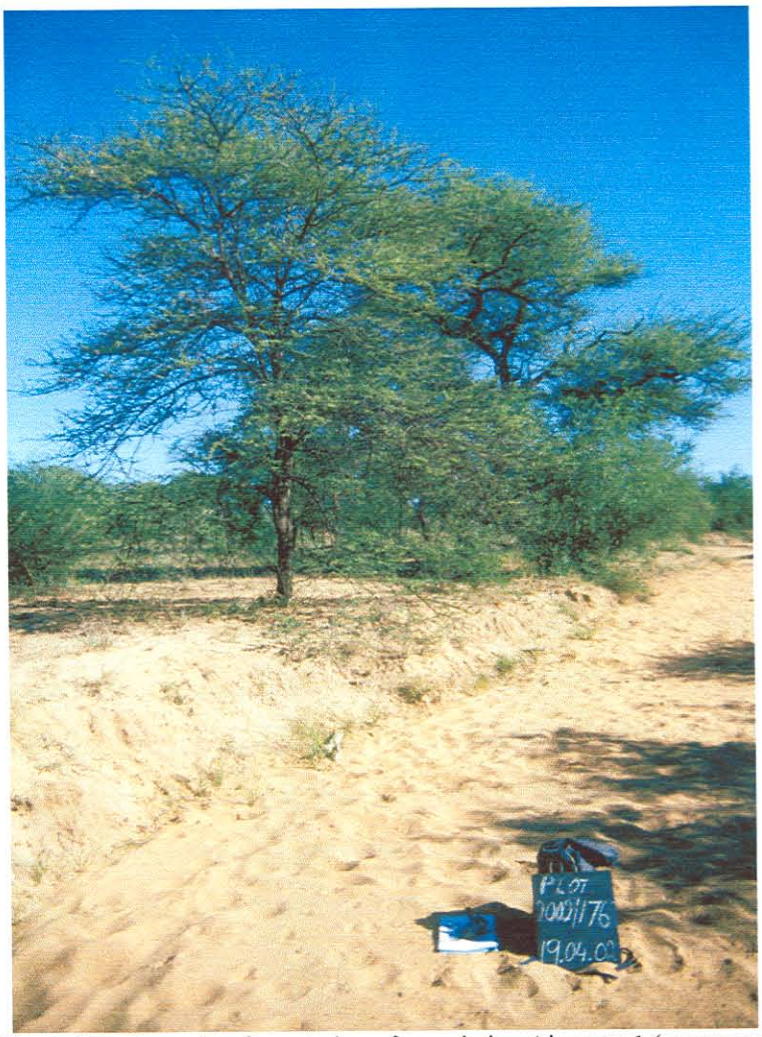

Figure 38: Example of vegetation of association 4 in state 1 (very poor)

Figure 39: Example of vegetation of association 4 in state 5 (good).

9.4.5. Association 5: *Acacia mellifera - Monechma genistifolium* low semi-open bushland

This vegetation is fairly wide-spread especially south of the Omatako Mountains. 60 % of relevés of this vegetation are regarded to be in a very poor to poor state (Figure 41), another 26 % as degraded while only 14 % of relevés show a moderate to good grass cover. When looking at the habitat, it could be assumed that soils have a less favourable moisture regime than those found in association 6, which has a generally better condition while also occurring in more or less the same range. However, soil records thus far are not detailed enough to draw any definite conclusion. It may, however, be assumed that this vegetation is in general over-utilised.

Such assumption is based on the species composition of grasses found in this vegetation (vegetation states are shown in Figure 40). By far the most common grass species, sometimes reaching densities of 30 - 60% cover is *Aristida adscensionis*. If one considers that this grass is a relatively small plant, one tuft hardly measuring more than 10-15 cm diameter, the above cover percentages are rather significant. The more palatable *Enneapogon cenchroides*, also a pioneer, only reaches densities of 5-15%, but is also generally found in all relevés.

Relevés considered in a good state show a fair cover of mostly *Stipagrostis uniplumis*, but also *Cenchrus ciliaris*, indicating that overall the grass layer could be improved.

The above degradation of grass layer is may also explain the relatively consistent levels of bush encroachment found here (by *Acacia mellifera*). Notable is that, compared to other vegetation types - this bush encroachment appears to be more recent - the highest densities are recorded for shrubs up to 1 m height. In general, bush densities of 15 to 30% are recorded throughout this vegetation type.

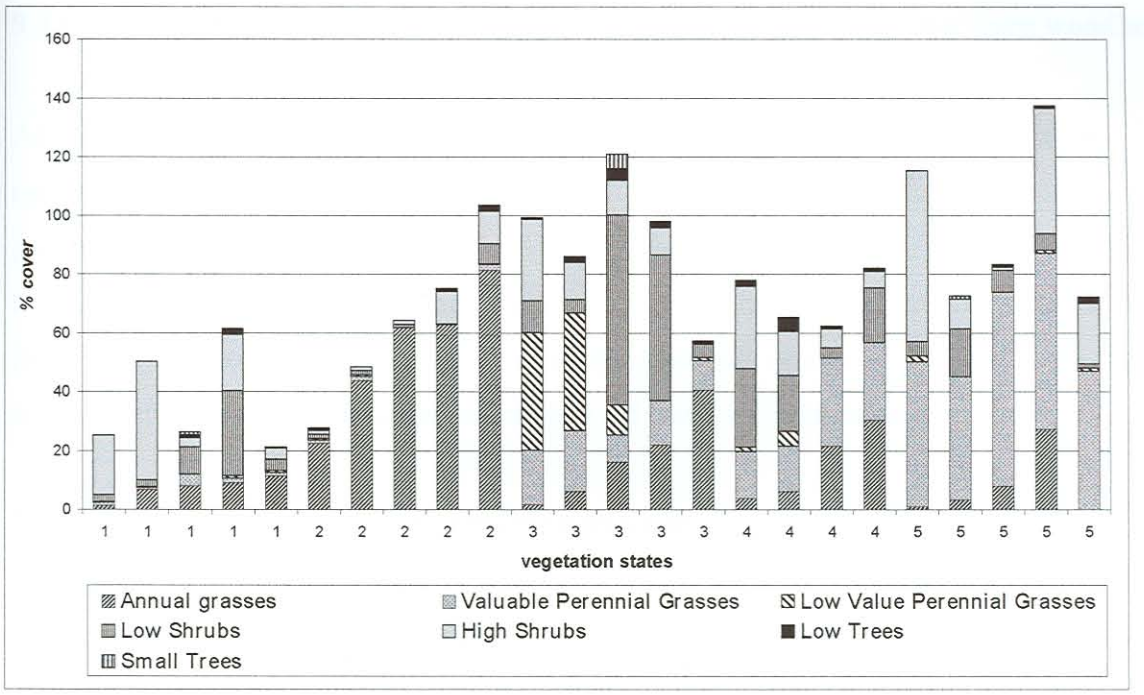

Figure 40: Selection of samples representing the different vegetation states found in association 5.

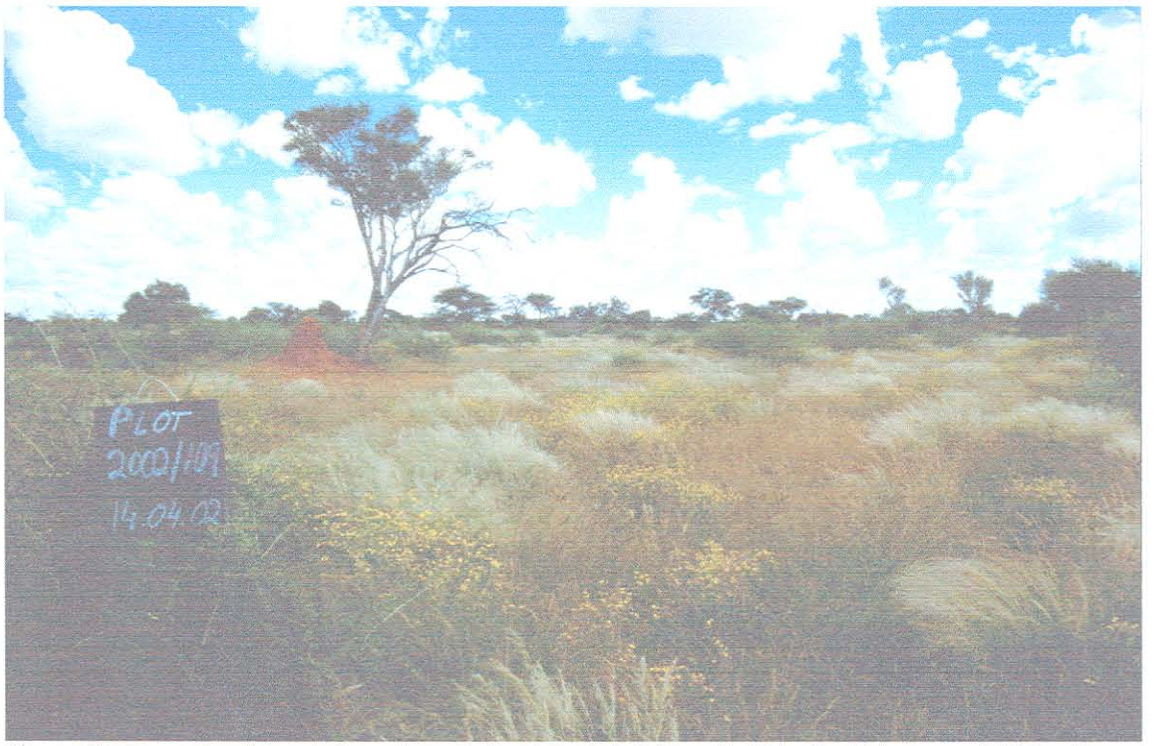

Figure 41: Example of vegetation of association 5 in state 2 (poor). Note the high cover of *Nidorella resedifolia* with its conspicuous yellow flowers and *Aristida adscensionis* (lower grass without plumes).

9.4.6. Association 6: *Albizia anthelmintica - Stipagrostis uniplumis* low open woodland

As already indicated above, association 6 is also found mainly south of the Omatako mountains, but only in relatively small patches. 63 % of relevés of this vegetation are in a good state (Figure 43). Only 7 % of relevés are classified as very poor to poor, with 12 % regarded as degraded and 19 % regarded as moderate. The main difference in habitat so far visible is a more common presence of coarse materials (gravel, stones and some degree of rock-banks) in the soil surface, which may aid water infiltration rates.

The most common and abundant grass throughout this vegetation type is *Stipagrostis uniplumis* - densities of 50 % cover are common. On the other hand, the most common annual grasses found throughout this vegetation type are *Aristida adscensionis, Eragrostis porosa* and *Pogonarthria fleckii* - all indicators of degradation of grazing. The only other commonly present valuable grass is *Eragrostis trichophora*, which is regarded as a subclimax grass. These trends (Figure 42) clearly show that this vegetation type is also being utilised more than it should be - although not that visible at this stage, future management practices should be aware that this vegetation type may also progressively degrade under high utilisation levels.

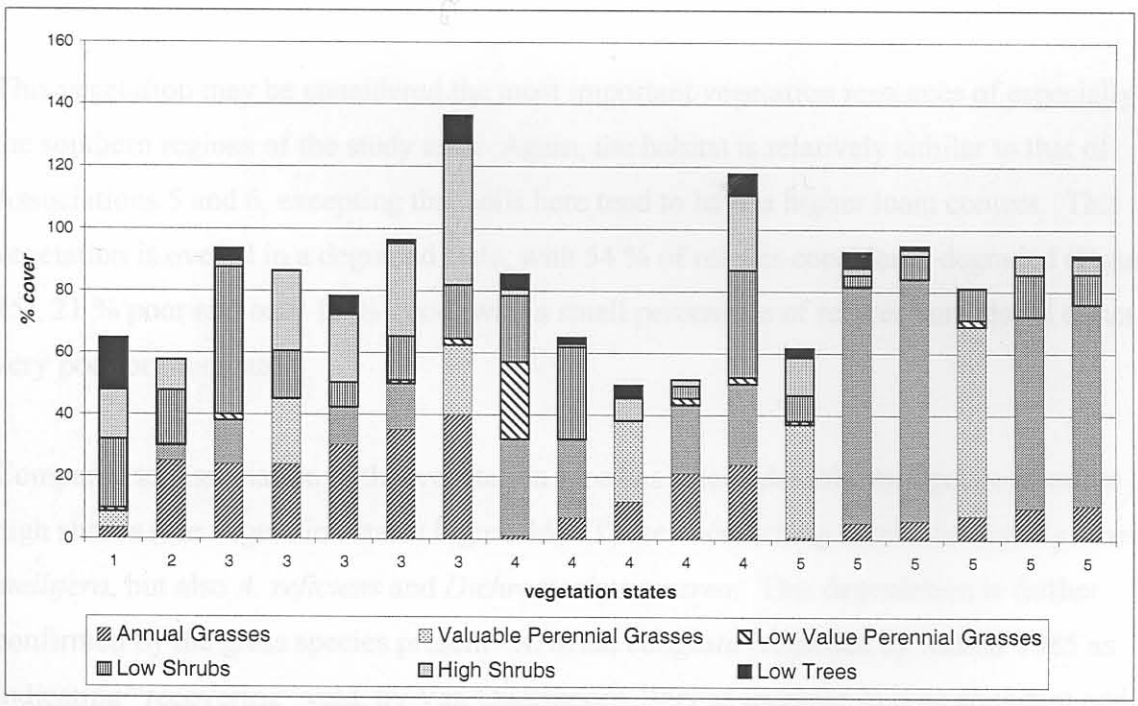

Figure 42: Selection of samples representing the different vegetation states found in association 6.

Figure 43: Example of vegetation of association 6 in state 5 (good).

9.4.7. Association 7: *Acacia mellifera - Aristida congesta* low semi-open bushland

This vegetation may be considered the most important vegetation resources of especially the southern regions of the study area. Again, the habitat is relatively similar to that of Associations 5 and 6, excepting that soils here tend to have a higher loam content. This vegetation is overall in a degraded state, with 54 % of relevés considered degraded (Figure 45), 21 % poor and only 18 % good, with a small percentage of relevés considered either very poor or moderate.

Compared to Association 5, this vegetation type has a considerably stronger component of high shrubs (see vegetation states Figure 44). These encroaching shrubs are mainly *Acacia mellifera*, but also *A. reficiens* and *Dichrostachys cinerea*. This degradation is further confirmed by the grass species present - *Aristida congesta* (regarded by Müller 1985 as indicating "recovering" veld, by Van Oudtshoorn 1999 as inceaser 2) is as abundant and common as *Stipagrostis uniplumis*. There is also an increasing presence of hard, little

utilised species such as *Eragrostis rigidior* and *E. jeffreysii*. *Eragrostis rotifer* as well as *E. trichophora* make up the remainder of the more valuable perennial grasses.

Looking at the more degraded relevés, the most common grasses are *Eragrostis cylindriflora, E. porosa, Aristida adscensionis* and *Pogonarthria fleckii*. Overall it would appear that this vegetation type is largely over-utilised.

One aspect very noticable on some farms was a high presence of poisonous plants - especially *Geigeria ornativa* and *Ondetia linearis*. Farmers as especially concerned about the latter, where cover percentages of up to 5 % have been recorded in one sample. Farmers in general have stated that once this plant is established in their veld, its density often doubles from one year to the next if the grass layer is not dense enough. *Ondetia* is one of the first species to have green foliage after the dry season, and one farmer reported great losses of both game and cattle due to this plant during a year where rains only started very late.

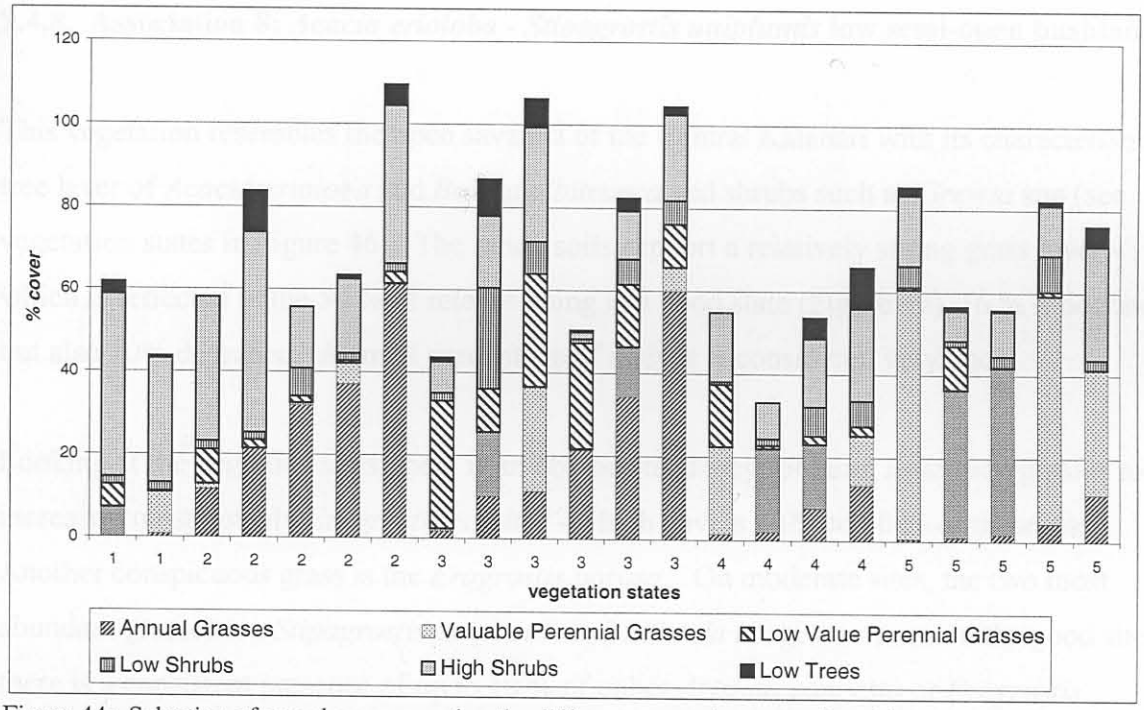

Figure 44: Selection of samples representing the different vegetation states found in association 7.

Figure 45: Example of vegetation of association 7 in state 3 (degraded). Note the large amount of dead garss material - all from hard grasses not utilised by cattle, as well as the increasing density of *Acacia mellifera*.

9.4.8. Association 8: *Acacia erioloba - Stipagrostis uniplumis* low semi-open bushland

This vegetation resembles the open savanna of the Central Kalahari with its characteristic tree layer of *Acacia erioloba* and *Boscia albitrunca* and shrubs such as *Grewia* spp (see vegetation states in Figure 46). The sandy soils support a relatively strong grass layer - which is reflected in the 50 % of relevés being in a good state (Figure 47), 16 % moderate, but also 30% degraded. A small percentage of relevés is considered very poor.

Looking at the degraded sites, there is an obvious tendency for hard, little used grasses to increase - most notably *Eragrostis rigidior* - which covers 20 % to 60 % of these sites. Another conspicuous grass is the *Eragrostis porosa*. On moderate sites, the two most abundant grasses are *Stipagrostis uniplumis* and *Aristida congesta* - even on the good sites there is a consistent presence of up to 10 % of either *Aristida congesta* or *Eragrostis rigidior* - leading to the assumption that this vegetation is over-utilised and may easily degrade further. Further, although this vegetation type has a naturally higher component of shrubs (especially *Grewia* spp) - degraded sites tend to become encroached with *Acacia mellifera*. In both degraded and moderate sites stands of 15 % - 30% have been recorded.

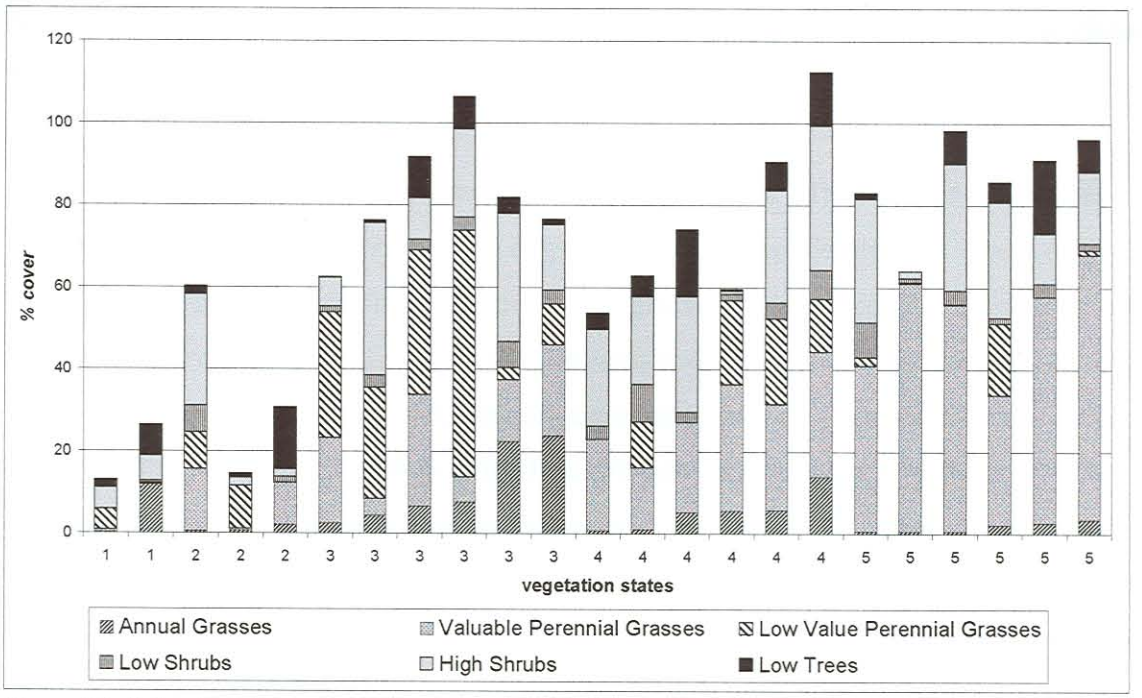

Figure 46: Selection of samples representing the different vegetation states found in association 8.

Figure 47: Example of vegetation of association 8 in state 5 (good).