CHAPTER 7

FORAGE UTILIZATION AROUND WATER POINTS

7.1 Introduction

Uneven use of rangeland by livestock has been and, continues to be, a major problem confronting range resource managers. An ideal distribution of grazing animals means that grazing pressure is spread over as large a rangeland area as possible. Distribution problems are most severe in arid or desert areas and in mountainous terrains. Factors causing uneven use of rangelands include distance from water, mountainous topography, diverse vegetation and the wrong type of animal. Poor water distribution has been reported to be the chief cause of poor livestock distribution on most rangelands (Holecheck *et al*. 1998). In semiarid environments, water is in short supply and is often poorly distributed. Where available water points are infrequent, large sacrifice areas around such points often occur.

The utilization of the Kalahari sandveld of Botswana on a permanent basis has been facilitated by the deep borehole technology that overcame restrictions of a lack of surface water. Most of these rangelands, especially the communal grazing areas, are today grazed continuously. Even those areas that are properly stocked may be overgrazed near the water points, while remote areas are often grazed lightly, or not at all, due to the fact that with increasing distance from the water point there is an exponential increase in the size of grazing area.

The percentage utilization of different species in most situations is considered an index of preference, or palatability, of a plant species and hence comparative utilization between species often expresses the preference that an animal shows for one species over another. In this context, the term utilization refers to the amount of total herbage production that has been removed currently. Selective grazing, due to differences in relative palatability of species, is confronting all who are concerned with the correct utilization of the rangeland. Theron & Booysen (1966) indicated two forms of selective grazing: species selective grazing

and area selective grazing. The causes for differences in palatability between both grasses and vegetation types are not as yet clearly understood in spite of the fact that numerous attempts have been made to relate palatability differences to a number of factors (Heady 1964; Theron & Booysen 1966; O'Reagain & Mentis 1989). When forage plants on a given rangeland are evaluated on the basis of economic importance to grazing animals both the quantity present and the percent utilization need to be considered. The influence of grazing on plants is dependent on several important variables. These include the intensity, degree, frequency and season of grazing. All of these are important in determining the standards of use for range plants.

Many methods have been proposed for measuring the percentage utilization of range plants. The accuracy and interpretation of the measurements obtained have, however, varied widely (Holechek *et al.* 1998). As a result, the concept of utilization and method of calculation are not well understood and remain a controversial subject.

Generally speaking, range utilization, as a whole will be determined by the impact of livestock grazing on the decreaser and increaser plant species. If the ecology of the area is reasonably understood the approach to utilization may be further simplified by selecting one or two key species upon which to base proper utilization. This study was designed to evaluate the impact of livestock grazing on the individual plant species, as affected by the distance from the water point.

7.2 Material and methods

The degree of herbaceous plant utilization was assessed at the same location where plant phytomass was recorded (chapter 5). A single pin was placed into the ground. The area around the pin was divided into four quarters by drawing two imaginary lines through the pin. Within each quarter of the sampling unit the nearest plant to the pin was assessed and recorded by species. The assessment procedure followed that used by Daines (1976), which arbitrarily classified plant utilization into four classes.

These classes were:

Class 4. Ungrazed plant. No sign of plant having been grazed by the animal.

Class 3. Less than 50% of the plant removed.

Class 2. More than 50% of the plant removed.

Class 1. Totally utilized. All material removed, only stubble remaining.

Each point consisted of four plants. A total of fifty points (200 plants) were recorded at each distance in a straight line at every two meter interval.

7.2.1 Statistical Analysis

Descriptive statistics were used to summarize the data according to relevant parameters. The main effects of season, grazing system and distance from water on forage utilization was determined by General Linear Model (SAS 1990). Where differences were significant at the 5 percent level, Scheffe's test was used to separate the means.

7.3 RESULTS

7.3.1 Seasonal forage utilization in controlled grazing conditions

The mean utilization of individual plant species between the seasons is illustrated in Table 7.1. There were significant differences between the seasons in the utilization of each species. Significantly ($P<0.05$) higher utilization of individual plant species was observed during spring and was lowest in summer of both years. Utilization of each plant species was higher during the 1997/98 dry season than in 1996/97 dry season. This might have been accounted for by the low available phytomass experienced during 1997/98, due to the poor rainfall (chapter 2).

The utilization of D. aegyptiun, E. africana, T. terrestris and A. thumbergii increased significantly ($P<0.05$) from summer through autumn and winter into spring to the extent that available forage could not be found during spring. P. maximum followed a similar trend. Among the other perennial grasses, D. eriantha, E. lehmanniana and S. pappophoroides were more heavily utilized than S. uniplumis, E. rigidior and miscellaneous grasses. However, the

utilization of D. eriantha was markedly lower during summer compared to other seasons. While the forb component was generally poorly utilized in all seasons, U. trichopus and M. albescens were notably better utilized than grasses such as S. uniplumis and E. rigidior.

Table 7.1. Seasonal utilization (%) of forage species in the sward over two years in controlled grazing condition at Mahki ranch

	Season of year							
Plant Species	Summer 1996/97	Autumn 1996/97	Winter 1996/97	Spring 1996/97	Summer 1997/98	Autumn 1997/98	Winter 1997/98	Spring 1997/98
D. eri	2.0^{d}	18.0^{c}	31.0^{b}	60.75^{a}	3.5^{d}	19.75^{c}	32.75^{b}	62.5^{a}
E. leh	7.75^{d}	15.25^{c}	26.5^{b}	50.25^{a}	5.75^{d}	15.0^{c}	26.25^{b}	50.0^{a}
E. rig	6.75^{c}	6.0^{c}	17.0^{b}	34.25^{a}	6.0^{c}	16.0^{b}	27.0^{b}	44.25^{a}
S. pap	4.0^{d}	9.25^{c}	26.5^{b}	49.75^{a}	7.5^{d}	17.25^{c}	34.5^{b}	57.75^{a}
S. uni	1.5^{c}	3.5^{c}	15.0^{b}	40.75^{a}	3.75^{c}	4.5^{c}	19.0^{b}	44.75^{a}
P. max	30.5^{d}	53.0^{c}	$69.5b^{c}$	87.5^{b}	38.5^{c}	70.75^{b}	87.25^{b}	100.0^{a}
Misc grass	1.0^{c}	8.5^{b}	10.5^{b}	43.5^{a}	$.75^{c}$	3.0^{c}	5.0b	38.0^{a}
M.alb/U.tri	1.5^{e}	4.75^{d}	22.75^{c}	52.75^{b}	6.75^{d}	19.75^{c}	37.75^{bc}	67.75^{a}
C.bie/I.dal	0.25^{c}	1.0^{c}	4.25^{b}	47.25^{a}	$.5^{c}$	2.75^{b}	6.0^{b}	49.0^{a}
D.aeg/E.afr	26.5^{d}	52.25^{c}	75.0^{b}	100.0^{a}	47.0^{c}	73.0^{b}	95.75^{a}	100.0^{a}
A.thu/T.ter	16.5^{d}	56.25^{c}	74.25^{b}	100.0^{a}	39.0^{c}	54.75^{c}	77.25^{b}	100.0^{a}
Misc forbs	$.25^{c}$	2.75^{c}	11.25^{b}	26.5^{a}	1.25^{c}	5.5^{c}	17.0^{b}	32.5^{a}
Mean	8.20	19.79	25.83	57.77	13.35	25.42	38.79	62.21

Means in each column followed by the same superscript are not significantly different between the seasons

7.3.2 Forage utilization along the transect from the water point in controlled grazing conditions

The mean percentage utilization of all plant species at each point along the transect from the water point was 69.25, 22.75, 21.25, 20.00 and 14.5 at 0, 600, 1200, 1800 and 2400m, respectively (Table 7.2). Grazing tended to be more uniformly distributed between 600 and 1800m zone along the transect and was slightly lower at 2400m.

The point in the immediate vicinity of the water point contained no D. eriantha, S. uniplumis, S. pappophoroides and I. daleoides/ C. biensis probably due to trampling or over utilization in the foregoing years. The utilization of annual grasses and forbs growing in the vicinity of the water point was higher than that of other annual grasses growing elsewhere (U. trichopus and M. albescens).

Panicum maximum was the most heavily utilized throughout the transect from the water point while forbs were the most lightly utilized. Digitaria eriantha and S. pappophoroides were generally more heavily utilized than E. lehmanniana and E. rigidior, which in turn were better utilized than S. uniplumis or miscellaneous grasses. Excluding the first point along the transect where, because of trampling, S. uniplumis and the perennial forbs (I. daleoides and C. biensis) were absent, these species were utilized 13% and 6%, respectively.

Table 7.2. Percent utilization of forage species at each point along the transect from the water point in controlled grazing.

Plant species	**Distance from water (m)**					
	0	600	1200	1800	2400	Mean
D. eri	n/a	32.75[a]	26.50[b]	21.00[c]	17.75[d]	39.60
E. leh	44.00[a]	29.75[b]	22.00[c]	15.00[d]	15.75[d]	25.30
E. rig	66.75[a]	20.75[b]	13.25[c]	12.00[c]	12.25[c]	25.00
S. pap	n/a	32.75[a]	23.75[b]	18.75[c]	20.25[c]	39.11
S. uni	n/a	17.75[a]	13.75[b]	11.25[b]	11.25[b]	30.80
P. max	62.00[a]	40.25[b]	31.25[b]	40.75[b]	45.75[b]	44.00
Misc grasses	38.25[a]	13.50[b]	8.85[c]	7.25[c]	8.85[c]	15.34
M. alb / U. tri	46.75[a]	19.75[b]	11.50[c]	8.75[d]	9.75[d]	19.30
C. bie / I.dal	n/a	8.25[a]	3.25[a]	3.50[a]	9.75[a]	24.94
D. aeg / E. afr	56.50[a]	46.25[b]	n/a	n/a	n/a	51.38
T. ter / A. thu	41.00[a]	n/a	n/a	n/a	n/a	41.00
Misc forbs	21.00[a]	10.00[b]	4.50[c]	3.00[c]	.50c	7.80
Mean	69.25	22.75	21.25	20.75	14.50	30.30

Values in each column followed by the same superscript are not significantly different between the distances

7.3.3 Forage utilization between grazing systems

The mean utilization of all plant species was not significantly (P>0.05) different on the different grazing systems although the 9 – paddock system tended to be slightly more heavily utilized (Table 7.3). The stocking rate applied might be not have been sensitive enough to give differences between the grazing systems. Miscellaneous grasses were only slightly more heavily utilized in the 9 – paddock system compared to other systems, while forbs were poorly utilized in all grazing systems. Panicum maximum and annual grasses or forbs growing around the water point were utilized more heavily than other plants and their utilization was higher in the 1 – paddock and 3 – paddock systems than the 9 – paddock

system. In general, D. eriantha, E. lehmanniana and S. pappophoroides were utilized more than other perennial grasses, with the exception of P. maximum.

Table 7.3. Percent utilization of forage species in each grazing system at Makhi ranch

Plant species	Grazing System		
	1 – P system	3 – P system	9 – P system
D. eri	23.50[b]	25.25[a]	24.00[a]
E. leh	19.50[c]	22.00[b]	28.25[a]
E. rig	20.50[a]	18.00[a]	14.25[a]
S. pap	22.50[b]	25.75[a]	23.25[b]
S. uni	14.75[a]	10.75[b]	12.50[ab]
P. max	58.75[a]	61.5[a]	55.25[a]
Misc grasses	10.50[a]	10.25[a]	11.00[a]
M. alb / U. tri	11.75[b]	14.25[a]	12.75[b]
C. bie / I. dal	4.50[a]	4.75[a]	6.25[a]
D. aeg / E. afr	59.50[a]	61.75[a]	47.75[b]
A. thu / T. ter	41.75[a]	43.25[a]	23.50[b]
Misc forbs	7.25[a]	8.00[a]	4.00[b]
Mean	24.5	25.46	26.75

Values in each column followed by the same superscript are not significantly different between the grazing systems

7.3.4 Seasonal forage utilization in the free range grazing areas

The mean utilization of individual plant species between the seasons in free range grazing areas is illustrated in Table 7.4. Significantly ($P<0.05$), higher utilization of the individual forage species was achieved by spring and was lowest in summer of both years. Utilization of most plant species tended to be higher during the 1997/98 grazing year compared to that of 1996/97. This was probably due to the lower forage availability in that season due to the low rainfall.

Significantly ($P<0.05$) higher utilization rates of annual plant species growing in the immediate vicinity of the water point during the growing seasons was observed and they were totally utilized during the dry periods. Utilization of miscellaneous grasses and forbs was relatively light compared to D. eriantha, E. lehmanniana and S. pappophoroides. Amongst the perennial grasses, D. eriantha was in the first order of being utilized by grazing animals. Panicum maximum was notably absent from this rangeland. Animals also tended to utilize E. lehmanniana and S. pappophoroides more heavily than S. uniplumis or E. rigidior. However, D. eriantha tended to be lightly utilized during the summer period compared to the other major perennial plants of this sandveld.

Table 7.4. Seasonal utilization (%) of forage species in the sward in the free – range

grazing area

Plant species	Season of year							
	Summer 1996/97	Autumn 1996/97	Winter 1996/97	Spring 1996/97	Summer 1997/98	Autumn 1997/98	Winter 1997/98	Spring 1997/98
D. eri	4.25^{e}	6.00^{e}	25.50^{d}	53.75^{b}	3.75^{e}	42.00^{c}	61.00^{b}	89.75^{a}
E. leh	21.75^{b}	19.00^{c}	27.75^{b}	58.25^{a}	14.75^{c}	23.50^{b}	32.25^{b}	61.75^{a}
E. rig	5.25^{d}	14.75^{c}	18.75^{c}	46.00^{a}	8.00^{c}	24.25^{b}	28.25^{b}	55.50^{a}
S. pap	1.50^{e}	13.50^{d}	31.00^{c}	46.25^{b}	8.25^{de}	12.25^{d}	44.50^{b}	59.75^{a}
S. uni	2.25^{bc}	6.75^{b}	8.50^{b}	40.25^{a}	1.00^{e}	1.00^{c}	9.50^{b}	41.25^{a}
Misc gr	5.25^{d}	10.25^{c}	25.50^{b}	49.00^{a}	4.75^{d}	10.25^{c}	31.50^{b}	59.00^{a}
M.alb	6.75^{e}	13.00^{c}	25.25^{b}	50.25^{a}	7.50^{e}	12.00^{c}	24.25^{b}	53.25^{a}
C.bie	1.00^{b}	4.50^{b}	8.00^{b}	38.00^{a}	.75^{b}	2.00^{b}	3.50^{b}	35.50^{a}
D.aeg	50.00^{d}	57.00^{c}	75.00^{b}	100.0^{a}	50.00^{d}	68.50^{b}	76.00^{b}	100.0^{a}
T.ter	47.50^{c}	74.00^{b}	75.00^{b}	100.0^{a}	57.75^{c}	57.75^{c}	87.50^{b}	100.0^{a}
Misc.for	6.50^{c}	7.75^{c}	19.00^{b}	39.00^{a}	7.75^{c}	9.25^{c}	21.75^{b}	37.75^{a}
Mean	13.82	20.59	30.84	56.39	14.93	23.89	38.18	63.05

Values in each column followed by the same superscript are not significantly different between the seasons

7.3.5 Forage utilization along the transect from the water point in free – range grazing areas

Table 7.5 illustrates the utilization of the individual plant species along transects from the water point in the free range grazing area. Significant ($P<0.05$) differences in the utilization of each species occurred between the points. The mean herbage utilization for all plant species at each point was 68.73, 45.82, 20.78, 15.40 and 9.44 at the 0, 500, 1000, 2500 and 4000m from the water point, respectively. In the immediate vicinity of the water point, perennial grasses were completely absent, and only annual plants occurred. Forage utilization was 23% higher at the 0m point than at 500m (68.7% vs. 45.8%), which was also 36.4% higher than at the 4000m point. The average utilization of the major perennial grasses was 48% higher at 500m point (a zone where they start to occur) than at the 4000m point along the transect from the water.

Digitaria eriantha was utilized more heavily at 1000m point compared to other perennial grasses and the miscellaneous grasses were the least utilized. Eragrostis rigidior and S. uniplumis become more available at 1000m point, while D. eriantha and E. lehmanniana were about 60% grazed at 2500m point from the water. The influence of grazing had not tapered off at 4000m from the water point indicating that animals travel beyond this point.

Utilization of D. aegyptium, E. africana, A. thumbergii and T. terrestris at the 1000m point or beyond was minimal or not present because these species were largely limited to where soil disturbance occurred. Miscellaneous forbs and grasses were poorly utilized throughout the transects.

Table 7.5. Percent utilization of forage species at each point along the transect from the water point in the free range grazing area

Plant species	**Distance from water**					
	0	500	1000	2500	4000	Mean
D. eriantha	100.00	60.50^{a}	52.00^{b}	30.00^{c}	10.50^{d}	50.80
E. lehmanniana	75.00^{a}	56.50^{b}	28.00^{cd}	33.75^{c}	23.50^{d}	45.35
E. rigidior	100.00	58.50^{a}	24.25^{b}	7.50^{c}	4.50^{c}	38.95
S. uniplumis	100.00	55.00^{a}	18.25^{b}	14.00^{b}	9.75^{b}	39.40
S. pappophoroides	100.00	66.50^{a}	26.50^{b}	22.25^{b}	10.00^{c}	45.10
Misc grasses	53.75^{a}	40.25^{a}	15.50^{b}	13.50^{b}	13.50^{b}	27.30
M. alb / U. tri	68.00^{a}	31.75^{b}	16.50^{c}	12.25^{c}	7.25^{d}	27.15
C. bie / I. Dal	8.55^{a}	7.25^{a}	5.50^{a}	3.50^{a}	3.50^{a}	5.66
D. aeg / E. afr	65.75^{a}	62.50^{a}	n/a	n/a	n/a	64.12
A. thu / T. ter	51.00^{a}	48.50^{a}	18.75^{b}	n/a	n/a	49.75
Misc forbs	34.00^{a}	16.75^{b}	2.75^{c}	1.50^{c}	2.75^{c}	11.55
Mean	68.73	45.82	20.78	15.40	9.44	36.65

Values in each column followed by the same superscript are not significantly different between the distances

7.4 DISCUSSION

The determination of forage utilization of different species is necessary as all grasses are not

equally utilized by grazing animals. By considering the forage utilization of dominant grasses in a particular area, one can obtain an indication of their grazing potential.

The above results indicate that the utilization of forage species varied with season, species and distance from the water in both 1996/97 and 1997/98 seasons. Forage utilization was heaviest during spring and lowest in summer period. These differences were caused by the different phenological growth stages of plant and cumulative utilization, after growth, of the available forage by the grazing animals. Utilization during early phenological growth stages (eg. Summer) appeared to be low because plants were growing actively and being grazed at the same time. The highest percentage forage utilization was in the year of low production and the lowest percentage forage utilization was in the year of high production, confirming the findings of Martin & Ward (1970) and Cook *et al.* (1965) working in the desert grassland. If high forage utilization rates coincide with drought, then the vigour of preferred perennial species might diminish; and an increase in annual plant species may be expected the following year due to a reduction in cover.

Forage utilization of grasses in the zone within 600m of the water was at least double that in the zone 600 – 1500m zone under controlled grazing management. Comparisons between 600 – 1800m from water showed no difference in forage utilization at Makhi ranch. Utilization of the five major perennial grasses was affected to different degrees by the distance from water (Table 7.2 & 7.5). Digitaria eriantha was the most affected followed by E. lehmanniana and S. pappophoroides by the end of the grazing season. Digitaria eriantha is considered to be a decreaser while E. lehmanniana and S. pappophoroides are considered increasers II in terms of grazing response. S.uniplumis is the other abundant perennial grass found in the sandveld. It was not utilized much by cattle, and exhibited no definite trend with distance from water. This grass is highly fibrous and lower in nutritional value than other perennial grasses (Chapter 6). Eragrostis rigidior was slightly better utilized than S. uniplumis.

The degree of utilization along the transect from water did not taper off at the 4000m point in the free range grazing area, suggesting that livestock travel beyond this point. Farmers in the free range grazing area usually water their cattle every other day to increase their range of grazing during periods of forage scarcity. Maximum “piosphere” size is determined by the

distance livestock travel before returning to water. The presence of annual plants, associated with soil disturbance at the 1000m point from water, were indications that the 'sacrifice' zone was larger in the free range grazing management area than in the controlled ranch management condition (Table 7.2 & 7.5).

Most grazing systems do not attempt to improve plant production around the water points, but either accept it, as it occurs, or simply do not concern themselves with this problem. It should be noted that many of the plants growing in these 'sacrifice' zones are frequently toxic to livestock and may cause problems at certain seasons. Improved plant composition around water points is certainly a worthy goal, if it will help alleviate these problems. Grazing distribution is the major problem that grazing systems seek to solve. It then becomes critical to select a grazing system that allows forage plants near water points to increase or maintain their productiveness while the grazing animals make better use of the plants some distance away from water. These sacrifice zones are often accepted as inevitable and it is generally thought that the larger the paddock and, the longer the animals stay in the paddock, the bigger the sacrifice zone. Such factors have a negative impact on forage production in the free range grazing management areas, where animals stay permanently on the same area. One grazing system that addresses this problem is rotating access to water (Martin & Ward 1970). This system may be suited for borehole dependent livestock such as those found in Botswana free range grazing areas, where distances between boreholes is greater and grazing often does not overlap between water points.

7.5 CONCLUSION

Livestock use forage plants more heavily near water points compared to areas away from water. Data from this study confirms that forage utilization in both free range grazing and controlled grazing management systems was heaviest in the zone around the water point. The utilization of perennial grasses in the 500m zone was 59 % in the free range grazing area while only 26 percent was recorded in the ranch condition. Forage utilization and the 'sacrifice zone' were greater in the free range grazing management system than the controlled management system.

In general, utilization was higher following a drought year, when grazing pressure was concentrated on reduced available forage. Forage utilization was greatest in spring and least in summer. Amongst the perennial grasses D. eriantha, E. lehmanniana and S. pappophoroides were in the first order of utilization following those annual species growing in the vicinity of the water point. Panicum maximum, where it occurred, was the most palatable. Forbs, excepting those found near the water point, were general poorly utilized by livestock.

Grazing along the transect from the water point tended not to taper off in the free range grazing area suggesting that livestock travel beyond 4000m. Piopshere size, as determined by the distance livestock can travel, was greater in free range grazing management area than in the ranch management condition.

Rotating access to water by livestock has been indicated as a method to promote production of forage around water points and to reduce the grazing impact in this zone.