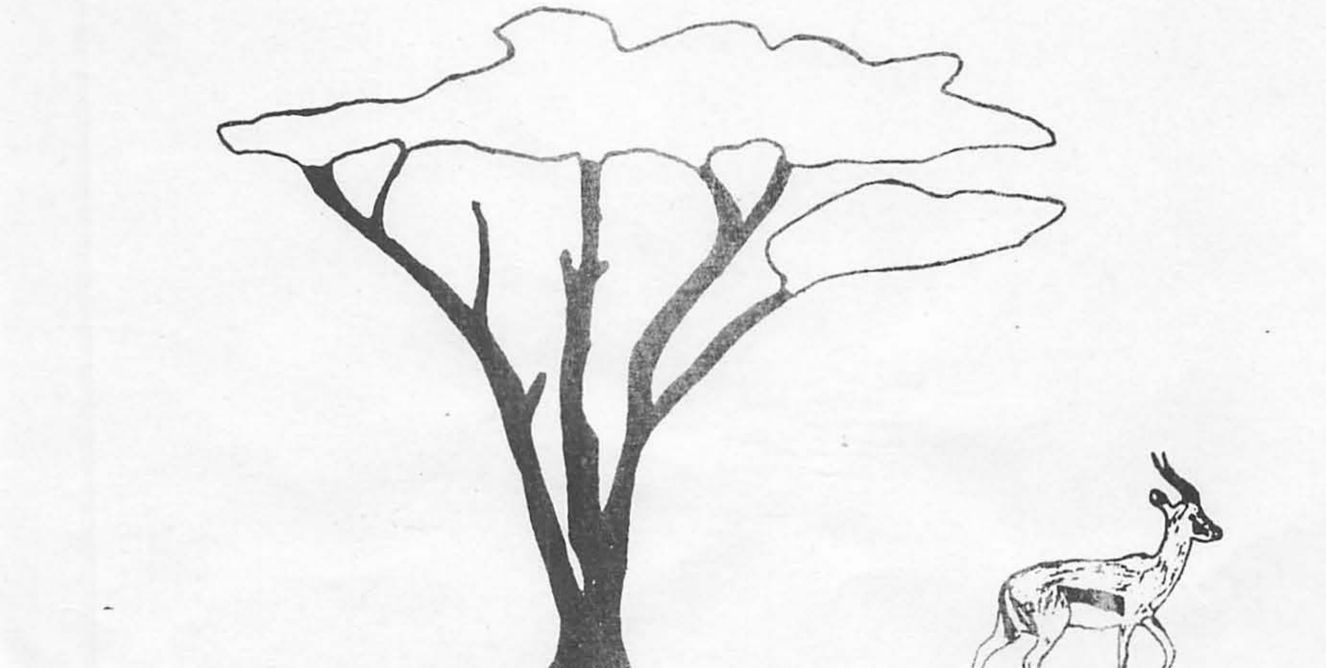
SOMALI JOURNAL OF RANGE SCIENCE

Publication of the
Department of Botany and Range Science
Faculty of Agriculture
Somali National University

Vol. 3, No. 1
April, 1988



SOMALI JOURNAL OF RANGE SCIENCE VOLUME 3, NUMBER 1

The Somali Journal of Range Science serves as a forum for the presentation of scientific research pertaining to the study, management and use of Somalia's rangeland resources. This journal is published twice yearly. Articles relating to all aspects of natural resource research in Somalia are welcomed. Submitted manuscripts should follow the same general format as used in this issue. Papers should clearly and concisely state the purpose of the research. Unsupported hypotheses and rambling discussion should be avoided. The submission deadline for the next issue will be May 1, 1988.

TABLE OF CONTENTS

Volume 3, Number 1, April 1988

RESPONSE OF VEGETATION OF THE ACACIA NILOTICA/DICHROSTACHYS KIRKII SHRUBLAND RANGE SITE TO LAND USE INTENSITY, CEEL DHERE DISTRICT, SOMALIA

Dennis J. Herlocker, Ahmed M. Ahmed and Thomas L. Thurow

The changes in plant community structure and composition associated with distance from permanent water can be used to approximate a retrogression sequence associated with increasing land use intensity (Graetz and Ludwig 1978, Foran 1980). Herlocker et al. (1987) documented vegetation response along such a gradient located on an Acacia reficiens/Dichrostachys kirkii range site. An objective of this research was to document the response of vegetation along a similar land use intensity gradient on the adjacent range site and to compare patterns of vegetation succession.

STUDY AREA

The study site was a level to gently undulating shrubland located in the Ceel Dhere District of central Somalia ($4^{o}10'$N, $46^{o}50'$E) (Fig. 1). This range site was dominated by Acacia nilotica and Dichrostachys kirkii. A water well was established in 1970 at Nooleye, after which intensity of land use probably increased significantly. A similar development history occurred at Galcade located on the Acacia reficiens/Dicrostachys kirkii range site. The wells at these two villages were the only sources of permanent water within the respective study sites.

The environmental factors that characterized the Acacia nilotica/Dichrostachys kirkii range site studied in this research were in many respects similar to those that characterized the adjacent Acacia reficiens/Dichrostachys kirkii range site described by Herlocker et al. (1987). Both sites had a similar climate in terms of mean annual temperature (20-30 C) (UNESCO 1979) and annual rainfall (250-300 mm/yr) (RMR 1979). Annual precipitation amounted to only 3-20% of evaporative demand. Rainfall was restricted to two seasons (Gu' = April-May and Dayr = November). The monsoonal winds, especially the strong, dry southwestern wind of the Xagaa season (June-October), were a major erosive factor (Hemming 1972). On both sites camels and goats were the most common types of livestock; sheep and cattle were also present. Pastoralism and farming were the two main land uses, with much of the population being engaged in both forms of land use (agropastoralism) (RMR 1979, Holt 1985). Farms and enclosures fenced with cut thorn bushes occurred throughout both range sites and were greatest near the villages. Cultivated fields were 1-4 hectares large and were used to produce primarily cow peas and sorghum. The duration of cultivation on any particular field is about 5 years after which the site is fallowed for about 30-50 years. Fences may or may not be maintained during the fallow period. Thus the specific history of use for any particular piece of land was often unknown.

The primary environmental difference between the Acacia nilotica/Dicrostachys kirkii range site and the Acacia reficiens/Dicrostachys kirkii range site was that the very fine, mildly alkaline, reddish-yellow, sandy soil found on both sites was deeper on the Acacia nilotica/Dichrostachys kirkii range site (> 1.5 m deep) (RMR 1979). Livestock stocking rate was greater on the Acacia nilotica/Dichrostachys kirkii range site (3350 Kg/Km^2/yr) compared with the stocking rate of 3000 Kg/Km^2/yr on the Acacia reficiens/Dichrostachys kirkii range site.

First and second authors are respectively the Range Ecologist and District Range Officer for the Ceel Dhere District, Central Rangelands Development Project, P.O. Box 2954, Mogadishu, Somalia. Third author is professor, Department of Botany and Range Science, Faculty of Agriculture, Somali National University.

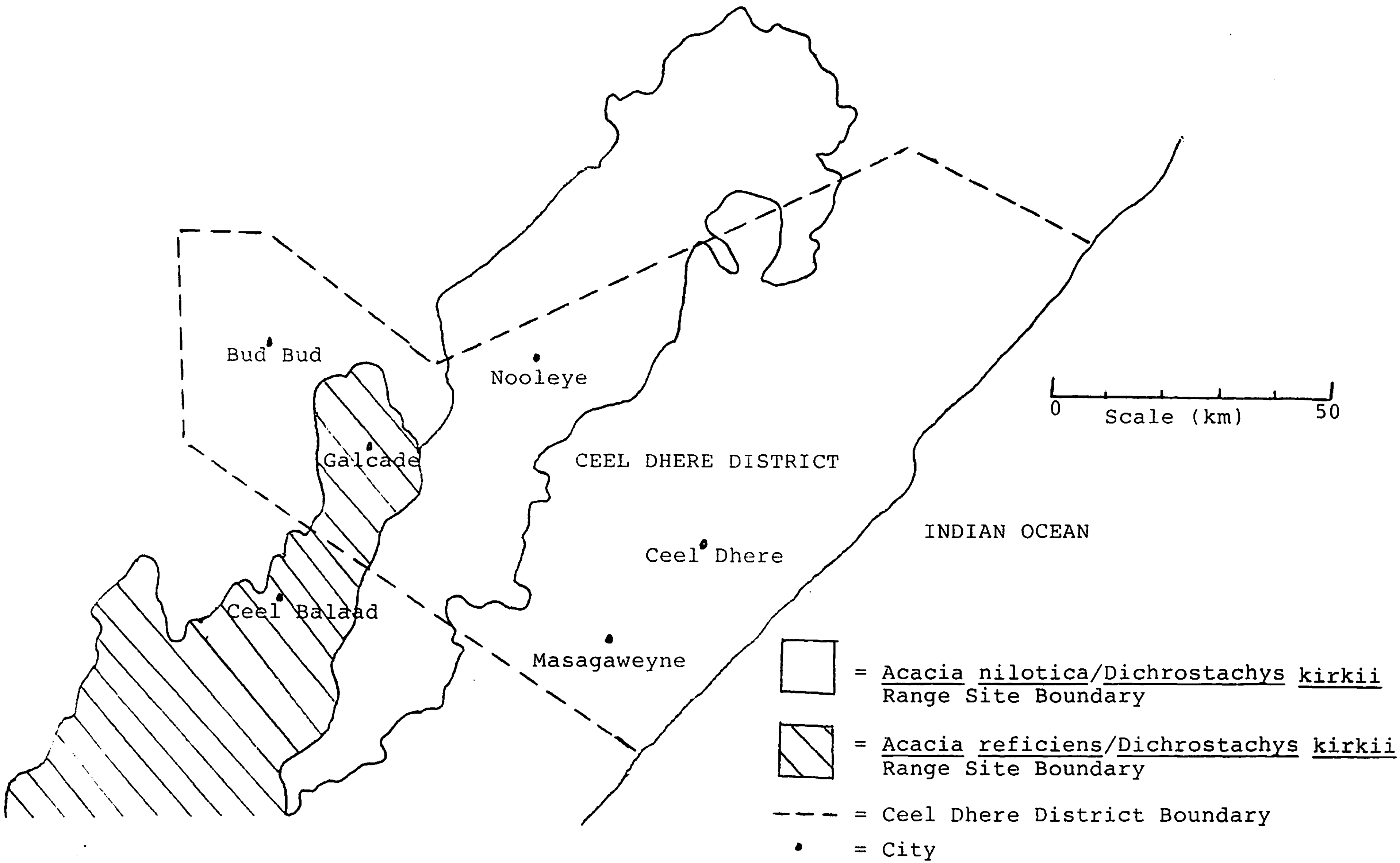


Figure 1. Map of Ceel Dhere District and the <u>Acacia nilotica/Dichrostachys kirkii</u> range site.

METHODS

The methods used were the same as described by Herlocker et al. (1987) which facilitates comparison of results between these studies. The range site boundaries of the study area were deliniated using subjective estimates of dominant plant species, surface soil attributes and general topography. Vegetation attributes were measured by placing fixed area circular plots at sampling stations along all major vehicle tracks within the range site. Intervals between sampling stations ranged from 0.5 to 5 Km. Shrub and dwarf shrub cover were measured by using 100 m^2 and 10 m^2 sized plots, respectively. The plant height and crown diameter of each individual shrub within the plot was measured and recorded by species. Species composition and foliar cover of herbaceous vegetation were measured along a 10 m transect of 1,000 points at each sample station. Measuring basal cover would have required a logistically prohibitive number of transects to obtain an adequate sample because basal cover was very low (<2%).

Range condition was classified at each station using the criteria of Naylor and Herlocker (1984). This approach to range condition classification uses subjective ratings of edaphic factors, herbaceous growth form and accumulated utilization rather than botanical criteria. Plots and transects were placed in a nested fashion approximately 50 m away from roads to reduce the influence of passing traffic (human, vehicular and livestock) on the vegetation and soils. Species diversity was calculated using the Shannon-Weiner diversity index (Krebs 1972).

Soil and vegetative attributes were related to distance from permanent water. All graphs are composed of a running average of three consecutive sample points. This procedure aids in graphic display of spacial trends in that it helps smooth variation of individual sample points that may be due to natural site diversity.

RESULTS

Range condition on the Acacia nilotica/Dichrostachys Kirkii range site increased rapidly from poor condition near the well site to a mid-fair condition which prevailed throughout the rest of the study site (Fig. 2). Dwarf shrub cover declined from 18% at 1 Km from the well site to 5-8% at 7 Km and beyond (Fig. 3). Arborescent shrub cover increased rapidly until about 12 Km but increased slowly thereafter (Fig 3). Thus, total shrub cover (the combination of dwarf and arborescent shrubs) increased from about 25% at 1 Km from the well site to a plateau of 41-44% between 12 and 22 Km.

The relative cover of the most common shrub species is shown in Figures 4 and 5. The distribution of Solanum incanum was restricted to the intensively used area near the borehole where it was the dominant shrub. Following an initial increase in cover from 1-3 Km from the well, Indigofera ruspolii, another dwarf shrub, also declined as distance from the well site increased, leveling off at about 11% relative shrub cover at 12 Km and beyond. Acacia nilotica rapidly increased as distance from the well site increased before peaking at 35-40% relative cover between 7-12 Km, beyond which it rapidly declined. As Acacia nilotica began to decline with distance away from the well site, shrubs such as Acacia mellifera and Acacia reficiens increased. Dichrostachys kirkii and Acacia horrida maintained relative cover throughout most of the study site at approximately 10%.

Herbaceous cover increased steadily from about 2% cover 1 Km from the well to 7% cover at 22 Km (Fig. 6). This increase in herbaceous cover was composed primarily by an increase in grass cover associated with distance from the borehole. Litter cover increased from about 4% at 1 Km from the well to 7% at 22 Km. Figures 7 and 8 show relative herbaceous cover of the most common herbaceous species. Cynodon dactylon, Dactyloctenium scindicum and Tephrosia sp. decreased as distance from the well increased. Conversely, Aristida sieberiana steadily increased as distance from the well site increased.

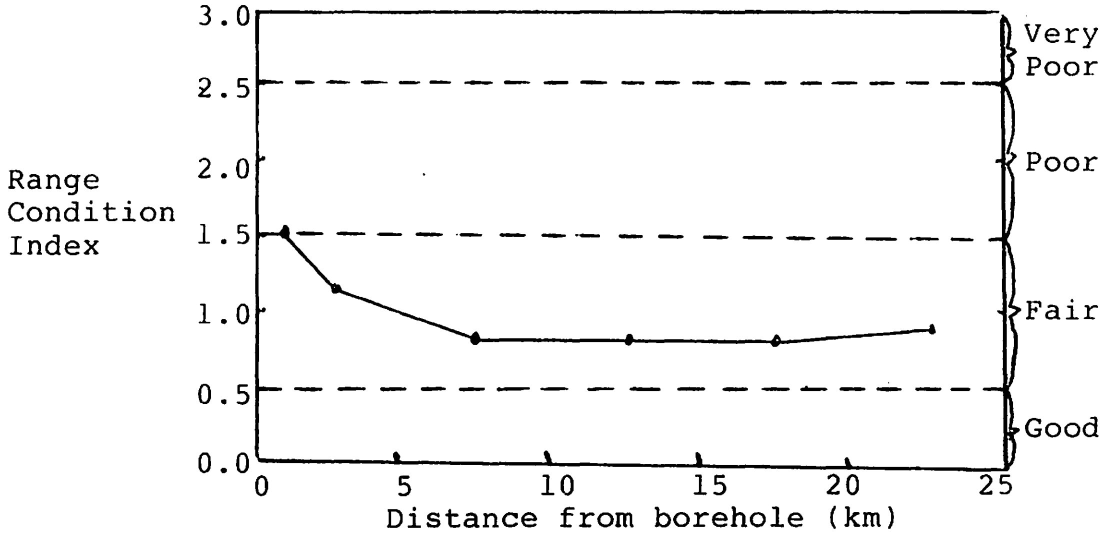


Figure 2. Range condition associated with changes in land-use intensity which is a function of distance from the borehole.

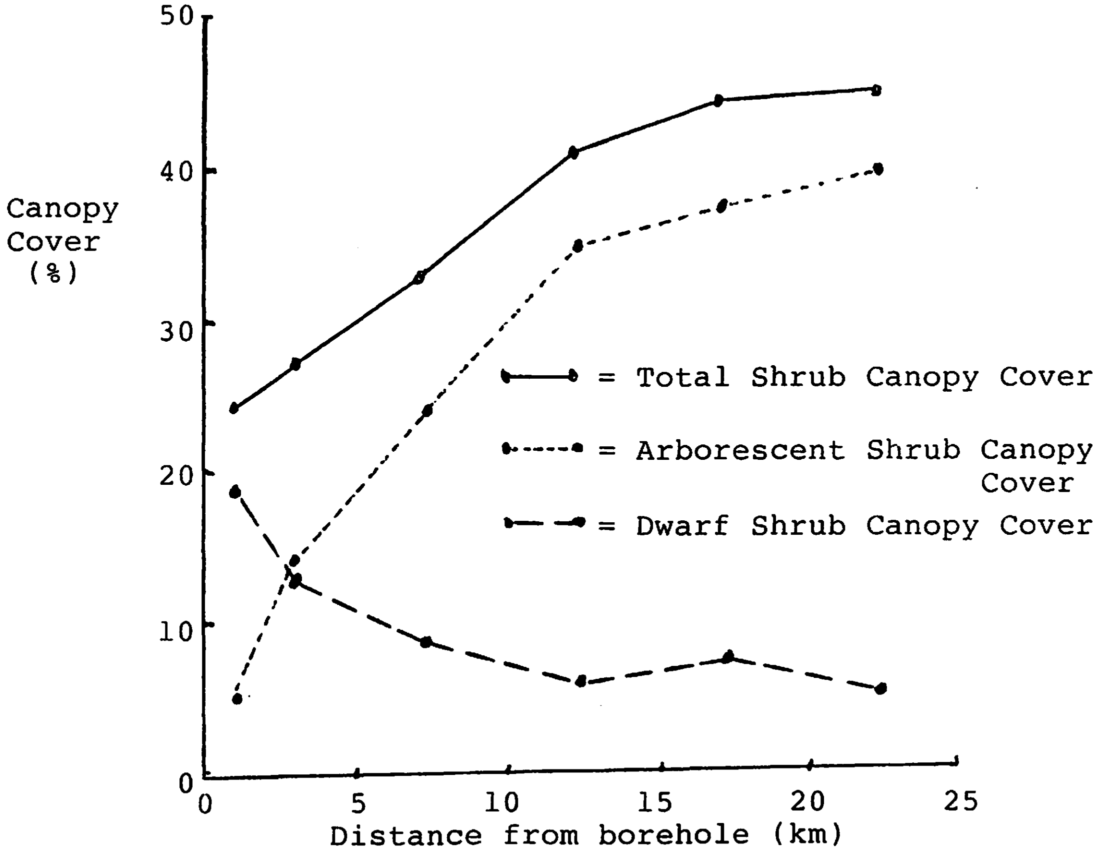


Figure 3. Shrub canopy cover changes associated with changes in land-use intensity which is a function of distance from the borehole.

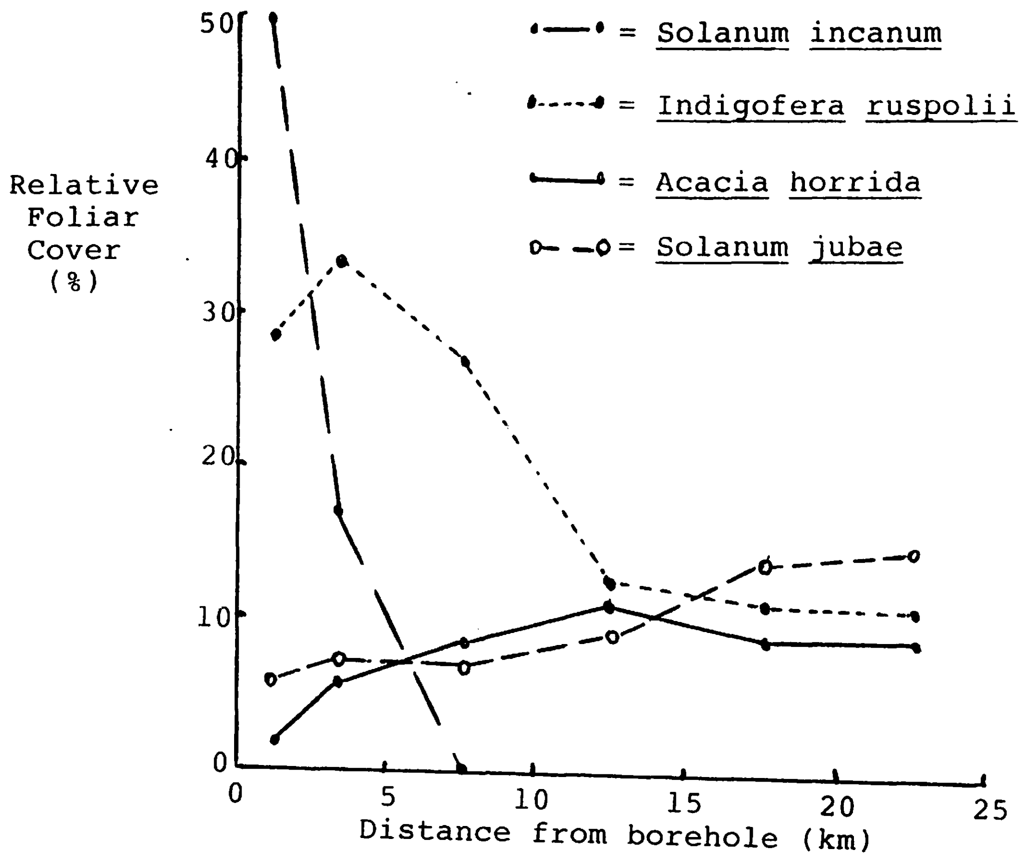


Figure 4. Changes in relative canopy cover of shrub species associated with changes in land-use intensity which is a function of distance from the borehole.

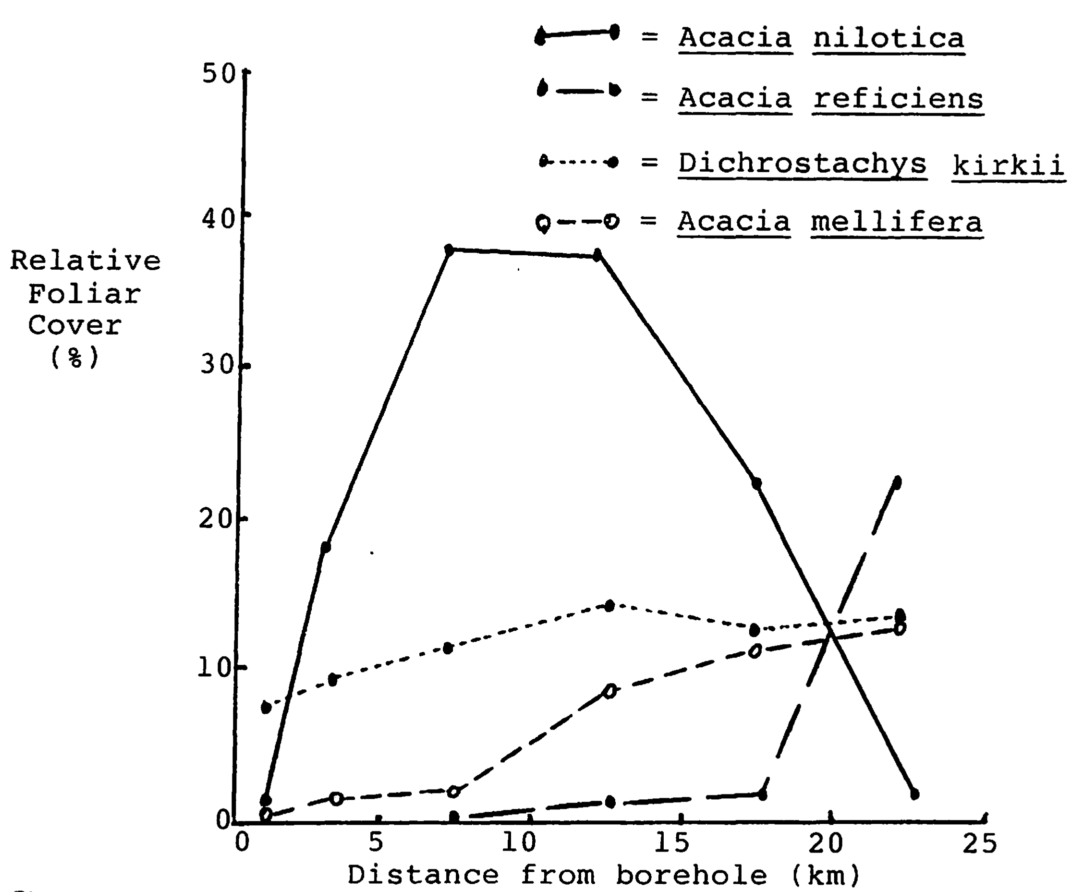


Figure 5. Changes in relative canopy cover of dominant shrub species associated with changes in land-use intensity which is a function of distance from the borehole.

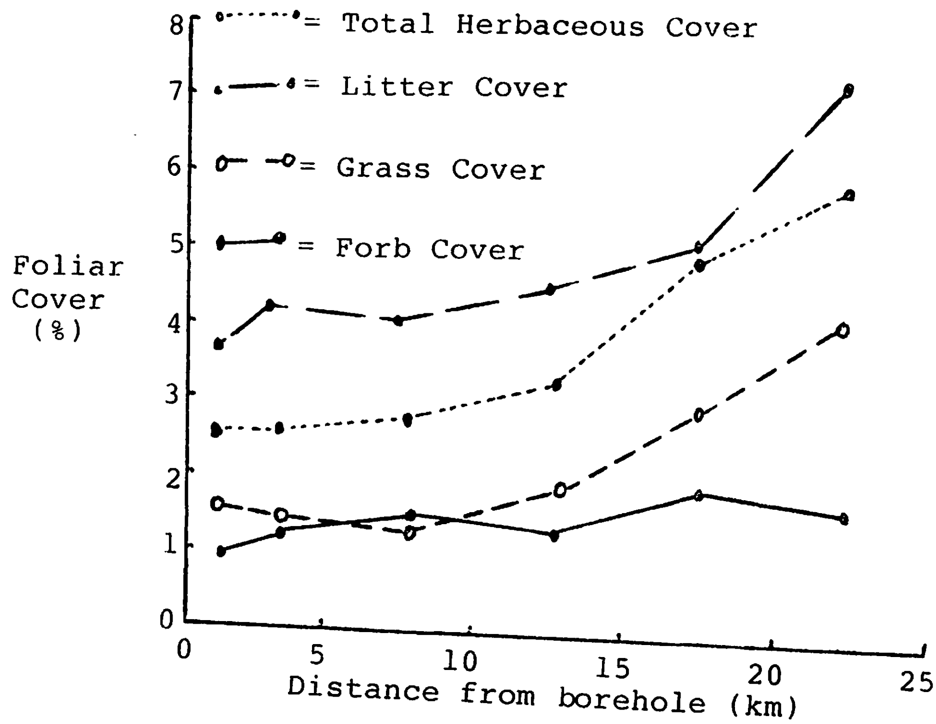


Figure 6. Herbaceous and litter cover changes associated with changes in land-use intensity which is a function of distance from the borehole.

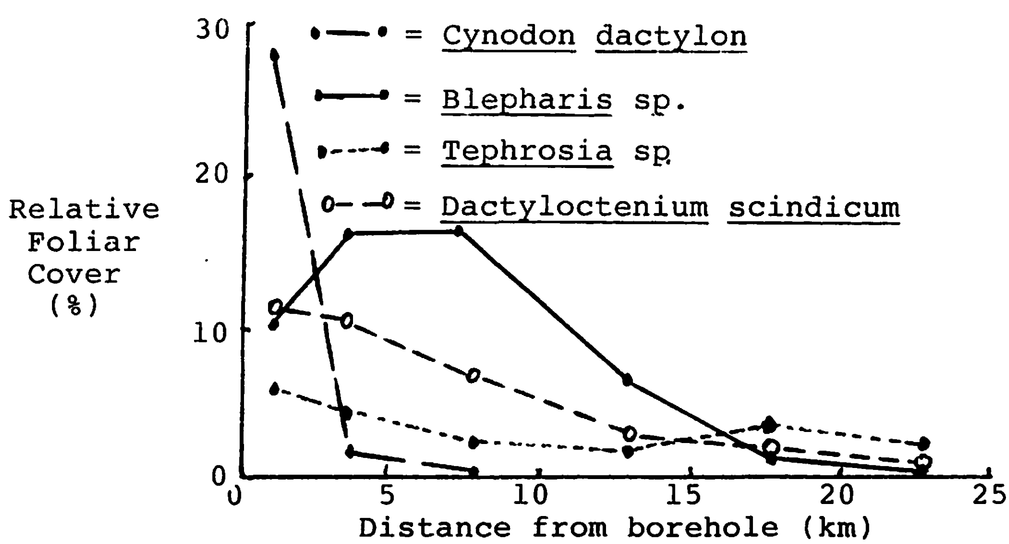


Figure 7. Changes is relative foliar cover of herbaceous species associated with changes in land-use intensity which is a function of distance from the borehole.

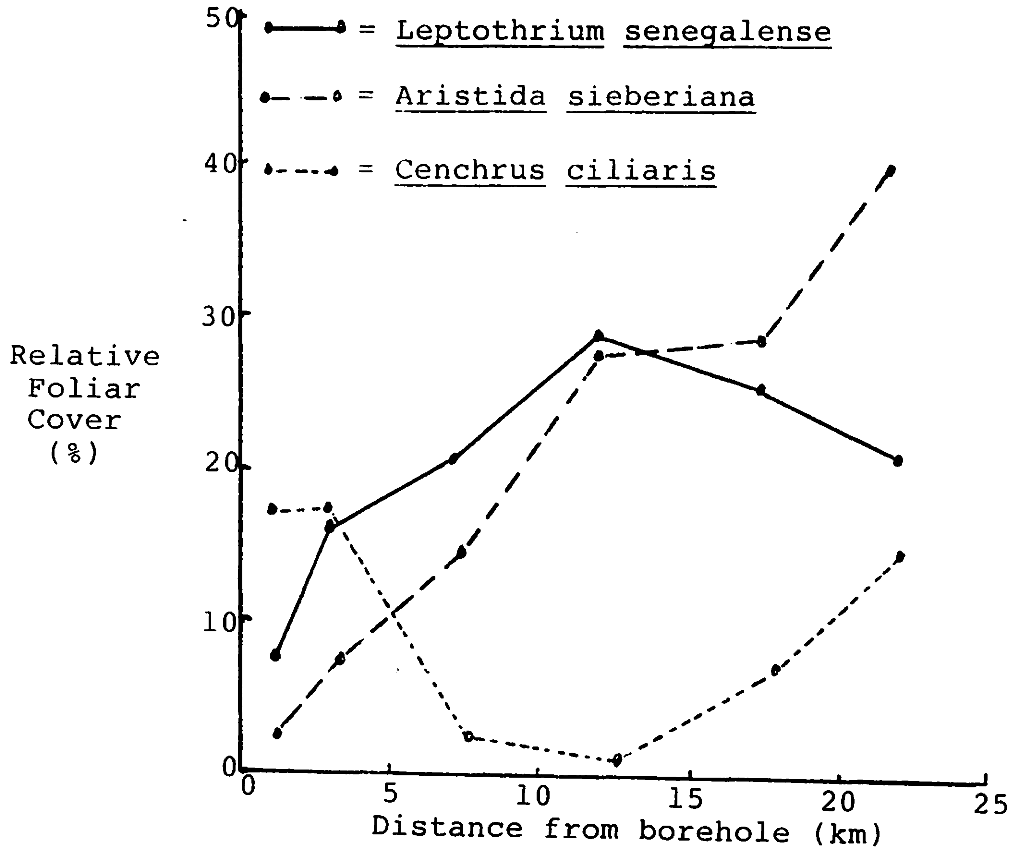


Figure 8. Changes in relative foliar cover of herbaceous species associated with changes in land-use intensity which is a function of distance from the borehole.

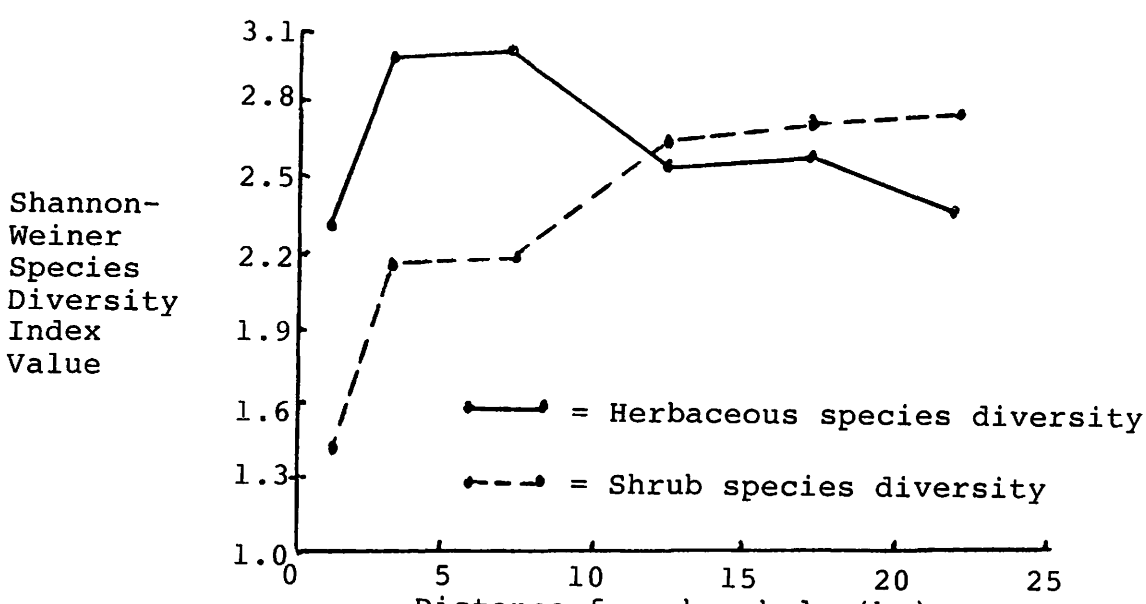


Figure 9. Shannon-Weiner species diversity index trends of herbaceous and shrub diversity associated with changes in land-use intensity which is a function of distance from the borehole.

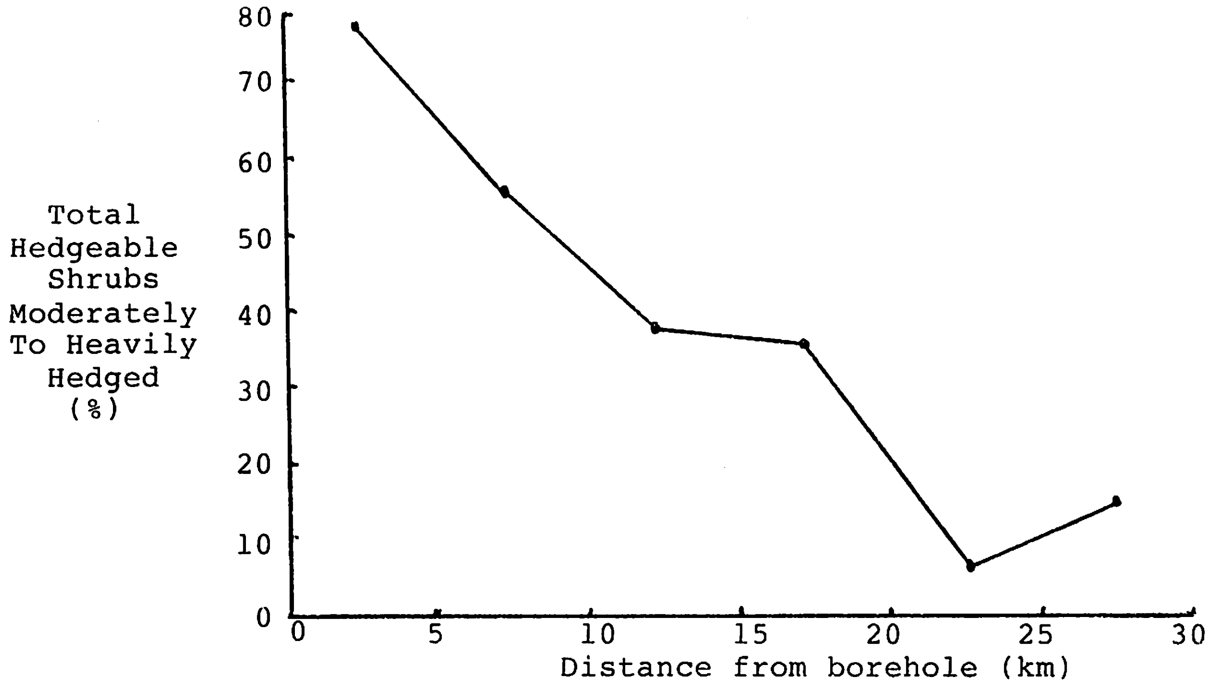


Figure 10. Changes in the percent of hedgeable shrubs that are moderately to heavily hedged associated with changes in land-use intensity which is a function of distance from the borehole.

The species diversity of the shrub community increased with distance from the borehole until about 12 km, beyond which it leveled off (Fig. 9). Species diversity of the herbaceous species increased and then decreased with distance from the borehole.

DISCUSSION

The compositon and structure of the vegetation community extending out from Nooleye were assumed to be the result of changes in land-use intensity by humans and their livestock. This impact was assumed to increase with proximity to permanent water at the village. Therefore distance in relation to permanent water provided a relative estimate of land use intensity. By studying vegetation community changes along this gradient a retrogression sequence can be documented that is useful for contributing to an understanding of range condition and trend.

The lack of improvement in range condition beyond 7 km from the borehole is at odds with the fact that grass and litter cover increased with distance and the level of browsing intensity decreased (Fig. 10). These data indicate that range condition probably did improve but so gradually that it was not detectable using the methods of Naylor and Herlocker (1984).

The effect of shrub cutting on woody cover was apparently primarily confined to a 12 km radius of the village. Within this zone shrub cover rapidly declined as distance from the village decreased. Cut shrubs were primarily used to build and maintain fences around farms and private grazing reserves. Although farms may occur throughout the range site their frequency markedly increased within this 12 Km zone. As arborescent shrub cover was reduced dwarf shrub shrub cover increased. Dwarf shrubs were not used for fencing material and were able to increase as the larger competing shrubs were removed. Solanum incanum, which is an unpalatable invader (Pratt and Gwynne 1977), was restricted to the intense land use areas within several kilometers of the village. Indigofera ruspolii, which is palatable, decreased rapidly between 3-12 km but then leveled off and maintained a relative cover of about 11% on land greater than 12 km from the borehole. These patterns corroborate the trends for these these dwarf shrub species observed on the Acacia reficiens/Dichrostachys kirkii range site. Cordia suckertii followed a similar pattern to Indigofera ruspolii (i.e. as a late increaser) on the Acacia reficiens/Dichrostachys kirkii range site but was uncommon on the Acacia nilotica/Dicrostachys kirkii range site.

Dichrostachys sp. and Acacia horrida relative cover increased gradually out to about 7 km from the borehole, beyond which they maintained a relative cover of about 10%. The response for Dichrostachys kirkii was markedly different on the Acacia reficiens/Dichrostachys kirkii range site where Dichrostachys kirkii relative cover reached a peak of about 55% at 5 km from the borehole beyond which it rapidly declined. The difference in relative cover of Dichrostachys sp. between the range sites probably reflected differing degrees of competition from Acacia nilotica. Acacia horrida was uncommon on the Acacia reficiens/Dichrostachys kirkii range site.

Acacia nilotica followed a similar pattern on both range sites except that its peak relative cover was 37% on the Acacia nilotica/Dichrostachys kirkii range site compared to 27% on the Acacia reficiens/Dichrostachys kirkii range site. The increase in relative cover of Acacia reficiens and Acacia mellifera at the sample points farthest from the boreholes occurred on both sites. Acacia reficiens was less common and Acacia mellifera was more common on the Acacia nilotica/Dichrostachys kirkii range site than on the Acacia reficiens/Dichrostachys kirkii range site. Both Acacia mellifera and Acacia reficiens are probable components of late successionl stages. The gradual relative cover increase of Solanum jubae was due to the crowns of the original invading individuals getting larger rather than an influx of more individuals. Solonam jubae is a shrub of low palatability which invades recently abandoned farms. It is unsuitable for fencing or firewood and therefore persisted as a component of vegetation regrowth long after land was fallowed.

The herbaceous vegetation response to land use intensity was very similar on both range sites. Cynodon dactylon and Tephrosia sp. were late invaders. Dactyloctenium scindicum was an early invader that maintained at least several percent relative cover at all locations by exploiting localized areas of disturbance. Leptothirum senegalense was an increaser and Aristida sieberiana and Afrotrichloris hyaloptra were decreasers. Afrotrichloris hyaloptra was found only at the sample sites 27 km from the village reflecting a similar decreaser response as that documented on the Acacia reficiens/Dichrostachys kirkii range site. Cenchrus ciliaris probably was a late decreaser but was found throughout the gradient because of the ability of well established individual plants to withstand heavy grazing.

On both range sites forb cover remained generally constant with the increase in herbaceous cover associated with distance from well site being accounted for by an increase in grass cover. Crotalaria dumosa, which was a common forb increaser on the Acacia reficiens/Dichrostachys kirkii site, was uncommon on the Acacia nilotica/Dichrostachys kirkii range site. Blepharis sp., which responded as an increaser on the Acacia nilotica/Dichrostachys kirkii range site, was uncommon on the Acacia reficiens/Dichrostachys kirkii range site.

Shrub species diversity remained relatively high on the Acacia nilotica/Dichrostachys kirkii range site whereas it decreased on the Acacia reficiens/Dichrostachys kirkii range site. The greater species diversities of the herbaceous and shrub cover on the Acacia nilotica/Dichrostachys kirkii range site may be attributed to the deeper soils which aided soil moisture retention and made the site more productive. Greater production potential may also be attributed to cause the wider dominance of Acacia nilotica since this species is able to apparently dominate by outcompeting Dichrostachys kirkii near the well site. In contrast, on the shallow soiled site near Galcade, water may be more limiting which may cause Acacia nilotica to decline more rapidly and thus provide the niche for Dichrostachys kirkii to dominate. It is interesting to note that total shrub cover on stands dominated by Acacia nilotica was similar on both range sites.

CONCLUSIONS

The retrogression patterns of the two range sites had many similarities. These patterns are useful indicators for the assessment of range condition on these range sites and are outlined as follows:

1) Range condition declined within increasing intensity of land use, especially within 5 km of a borehole.

2) Forb cover remained relatively uniform along the land-use gradient. Herbaceous cover decreases, which occurred as land-use intensity increased, were due to the concurrent decrease in grass cover.

3) Cynodon dactylon and Tephrosia sp. were late invaders. Dactyloctenium scindicum was an early invader which could be found throughout the land use gradient on local disturbed sites. Leptothrium senegalense and Blepharis sp. were increasers and Afrotrichloris hyaloptra and Aristida sieberiana were decreasers. On both sites Cenchrus ciliaris showed an erratic distribution but was probably a late decreaser capable of withstanding heavy grazing.

4) Herbaceous species diversity increased until it peaked about 3 km from the borehole after which there was a gradual decline.

5) Dwarf shrubs dominated the woody cover in heavy use areas within several kilometers of the borehole. Solanum incanum was an invader restricted to heavy use areas near the borehole. Indigofera ruspolii was a late increaser.

6) Arborescent shrubs dominated woody cover beyond several kilometers of the boreholes. Acacia nilotica was an increaser and Acacia reficiens and Acacia mellifera were decreasers.

7) Differences in vegetation responses probably reflected differences in soil depth of the two adjacent range sites.

LITERATURE CITED

Foran, B.D. 1980. Change in range condition with distance from watering point and its implications for field survey. Australian Rangeland Journal 2:59-66.

Graetz, R.D. and J.V. Ludwig. 1978. A method for the analysis of biosphere data applicable to range assessment. Australian Rangeland Journal. 1:126-136.

Hemming, C.F. 1972. Ecological and grazing survey of the Mudugh Region. Survey of Northern Rangelands. Somali Democratic Republic. FAO/AGP:DP/SOM/70/512. Working paper. Rome. 15 p. plus maps.

Herlocker, D.R., A.M. Ahmed and T.L. Thurow. 1987. Response of vegetation of the Acacia reficiens/Dichrostachys sp. shrubland range site to land use intensity, Ceel Dhere District, Somalia. Somali Journal of Range Science. 2:10-24.

Holt, R.M. 1985. Agropastoralism and desertification in Ceel Dhere District, Central Somalia. Preliminary investigations and trial results. CRDP Technical Report 3. 129 p.

Krebs, C.J. 1972. Ecology - The Experimental Analysis of Distribution and Abundance. Harper and Row, New York.

Naylor, J. and D.J. Herlocker. 1984. Criteria for range condition classification. CRDP Technical Report 6. 8 p.

Pratt, D.J. and M.A. Gwynne. 1977. Rangeland Management and Ecology in East Africa. Hodder and Stroughton, London.

Resource Management and Research (RMR). 1979. Static Range Resources Vol. 1, Part 2. Maps. Central Rangeland Survey. Somali Democratic Republic.

United Nations Educational and Scientific Organization (UNESCO). 1979. Map of the world distribution of arid regions with explanary note. UNESCO. Paris, 54 p.

DRY HERBAGE YIELDS OF CENCHRUS CILIARIS L. IN RESPONSE TO VARIOUS CLIPPING TREATMENTS

Mahdi M. Kidar and Jerry R. Barker

Cenchrus ciliaris L. (buffel grass) is a robust perennial bunchgrass occurring throughout Africa (IBPGR 1984, Pratt and Gwynne 1977). Plant growth form varies from spreading to erect with culm height reaching 150 cm. This species grows abundantly in tropical, arid and semi-arid grasslands and bushlands in sandy, well drained soils with an annual precipitational requirement of 350 to 550 mm. C. ciliaris is a highly valuable forage grass (IBPGR 1984) because of its use by an array of livestock and wildlife (Herlocker and Kuchar 1986, Pratt and Gwynne 1977, Thurow et al. 1987). Grazing animals accept young, succulent tissue readily while old, mature tissue is usually refused. Green herbage protein varies from 6 to 16 % (Buuh, Gahir and Barker 1986, IBPGR 1984).

As an important forage species, C. ciliaris plants should be kept vigorous and productive for livestock and wildlife use. If a sustained, high rate of herbage yields are to be maintained, its adaptability to grazing frequency and intensity must be understood. A study was therefore initiated to evaluate whether defoliation by clipping will decrease C. ciliaris dry-herbage yield and subsequent tiller growth. Although foliage removal by clipping does not simulate ungulate grazing, it does provide an indication of a plant species response to defoliation (Jameson 1963).

METHODS

Cenchrus ciliaris plants growing in sandy soil were collected on 1 February 1986 from a grazing exclosure near Mogadishu, Somalia. Fifty dormant plants approximately the same size were collected. The roots and shoots were pruned to a uniform length of 6.0 and 2.5 cm, respectively. Plants were then transplanted into 30 cm tall, 25 l plastic buckets containing sandy soil. Holes were punched in the bottoms of the buckets to allow water drainage. Plants were watered initially with 2.0 l of water and then watered with approximately 1.0 l every 3 or 4 days thereafter. Plants were fertilized once with N:P:K (8:8:8) granular fertilizer at a rate of 500 g/m^2. The study occurred during Somalia's longest rainy season (Gu') when the plants would normally be growing. The study was designed to evaluate C. ciliaris dry-herbage yield under favorable growing conditions. Therefore, no attempt was made to simulate natural precipitational events.

Clipping experiment

The clipping experiment began on 6 March 1986 when all plants were clipped to 2.5 cm. Three clipping frequency and two clipping intensity treatments, replicated six times, constituted the completely randomized, factorial design. The frequency treatments consisted of clipping at biweekly and monthly intervals and no foliage removal (control). Clipping intensity consisted of 30 and 60% foliage removal which represented clipping plants to a height of 5.0 and 2.5 cm, respectively (Kidar and Barker 1986). At each clipping period, removed foliage was placed into paper sacks, oven-dried at 80 C for 48 h, and then weighed to assess total plant production. On 5 May, when the control plants were in seed dispersal, all plants were clipped to a 2.5 or 5.0 cm height depending on their respective treatment. The resulting data were analyzed using analysis of variance

Authors are ecologist, National Range Agency/Central Rangeland Development Project and Professor, Faculty of Agriculture, Somali National University, Mogadishu, Somalia.

and Newman-Kuels multiple mean comparison test (Anderson and McLean 1974).

Regrowth experiment

This experiment was designed to evaluate plant regrowth and recovery immediately after the clipping experiment. However, no clipping occurred until 16 June when all plants were defoliated to a height of 2.5 cm after six weeks of growth. At this time the control plants were in the seed dispersal stage. The removed foliage was placed into paper sacks, oven-dried at 80 C for 48 h and weighed. Tiller growth rates were measured throughout the regrowth experiment. Four tillers per plant were tagged on 5 May for measurement. Growth rates were obtained by measuring length of the selected tiller from the base to the apex. Measurements occurred on 5, 10, 13, 18, 26 May and 2, 10, 16 June. Data were analyzed using analysis of variance and Newman-Kuels multiple mean test. Each observation date was independently analyzed.

RESULTS

Clipping experiment

The clipping frequency and intensity treatments significantly influenced C. ciliaris dry-herbage yield (Table 1). Plants clipped every month produced the greatest herbage yield ($P<0.999$) while yields for plants within the biweekly and control treatments were considerably lower. Plants that received the 30% defoliation treatment produced significantly ($P<0.975$) more herbage than the 60% defoliated plants. In addition, the frequency-intensity interactions were significant ($P<0.95$). Cenchrus ciliaris plants with the greatest herbage yield were defoliated 30% every month while the lowest yielding were the control plants.

Table 1. The influence of clipping frequency and intensity on Cenchrus ciliaris dry-herbage yields through one phenological cycle.

Factor	Yield, g
Frequency	
Control	11.8 b[1]
Biweekly	15.5 b
Monthly	23.8 a
Intensity	
30%	19.1 m
60%	14.9 n
Frequency and Intensity	
Control - 30%	13.4 yz
Control - 60%	10.2 z
Biweekly - 30%	15.1 y
Biweekly - 60%	15.9 y
Monthly - 30%	29.0 x
Monthly - 60%	18.6 y

[1] Means that are followed by a different letter were significant ($P<0.05$).

Regrowth experiment

Prior defoliation frequency significantly influenced (P<0.999) C. ciliaris herbage regrowth ability (Table 2). Herbage yield of the control and monthly defoliated plants were greater than the biweekly-clipped plants. Apparently, intensity of defoliation and the frequency-intensity interactions had little influence on dry-herbage yield.

Tiller growth rates were also significantly (P<0.999) influenced by the prior frequency of clipping treatments (Table 3). On 4 May, tiller lengths were equal in all three treatments. Thereafter, tiller growth rates of the control plants were the fastest and plants clipped biweekly were the slowest. The monthly clipped plants responded intermediately. On 16 June, tiller length for the control, biweekly and monthly clipped plants were 42.2, 24.2, and 36.0 cm respectively. Intensity of clipping and the frequency-intensity interactions were not significant.

DISCUSSION

A substantial body of literature on plant clipping experiments exists and shows that many factors influence plant regrowth after defoliation (Haferkamp 1982, Holshier 1945, Jameson and Huss 1959, Lang and Barnes 1945, McLean and Wikeem 1985, McNaughton 1979 Mohammad, Dwyer and Busby 1982, Sosebee and Weibe 1971, Taintan and Booysen 1965, Vogel and Bjugstad 1968). Such factors may include phenological stage, vigor of plant, physiological condition, environmental condition, plant genetics, and past defoliation history. One general principle seems consistent throughout the literature: Frequent, intense defoliation results in reduced herbage yields, plant vigor and perhaps plant death. However, research has shown that certain levels of defoliation may increase herbage yields (Buuh, Gahir and Barker 1986, Haferkamp 1982, McNaughton 1979, Mohammad, Dwyer and Busby 1982).

In the current study, plants that received 30% defoliation every month produced the greatest herbage yield while yields of the control and 60% defoliated were the lowest. Perhaps, herbage yields were stimulated by receiving the 30% defolation every month. Increased herbage yields may result from one or a combination of several mechanisms such as increased photosynthetic rates, reallocation of growth substrates from elsewhere in the plant, and improved plant water and nutrient relationships (McNaughton 1979). Furthermore, McNaughton (1979) reasons that when defoliation proceeds beyond an optimization point, herbage yields and survivability are reduced. McLean and Wikeem (1985) found this to be true with the cool season grass Agropyron spicatum.

The herbage yield and differential regrowth of C. ciliaris immediately following the clipping experiment may have resulted from differences in total nonstructual carbohydrates within the plants (Trlica 1977). Regrowth after defoliation seems to be slow for plants with suboptimal carbohydrate reserve levels. The biweekly-clipped plants probably reallocated photosynthetic substrates more often than plants in the other treatments to support foliage regrowth after defoliation. Therefore, nonstructual carbohydrates within the biweekly-clipped plants were not sufficient to support rapid tiller growth during the regrowth experiment. Several months of rest may be required for plants to replenish their carbohydrate resereves to optimal levels after severe defoliation (Trlica, Buwai and Menke 1977).

In addition, the frequent defoliation of the biweekly-clipped plants may have maintained a lower leaf area in comparison with the monthly-clipped and control plants (Jameson, 1963, Humphreys 1966). The low leaf area of the biweekly-clipped plants may have resulted in lower photosynthetic rates than the plants in the other frequency treatments. Thus, the low herbage yields of the biweekly-clipped plants.

Table 2. The forage regrowth ability of <u>Cenchrus</u> <u>ciliaris</u> through one phenological cycle after experiencing a clipping treatment.

Factor	Yield, g
Frequency	
Control	5.6 a[1]
Biweekly	3.0 b
Monthly	4.7 a
Intensity	
30%	4.9 m
60%	4.0 m

[1] Means that are followed by a different letter were significant (P<0.05).

Table 3. <u>Cenchrus</u> <u>ciliaris</u> tiller growth rates through one phenological cycle as being influenced by prior clipping frequency.

-Date-	----------Clipping Frequency---------		
1986	Control	Biweekly	Monthly
	----------Tiller lenght, cm-----------		
4 May	3.8 a[1]	3.8 a	3.8 a
7 May	13.9 a	5.8 c	9.7 b
10 May	16.5 a	6.8 b	10.7 a
13 May	28.8 a	9.8 c	18.8 b
18 May	34.3 a	10.3 c	23.5 b
26 May	36.9 a	11.8 c	25.8 b
2 June	39.1 a	17.4 c	29.2 b
10 June	39.8 a	21.9 b	32.5 a
16 June	42.2 a	24.2 b	36.0 a

[1] Means that are followed by a different letter within rows were significant (P<0.05).

Based on this experiment, <u>C.</u> <u>ciliaris</u> herbage yield should be favorable in a rotational grazing system. A rest period from grazing is required for this species to maintain its vigor and herbage yields. Continuous grazing would probably result in reduced herbage yields.

LITERATURE CITED

Anderson, V.L. and R.A. McLean. 1974. Design of experiments. Marcel Dekker, Inc., New York.

Buuh, B.B., M.J. Gahair and J.R. Barker. 1986. Response of four native grasses to clipping. Somali J. Range Sci. 1:19-24.

Haferkamp, M.R. 1982. Defoliation impacts on quality and quantity of forage harvested from big sacaton (Sporobolus wrightii Numro.). J. Range Manage. 35:26-31.

Herlocker, D. and P. Kurchar. 1986. Palatability ratings of range plants in Ceel Dhere and Bulo Burte Districts. Somalia National Range Agency Central Rangeland Development Project Tech. Rep. No 9.

Holschier, C.E. 1945. The effects of clipping bluestem wheatgrass and blue grama at different heights and frequencies. Ecology 26:148-156.

Humphreys, H.R. 1966. Pasture defoliation practice: A review. J. Aust. Inst. Agric. Sci. 32:93-105.

International Board for Plant Genetic Resources. IBPGR. 1984. Forage and browse plants for arid and semi-arid Africa. Royal Botanic Gardens, Kew.

Jameson, D.A. 1963. Evaluation of the response of individual plants to grazing. IN: Range research methods. United States Dept. Agric. Misc. Pub. No. 940.

Jameson, D.A. and D.C. Huss. 1959. The effect of clipping leaves and stems on number of tillers, herbage weights, root weights, and food reserves of little bluestem. J. Range Manage. 12:122-126.

Kidar, M.M. and J.R. Barker. 1986. Cenchrus ciliaris plant height-weight relationship. Somali J. Range Sci. 1:30-33.

Lang, R. and O.K.Barnes. 1945. Range forage production in relation to time and frequency of harvesting. Wyoming Agric. Exp. Stat. Bul. 253.

McLean, A. and S. Wikeem. 1985. Influences of season and intensity of defoliation on bluebunch wheatgrass survival and vigor in southern British Columbia. J. Range Manage. 38:21-26.

Mohammad, M., D.D. Dwyer, and F.E. Busby. 1982. Responses of crested wheatgrass and Russian wildrye to water stress and defoliation. J. Range Manage. 35:227-230.

McNaughton, D.J. 1979. Grazing as a optimization process: Grass-ungulate relationships in the Serengeti. The Amer. Nat. 113:691-703.

Pratt, D.J.and M.D. Gwynne. 1977. Rangeland Management and Ecology in East Africa. Robert E. Frieger Publ. Co., Huntington, New York.

Sosebee, R.E. and H.H. Weibe. 1971. Effect of water stress and clipping on photosynthate translocation in two grasses. Agron. J. 63:14-19.

Tainton, N.M. and P. Booysen. 1965. Growth and development in perennial veld grasses. I. Themeda traindra tillers under various systems of defoliation. South African J. Agric. Sci. 8:93-110.

Thurow, T.L. D. Herlocker, M. Shabanni, and B. Buh. 1987. Diets of large herbivores of the coastal plain of centeral Somalia. IN: Proc. Colloquio Produzione Foraggera in Somalia. Facolta Di Agraria, Universita' Nazionale, Somalia, Mogadishu.

Trlica, M.J. 1977. Distribution and utilization of carbohydrate reserves in range plants. IN: R.E. Sosebee (editor) Rangeland plant physiology. Society for Range Management, Denver.

Trlica, M.J., M. Buwai, and J.W. Menke. 1977. Effects of rest following defoliation on the recovery of several range species. J. Range Manage. 30:21-27.

Vogel, W.G. and A.J. Bjugstad. 1968. Effects of clipping on yield and tillering of little bluestem, big bluestem and Indiangrass. J. Range Manage. 21:136-140.

TRENDS AFFECTING LIVESTOCK HERD CHARACTERISTICS ON THE NORTHERN RANGELANDS OF SOMALIA

Mohamed A. Ahmed and Thomas L. Thurow

Pastoralism in Somalia is in a state of transition. The traditionally conservative pastoral lifestyle is faced with adapting to several dramatic changes that have altered the constraints that for many centuries influenced the strategy and form of Somali pastoralism. In the past 30-40 years several development programs have had significant implications for the pastoral society. Human health care has significantly lowered mortality primarily through successful vaccination campaigns and provision of disaster relief grain supplies to avert starvation during periods of prolonged drought. Veterinary supplies have in some localities also aided livestock health. Water development programs have established many new water sites. The combined impact of these factors has enabled a significant increase in the human and livestock population. The ramifications of these developments are that the traditional controlling factors under which the pastoral society has evolved have changed. Historically, the scarcity of dry season water supply and the almost complete dependence of the sparce human population on livestock products influenced herd composition, size and stocking rate. As these factors have changed so have the characteristics of the livestock holdings. The objective of this paper is to discuss some of the changes in livestock herd composition, size and stocking rate that have occurred over the past 40 years.

METHODS

Data was collected from nomads in the Banka-touyo and Iiaghuha regions of the inland plateau of northern Somalia (9°N, 44°E). The vegetation of the study site was characterized as Acacia bussei open woodland (Hemming 1970). Dominant herbaceous vegetation was Chrysopogon plumulosus, Sporobolus maraginatus and Veronica cinerascene. Rainfall is erratic, averaging 200-300 mm/yr and is restricted to two rainy seasons (April - May and November). Livestock herds in the region were primaily composed of camels, sheep and goats.

Pastoralists were interviewed regarding their herd practices and decision making strategies. Interviews were conducted both in the bush and at tea shops where elders gathered. Questions relating to camel husbandry were directed to male elders whereas much of the detailed sheep and goat information was obtained from female herders. The reason for this approach was that camel herding was the duty of males while sheep and goat husbandry was the main occupation of the females and children. Males make the principal decisions regarding all livestock but the day to day details of small stock care are left to the women. The support of the regional nomad leaders was instrumental in obtaining cooperation from the pastoralists.

In addition to interviews, detailed information was obtained through access to the account books of a trader involved in the regions livestock commerce since the mid-1950's.

The authors are respectively Range Specialist, CARE-Somalia and Professor of Range Science, Faculty of Agriculture, Somalia National University. This paper presents part of the senior author's B.S. thesis conducted at the Faculty of Agriculture.

RESULTS AND DISCUSSION

The herd composition and size has markedly changed over the past 40 years (Table 1). Small stock per herd have stayed relatively constant over time but the number of camels per herd has declined. This has resulted in an increase in the relative percent of small stock per herd. The decrease in the number of camels per herd also has resulted in a decrease of standard stock units per herd. A standard stock unit (SSU) is defined here as being equivalent to 1 camel or 2 cattle or 10 sheep or goats (Brown 1971). This decrease in overall herd size is attributable to the fact that as human population has increased livestock wealth has been dissipated among the increasing numbers of heirs, resulting in the creation of many small herds instead of a few large herds. The reason for the decrease in the numbers of camels per herd may also be related to several other factors listed below:

1) Water development programs have made it easier to keep small stock. Historically, the shortage of dry season water sites required that livestock be able to sustain long periods without access to water. Often it was necessary to travel long distances between water points. Camels were the type of livestock best suited for living within the range resource constraints. Over the past 20 years water development programs, in the form of bore holes and water catchment reservoirs, have increased the number of water sites. Also, the increase in roads makes it possible for water to be trucked into areas where water is needed or allows small stock to be trucked out to areas where water and forage are available. These developments give the pastoralist the option to raise goats and sheep in areas where historically limited water supplies restricted small stock husbandry.

2) The diet of the pastoralist has undergone a major shift over the past 40 years (Table 2). Historically, grain supplies were limited and unreliable. Consequently, a pastoralists life depended upon obtaining food directly from his livestock. Milk was the major component of the diet. Because survival in the dry season was dependent upon obtaining milk, camels were valued livestock since their lactation period is 12 - 18 months and they will continue to produce milk throughout the dry season. Milk availability throughout the year became less crucial as grain supply became increasingly available and affordable.

3) Camels are a large capital investment, therefore selling a camel is a major financial transaction. In contrast, small stock may be easily sold to provide money needed for small financial needs.

4) The lack of refrigeration makes butchering camels much less efficient than butchering a goat or sheep that may be consumed by a family in 1-2 days.

Table 1. Change in herd size and composition between 1946 and 1986.

	CAMEL		SHEEP		GOATS		TOTAL
Year	SSU	% of herd	SSU	% of herd	SSU	% of herd	SSU
1946	40	76.9	9	17.3	3	5.8	52
1956	40	76.9	8	15.4	4	7.7	52
1966	26	71.2	8	21.9	3	6.9	37
1976	26	66.7	10	25.6	3	7.1	39
1986	20	60.6	11	33.3	2	6.1	33

Table 2. Change in pastoralist diet (%) between 1946 and 1986.

	1946	1986
Milk	61	30
Meat	33	23
Grain	5	42
Fruit and Vegetables	1	5

Table 3. Change in livestock prices between 1962 and 1986.

Year	Camel Price (Somali Shillings)	Sheep & Goat Price (Somali Shillings)	Price Ratio Sheep & Goat : Camel
1962	150	10	15
1967	300	20	15
1972	600	40	15
1977	3000	200	15
1982	5000	820	6
1986	35000	6000	5.8

5) The export market is much wider for goats and sheep than it is for camels.

6) The role of camels as a commodity in which to store capital is reduced. Historically, camel ownership was the dominant form by which status and wealth was measured. Payment in camels was required for bridal doweries, feud settlement etc. Now, however, money, trucks, reservoir ownership, etc. are increasingly recognized signs of status and wealth.

In response to a combination of all these factors, camel value relative to the value of small stock has declined over the past decade (Table 3).

The greater role of small stock in the pastoral society and the importance of small stock for export markets has created an emerging group of pastoralists (trader pastoralists) which specialize in producing small stock for export markets. The percentage of the trader pastoralists herd marketed per year (about 35% of the herd) is two to three times that of the traditional pastoralist. The emphasis of the trader pastoralist is to accumulate large herds, fatten them quickly and market them. To accomplish this, they buy young male sheep and goats from traditional nomads. The trader pastoralists often own trucks to facilitate transport of their stock to suitable grazing areas or to market. Trucks also facilitate transport of grain or water out to the rangeland where these commodities can be traded directly for livestock. Trader pastoralists also often invest in private water reservoirs (barkads) which enable them to buy and water livestock during the dry season when livestock prices are low. Traditional pastoralists concentrate on milk production and building herd size rather then gearing their operation for meat production. Consequently traditional pastoralists maintain herds with a large percentage of females.

The impact that increasing human population and water availabiltiy have on the compositon and size of the livestock herds has many implications for range resource planning. In terms of species composition, this is especialy true since camels have quite different land use impacts then do sheep and goats. Camels have padded feet which do not disturb the soil surface as much as the sharp-hooved goats and sheep. Goat and sheep tend to clip the herbaceous forage very short. Repeated intense grazing (as often occurs on dry season pasture) often causes long-term damage to the forage resource and may accelerate soil erosion. Camels however have the ability to forage at much greater distances from the well sites, therefore their impact is dissipated over a larger area. Also, camels can subsist on a wide variety of browse in the shrub canopy, thus the foraging patterns of camels are less disruptive to the herbaceous vegetation which stabilizes the fragile soil surface of the arid rangelands. The camels versatility in coping with drought is also an important asset in regions where periodic severe droughts occur. In terms of herd size, more people owning smaller herds creates increased vulnerability to drought since the families livelihood may drop below subsistance needs if only a small portion of the herd dies. The ramifications of these trends must be considered when planning future long-term range development programs.

Literature Cited

Brown, L.H. 1971. The biology of pastoral man as a factor in conservation. Biological Conservation 3:83-100.

Hemming, L.F. 1970. Ecological and grazing survey of the Somali Democratic Republic. FOA, AGP:DP/SOM. Rome.

THE RELATIONSHIP BETWEEN STANDING CROP AND VARIOUS DIMENSION MEASUREMENTS OF CENCHRUS CILIARIS AND INDIGOFERA TINCTORIA

Abdullahi M. Ali and Hussein I. Ali

The prime use of most of the semi-arid rangeland in Somalia is to provide grazing forage for livestock. One of the key pieces of information needed to determine the stocking rate potential is an estimate of vegetal standing crop. Manpower and logistic constraints make intensive clipping studies impractical over much of the remote rangelands. Therefore, it is desirable to develop a method to quickly but accurately estimate standing crop biomass of some of the major forage species.

Numerous studies have tried to develop indicies for predicting standing crop through use of various dimension analyses (Rittenhouse and Sneva 1977, Andrew et al. 1981). Some of these dimensions are much easier and faster to measure compared to clipping. Thus by understanding the relationship between plant dimension and standing crop, estimates can be made in a manner which is more cost and time efficient. The objective of this research was to measure a variety of dimensions on forage plants and determine the correlation between those dimensions and standing crop. Two important forage species for livestock on the rangelands near Mogadishu, Somalia were chosen for study: Cenchrus ciliaris (a bunchgrass) and Indigofera tinctoria (a woody forb).

METHODS

Data were collected on rangeland sites near Mogadishu and Afgoi, Somalia (2^oN; 45^oE). The soil texture was sand. Rainfall on the sites averages about 450 mm/yr and is concentrated in two seasons (April to June and November to mid-December). Growing season measurements of 50 individual plants of Cenchrus ciliaris and 50 individual plants of Indigofera tinctoria were collected on December 8, 1985, and another 50 individuals of each species was collected on May 5, 1986. The plants were selected by randomly chosing points on the rangeland and then measuring the nearest individual of each of the study species. Measurements taken on Indigofera tinctoria individuals included height, crown volume (estimated using the oblate spheroid formula: $V=4/3\pi h^2d$), area of canopy cover and standing crop (oven-dried at 60 C for 48 hours). Measurements taken on Cenchrus ciliaris individuals included height, basal area, number of culms per plant and standing crop (oven-dried at 60 C for 48 hrs). The information sets were not significantly different between the two sample periods ($P>0.05$) so these data were pooled for regression analysis. Regression analysis was conducted to determine the relationship of standing crop to each of the other measured parameters.

RESULTS AND DISCUSSION

The results of the measurements and the regression analysis are shown in Tables 1 and 2. None of the measured variables were strongly correlated with standing crop. Hence, none of the parameters serve as good predictors of standing crop. This is not suprising since variables such as height and crown volume may be influenced by a variety of biotic and abiotic factors that may alter the dimensions of the plant more than their affect on

---

This research was conducted while the authors were students of the Botany and Range Science Department, Somali National University. Thanks are extended to F. Thetford and S. Young who were advisors for the research.

Table 1. Mean and range of measured parameters of Cenchrus ciliaris and the correlation of standing crop with each of the variables.

	Mean	Range	Standing Crop Correlation Coefficient	Regression Equation
Standing crop (g)	27.6	(0.2 - 50.7)		
Height (cm)	45.4	(19.1 - 71.1)	.48 *[1]	Y = -5.1 + 0.34 X
Basal area (cm^2)	123.1	(1.8 - 361.0)	.55 *	Y = 1.6 + 0.14 X
Number of culms per plant	47.2	(2 - 134)	.71 *	Y = 2.8 + 0.30 X

[1] (*) indicates value was significant ($P<0.05$).

Table 2. Mean and range of measured parameters of Indigofera tinctoria and the correlation of standing crop with each of the variables.

	Mean	Range	Standing Crop Correlation Coeficient	Regression Equation
Standing crop (g)	43.5	(1.6 - 94.5)		
Height (cm)	51.9	(23.0 - 110.8)	.56 *[1]	Y = -22.6 + 0.87 X
Basal canopy cover (m^2)	0.32	(0.02 - 0.89)	.64 *	Y = 2.6 + 58.4 X
Crown volume (m^3)	0.72	(0.02 - 2.34)	.28	Y = 4.1 + 32.8 X

[1] (*) indicates value was significant ($P<0.05$).

standing crop (Murry and Jacobson 1982). The highest correlation with Cenchrus ciliaris standing crop was the number of culms per plant. Culm production is probably an indication of vigor; a vigorous growing plant being expected to produce more culms and more standing crop. Counting culms, however, is not a time efficient way of estimating biomass. Canopy cover had the highest correlation with biomass for Indigofera tinctoria and basal cover had a slightly lower correlation for Cenchrus ciliaris. Thus, cover estimates appear to be of moderate utility for obtaining a rough estimate of standing crop.

LITERATURE CITED

Andrew, M.H., I.R. Noble, R.T. Lang and A. Johnson. 1981. The measurement of shrub forage weight. Australian Range Journal 3:74-82.

Murry, R.B. and M.Q. Jacobson. 1982. An evaluation of dimension analysis for predicting shrub biomass. Journal of Range Management 35:451-455.

Rittenhouse, L.R. and F.A. Sneva 1977. A technique for estimating big sagebrush production. Journal of Range Management. 30:68-71.