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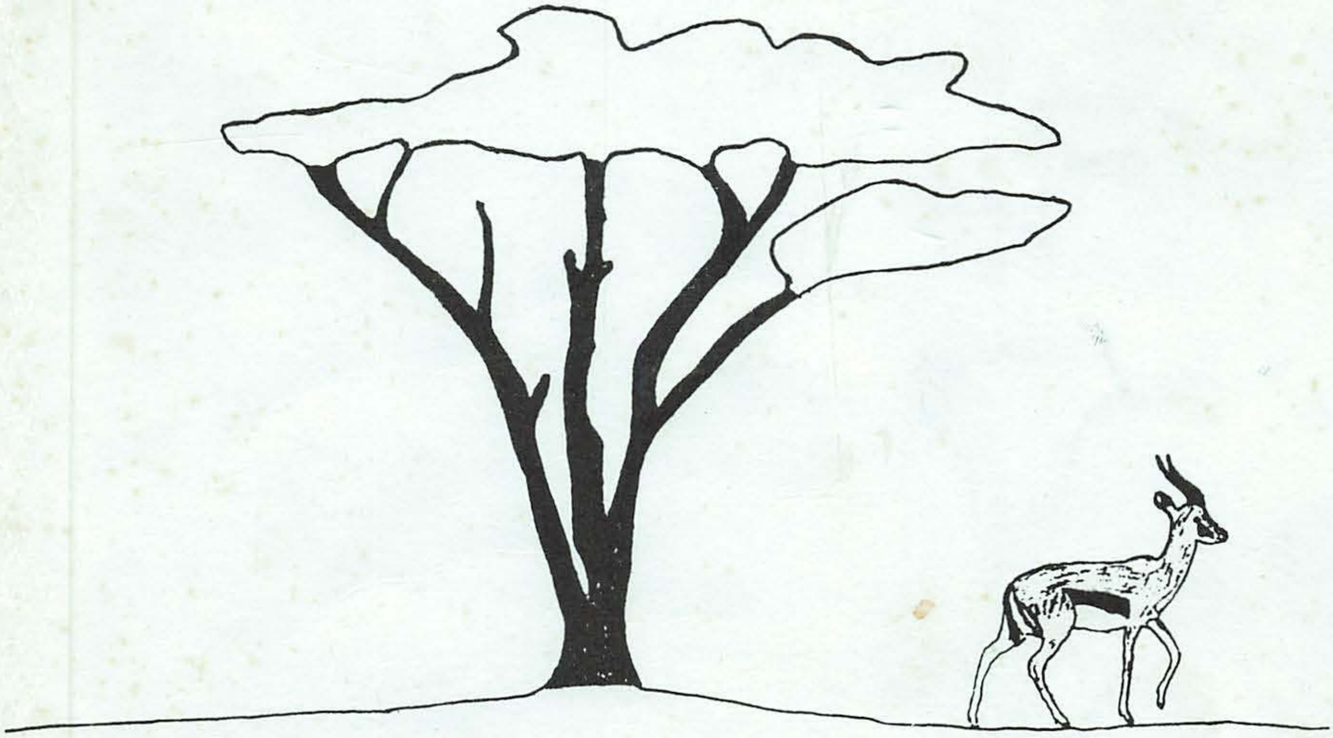

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SOMALI JOURNAL OF RANGE SCIENCE VOLUME 2, NUMBER 1

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 October 1, 1987.

UPLAND GAMEBIRD POPULATION DENSITY AND HABITAT PREFERENCE NEAR AFGOI, SOMALIA

A.N. Abu and T.L. Thurow

Very little is known about the upland gamebirds of Somalia. Indeed, for Africa as a whole information available for most species of gamebirds is confined to anecdotal observations which are summarized in the species discriptions of field guides (cf. Mackenworth-Praed and Grant 1957, and Williams and Arlott 1983). The approximate distribution within Somalia of all species of birds is summarized by Ash and Miskell (1983).

The objective of this research was to document the density and habitat preferences of the upland gamebird population on the rangeland and cultivated areas near Afgoi, Somalia. Within the broad context of upland gamebirds we included members of the following families: Phasianidae, Numididae, Turnicidae, Otididae, Charadriidae, Burhinidae and Pteroclididae.

Study Area

The study site was located 5 Km southwest of Afgoi, Somalia (2^{0} 10'N, 45^{0} 05'E). Rainfall averages about 500 mm per year. Precipitation is bimodal with significant rainfall restricted to the periods of April - June (Gu'), and October - December (Dayr). The dry periods are January - March (Jiilaal) and July - September (Xagaa). Three habitat sites were located on the study site: an area on which maize and sorgham was cultivated, an uncleared shrubland and a site on which much of the shrub cover had been cleared.

The cultivated site was on a clay-loam soil. Corn and sorgham were planted at the beginning of each rainy season. These crops (both the grain and the crop residue) were completely harvested at the beginning of the dry season. Thus, crops were present from April - July and October - December. The remaining portions of the year the fields were devoid of plant cover.

The rangeland sites were heavily grazed by cattle and goats. The soil texture was sand. The uncleared shrubland had a shrub canopy cover of approximately 80% with a mean canopy height about 5 m. Dominant shrub species were Acacia nubica, Acacia nilotica, Acacia tortilis, and Acacia horrida (Ibrahim and Barker 1986). Herbaceous cover was sparce and was primarily composed of short lived annual forbs such as Commelina foreskali and small bunches of Aristida adscensionis and Cenchrus ciliaris.

Much of the original shrub cover on the partially cleared shrubland site was removed with bulldozers and hand clearing in 1977 and 1983. These brush removal efforts were not completely effective. Shrub canopy cover was about 20% with a mean canopy height of about 1.5 m. The dominant shrub species were Dichrostachys cineria, Solanum coagulans, Acacia nubica, and Acacia senegal. Herbaceous cover greatly varied between the seasons. In the rainy seasons herbaceous cover was 95% and was dominated by short lived annual forbs such as Commelina foreskali, Priva adhaensis and Ipomea sp. and grasses such as

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Aristida adscensionis, *Cynodon dactylon*, *Dactylactenium scindicum*, and *Cenchrus ciliaris*. In the dry season herbaceous cover decreased to about 10%.

METHODS

A census route was established in each of the three habitat types. The length of the transects were 1.5 Km on the uncleared shrubland, 2 Km on the partially cleared shrubland and 3 Km on the cultivated fields. Three strip censuses were conducted in each habitat type in each season. Census routes were walked between dawn and 8:30 A.M., thus only one or two census routes were walked on any particular day. Dates during which the censuses took place were December 3 - 16, 1985 (Dayr), February 9 - 20 (Jiilaal), June 5 - 21 (Gu') and August 2-13 (Xagaa). Flushing distance and species was recorded for each individual sighted. Population density for each species was calculated according to the strip census method of Hayne (1949). In addition observations on breeding activity were recorded.

RESULTS

Ten species of upland gamebirds were observed during the course of walking the census routes. The estimated population density of each of these species in each habitat type for each season is presented in Table 1. In addition, a covey of six vulturine guinafowl (*Acryllium vulturinum*) was sighted once on the uncleared shrubland site although this species was never recorded on the census routes.

Nesting activity for all species of upland gamebirds appeared to be correlated to the anticipation of or onset of the rainy seasons. Two spotted thicknee clutches were found. Each clutch consisted of two eggs. The eggs were layed directly on the ground with no evidence of any attempt to form a nest scrape or re-arrange pebbles. Both clutches were located under *Acacia nubica* trees of about 3 m height. The clutches were found on October 14, 1985 and April 5, 1986. Thus, both clutches were layed several weeks before the onset of the rains. One parent incubated the eggs while the other parent remained in the vicinity of the eggs (usually 5-15 m away). It was the non-incubating bird who would first expose itself in an attempt to decoy the intruder away from the nest. The incubating bird would remain motionless on the eggs but would flush if the intruder approached nearer than about 5 m from the nest. The chicks of one clutch hatched (April 18, 1986) within several days of the onset of the rains. The eggs of the other clutch disappeared with no evidence that the young had hatched. The chicks and parents of the successful clutch were sighted within about 50 m of where the eggs were layed for the first four weeks. After that time their movements were not able to be distinguished.

Breeding displays of the buff-crested bustard were observed in early March, 1986, approximately 6 weeks before the onset of the Gu' rains. Broods of one or two chicks were observed in both the Dayr and Gu' seasons. One nest of the black-headed plover was found on March 28, 1986 about three weeks before the onset of the rains. The shallow nest scrape was located in an open sandy area and contained a single egg laid. Often the egg was partially buried in the sand by the adult during the heat of the day. Broods of one or two chicks of both the black-headed plover and crowned plover were observed in both the Dayr and Gu' rainy seasons.

On the strip censuses conducted throughout the study seven species were sighted in the thick bush, ten species were sighted in the open bush and three species were sighted in the cultivated fields. The Shannon-Weiner function of species diversity was greatest in the partially cleared shrubland (H=2.78; E=0.84). Species diversity was lowest on the cultivated fields (H=0.91; E=0.58). The species diversity of the uncleared site was intermediate in comparison with the diversity of the other two habitats (H=1.99; E=0.71).

Table 1. Population density (individuals/Km^2) for each species in each habitat type and season.

	UNCLEARED SHRUBLAND	PARTIALLY CLEARED SHRUBLAND	CULTIVATED FIELD
Crested Francolin (Francolinus sephaena)			
DAYR	35	37	0
JIILAAL	0	46	0
GU'	23	9	9
XAGAA	0	0	0
Harlequin Quail (Coturnix delegorguei)			
DAYR	0	12	0
JIILAAL	0	0	0
GU'	25	0	0
XAGAA	0	0	0
Yellow-necked Spurfowl (Francolinus leucoscepus)			
DAYR	0	7	0
JIILAAL	0	0	0
GU'	0	0	0
XAGAA	0	0	0
Buff-crested Bustard (Eupodotis ruficrista)			
DAYR	52	26	0
JIILAAL	37	31	0
GU'	59	16	0
XAGAA	8	15	0
White-bellied Bustard (Eupodotis senegalensis)			
DAYR	0	10	0
JIILAAL	0	0	0
GU'	0	0	0
XAGAA	0	0	0
Black-headed Plover (Vanellus tectus)			
DAYR	301	63	15
JIILAAL	79	89	5
GU'	214	110	36
XAGAA	16	53	25
Senegal Plover (Vanellus lugubris)			
DAYR	0	0	0
JILLAAL	0	0	0
GU'	84	0	0
XAGAA	0	0	0
Crowned Plover (Vanellus coronatus)			
DAYR	24	26	0
JILLAAL	63	95	13
GU'	40	21	0
XAGAA	0	5	0
Spotted Thicknee (Burhinus capensis)			
DAYR	31	44	0
JIILAAL	0	6	0
GU'	0	11	0
XAGAA	0	28	0
Black-faced Sandgrouse (Pterocles decoratus)			
DAYR	18	6	0
JIILAAL	0	22	0
GU'	0	17	0
XAGAA	22	161	0

DISCUSSION

Crested francolin, buff-crested bustard, black-headed plover, crowned plover, spotted thicknee and black-faced sandgrouse were recorded on the study site in every season of the year and may be considered residents. The Harlequin quail and Senegal plover were only present on the study area during the rainy seasons, implying they may be seasonal migrants. The combination of both a resident population and migrant population is the probable explaination for the increase in density of black-headed plover during the rainy seasons. The large increase of black-faced sandgrouse during the Xagaa season reflected the brief influx of large flocks into the region for several weeks during the census period.

One yellow-necked spurfowl and a pair of white-bellied bustards were both only sighted once. These species are not known for migratory habits; the infrequency of sightings probably indicates that these species were present as residents, but at a very low density. The same is probably true for the flock of vulturine guineafowl which was sighted on the study area but not during a census period.

Buff-crested bustard and black-headed plover population densities were clearly highest in the uncleared shrubland. The apparent anomoly of a plover preferring uncleared shrubland is explained by the fact that this species was usually confined to the small openings in that habitat type. In addition, the only sighting of vulturine guineafowl was in the uncleared shrubland.

The crested francolin, white-bellied bustard, senegal plover, crowned plover, spotted thicknee and black-faced sandgrouse all had higher population densities associated with the partially cleared shrubland. This probably reflected the effect of greater herbaceous species diversity and production in the partially cleared shrubland. Also the scattered, low growing shrubs may have provided a more prefered form of cover.

The cultivated fields were apparently a marginal habitat for all the species of upland gamebirds since each species had either a lower population density compared to the rangeland or were completely absent from the site. The low species abundance and population densities on the cultivated field habitat type are probably a function of monotypic cropping during the wet season and removal of all cover during the dry season.

Species diversity and density were consistently higher for all species on rangeland sites. This implies that rangeland habitat which provides native cover and food is important for upland gamebird maintenance in contrast to the monotypic planting practices and lack of native cover on the cultivated sites.

LITERATURE CITED

Ash, J.S. and J.E. Miskell, 1983. Birds of Somalia. English Press, Nairobi. 97 p.

Hayne, D.W. 1949. An examination of the strip census method for estimating animal populations. Journal of Wildlife Management. 13:145-157.

Ibrahim, M.A. and J.R. Barker. 1986. Pattern of Acacia distribution on a ranch near Afgoi, Somalia. Somali Journal of Range Sceince. 1:27-30.

Mackworth-Praed C.W. and C.H.B. Grant. 1957. Birds of eastern and northeastern Africa. Volume 1. Longmans, London. 836 p.

Williams J.G. and N. Arlott. 1980. A field guide to the birds of Africa. Collins, London. 415 p.

GERMINATION TRIALS OF THREE LEGUMINOUS RANGELAND PLANTS

Abdullahi Warsame Abdi and Jerry R. Barker

The poor and often erratic seed germination of many rangeland leguminous plants can be attributed to a physical dormancy resulting from a hard seed coat (Villiers 1972, Quinlivan 1966). An impervious seed coat inhibits water and gaseous exchange between the embryo and microenvironment. Thus the embryo does not receive the stimuli for germination to proceed (McDonough 1977).

Under natural conditions, a hard seed coat may be eroded by microbial action, wetting and drying cycles, alternating temperature regimes, abrasion, etc. (McDonough 1977, Villiers 1972). Such actions reduce the hardness of the seed coat allowing water and gaseous exchange to occur with subsequent embryo growth.

For range seeding projects to succeed, seeds must germinate rapidly after sowing to allow seedling establishment under favorable growing conditions (Guilliver and Heydecher 1973). Therefore, it is economical to treat the seeds of leguminous plants before sowing to improve their percent germination (PG) and mean germination time (MGT) (Doran et al. 1983). The purpose of this research was to investigate the influence sulphuric acid, water soaking and sandpaper rubbing has on improving the PG and MGT of _Acacia horrida_, _Acacia nubica_, and _Indigofera tinctoria_.

A. horrida subssp. _benadirensis_ (Chiov.) Hillcoat and Brenan, _A. nubica_ Benth., and _I. tinctoria_ L. were the species studied. _A. horrida_ (Somali = Sarman) is a large growing obconical shrub varying in height from 1 - 6 m. This subspecies is common in Somalia, Sudan, Ethiopia and Kenya growing on a variety of soils in arid and semi-arid range sites. This plant is of value for livestock and wildlife browse. _A. nubica_ (Somali = Gumar) is a large growing shrub from 1-5 m. This species is common throughout East Africa growing on a variety of soils in arid and semi-arid rangelands. The living plant gives off a strong oder when cut which is said to inhibit animal foraging. However, _A.nubica_ should be of value for rangeland rehabilitation projects and emergency forage. _I. tinctoria_ (Somali = Dharqo) is a shrubby herb from 0.5 - 1.7 m tall and grows on loamy, alluvial soils throughout central Africa. _I.tinctoria_ is a source of the dye indigo, forage for goats, and of value for rangeland rehabilitation projects such as sand dune stabilization.

METHODS

Seeds of the three species were collected at the Artificial Insemination Center, Afgoi the last week of November, 1985 from native populations. Seeds were hand cleaned and stored in paper bags at room temperature at the Faculty of Agriculture, Somali National University.

Preliminary trials conducted in January 1986 resulted in poor germination. Therefore, seeds were subjected to three scarification treatments: sulphuric acid soaking, water soaking, and sandpaper rubbing. Seeds of each species were placed into 95% sulphuric acid for 3, 6, and 9 minutes and then washed thoroughly with distilled water. The second treatment consisted of allowing the seeds to soak in hot or cool water (room temperature) for 24 hours. The hot water treatment was administered by adding the seeds to boiling water for approximately 30 seconds and then allowing them to soak as the water cooled to room temperature. For the final treatment, seeds were rubbed lightly with fine-textured sandpaper for periods of 2.5 and 5.0 minutes.

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After the scarification treatments were administered, 75 seeds per treatment were randomly selected for the germination trials. Plastic germination trays were utilized for the experiment. The trays were circular with a 300 ml water reservoir. The seeds rested on a raised, filter-paper covered platform with the water being wicked to them. The seeds were considered germinated when their radicals were visible. The sulphuric acid, water soaking and rubbing treatments were conducted as separate experiments.

A completely randomized design replicated three times was employed to evaluate the experiments. Cumulative germination data were reported as a percent for the 25 seeds per tray. The mean germination time for each treatment was calculated based on the summation of the number of seeds germinated per day multipled by day of germination and then divided by total germination number (Call 1986). Cumulative percent germination data were transformed with the arcsine transformation.

RESULTS

Seed PG and MGT for *A. horrida*, *A. nubica*, and *I. tinctoria* was influenced by the sulphuric acid treatments (Table 1). Seeds of *A. nubica* had a significiantly greater PG

Table 1. The influence of sulphuric acid soaking on percent germination and mean germination time (MGT) of *Acacia horrida*, *Acacia nubica*, and *Indigofera tinctoria* seed.

Parameter	Germination (%)	MGT (days)
Species		
Acacia horrida	9.3b[1]	2.7b
Acacia nubica	27.0a	5.1a
Indigofera tinctoria	10.3b	2.9b
Treatment		
Control	36.4m	7.6m
3 minutes	7.6n	2.1n
6 minutes	8.9n	2.9n
9 minutes	9.3n	1.6n
Interactions		
Acacia horrida-control	37.3x	10.8w
Acacia horrida-3 minutes	0z	0z
Acacia horrida-6 minutes	0z	0z
Acacia horrida-9 minutes	0z	0z
Acacia nubica-control	36.0x	5.5xy
Acacia nubica-3 minutes	20.0y	4.5xy
Acacia nubica-6 minutes	24.0y	5.5xy
Acacia nubica-9 minutes	28.0xy	4.9xy
Indigofera tinctoria-control	36.0x	6.5x
Indigofera tinctoria-3 minutes	2.7z	1.7z
Indigofera tinctoria-6 minutes	2.7z	3.3y
Indigofera tinctoria-9 minutes	0z	0z

[1]Those means followed by a different letter within columns were significantly different ($P<0.05$).

than the other two species, overall. However, the MGT of A. horrida and I. tinctoria was faster than A. nubica. Soaking the seeds of the three species for 3, 6, or 9 minutes in sulphuric acid significiantly reduced PG and MGT below the control seeds. This trend is further certified in the species-treatment interaction except for A. nubica. A. nubica seed soaked for 9 minutes in sulphuric acid was statistically the the same as the control seeds. Also, the sulphuric acid treatments did not reduce MGT of A. nubica.

Overall, soaking seeds in hot water significantly improved PG and MGT regardless of species (Table 2). The cool water treatment reduced MGT but not PG when compared with the control seeds. Apparently, the water scarification treatments had little influence on PG and MGT of the three species or species-treatment interaction.

Table 2. The influence of water soaking on percent germination and mean germination time (MGT) of Acacia horrida, A.nubica, and Indigofera tinctoria seed.

Parameter	Germination (%)	MGT (days)
Species		
Acacia horrida	34.2a[1]	6.1a
Acacia nubica	36.2a	5.2a
Indigofera tinctoria	35.1a	5.3a
Treatments		
Control	31.6m	6.1n
Hot water	40.0n	4.9m
Cool water	34.2m	5.6nm
Interactions		
Acacia horrida-control	32.0x	5.9x
Acacia horrida-hot water	37.3x	6.1x
Acacia horrida-cool water	33.3x	6.3x
Acacia nubica-control	30.7x	5.7x
Acacia nubica-hot water	42.7x	4.8x
Acacia nubica-cool water	36.0x	5.0x
Indigofera tinctoria-control	32.0x	6.7x
Indigofera tinctoria-hot water	40.0x	3.7x
Indigofera tinctoria-cool water	33.3x	5.4x

[1] Those means followed by a different letter within columns were significantly different ($P < 0.05$).

The sandpaper rubbing scarification treatments resulted in significant differences in PG and MGT among species, treatments, and their interactions (Table 3). I. tinctoria seed had a greater PG and faster MGT than A. horrida or A. nubica. Rubbing the seeds with sandpaper resulted in greater PG and faster MGT than the control seeds regardless of species. However, each species responded differently to the sandpaper treatments. The treatments had no effect on improving A. horrida seed PG but MGT of seeds rubbed for 5.0 minutes was significiantly reduced. Likewise, the PG of A. nubica seed was not significiantly different from the control treatment.

Table 3. The influence of sandpaper rubbing on percent seed germination and mean germination time (MGT) on Acacia horrida, Acacia nubica, and Indigofera tinctoria seed.

Parameter	Germination (%)	MGT (days)
Species		
Acacia horrida	47.5a[1]	6.0a
Acacia nubica	43.1a	6.2a
Indigofera tinctoria	64.0b	3.5b
Treatment		
Control	42.2m	6.3m
2.5 minutes	53.3n	4.9n
5.0 minutes	59.1n	4.5n
Interaction		
Acacia horrida-control	53.3yz	7.0x
Acacia horrida-2.5 minutes	44.0z	6.9x
Acacia horrida-5.0 minutes	45.3yz	4.1yz
Acacia nubica-control	33.3yz	7.2x
Acacia nubica-2.5 minutes	49.3yz	4.8y
Acacia nubica-5.0 minutes	46.7y	6.5x
Indigofera tinctoria-control	40.0yz	4.7y
Indigofera tinctoria-2.5 minutes	66.7yz	2.8z
Indigofera tinctoria-5.0 minutes	85.3x	2.9z

[1] Those means followed by a different letter within columns were significantly different (P<0.05).

However, A. nubica seeds that were rubbed for 2.5 minutes had a faster MGT than seeds in the other two treatments. I. tinctoria seed that received the 5.0 minute rubbing treatment had a greater PG than seeds in the other two treatments. Both the 2.5 and 5.0 minute rubbing treatments significantly lowered the MGT of I. tinctoria seed compared with the control treatment.

DISCUSSION

Treating seeds with concentrated sulphuric acid is a common procedure to remove dormancy resulting from the seed coat (McDonough 1977). However, in the current study the sulphuric acid treatments did not improve seed germination in any of the species. In fact, sulphuric acid significantly reduced PG below that of the control seeds for all species. Perhaps a treatment of 1.0 or 2.0 minutes would be adequate to improve the PG of A. horrida, A. nubica, and I. tinctoria. Embryo damage may result if seed is allowed to soak in sulphuric acid for long time periods. However, other researchers have used sulfuric acid successfully to improve leguminus seed germination (Blankership and Smith 1967, Call 1986, Doran et al. 1983, McDonough 1977). The sulphuric acid treatments did reduce the MGT of all species. However, such an effect is meaningless if PG is reduced to unacceptable levels.

Soaking leguminous seed in water is another effective method to improve seed germination (Doran et al. 1983). Such treatments were not very successful in the current study. However, the hot water treatment improved over-all seed germination by 21 percent over the control seeds while the cool water failed to improve germination. Doran (1983) points out that cool water is effective in improving germination only if the seeds are already permeable. On the other hand, hot water may remove the cutical and part of the seed coat resulting in improved germination.

The MGT of all species was improved by the water treatments regardless of species. Improved germination rates of rangeland seeds after receiving a presowing treatment such as water soaking may result from the advanced start they have in imbibing water and completion of pregerminative processes (Gulliver and Heydecker 1973).

The response of I. tinctoria PG to sandpaper rubbing was dramatic. Both A. horrida and A. nubica seed germination was not stimulated by the scarification treatment. Physical scarification such as hand rubbing with sandpaper aims to chafe the seed coat to allow water imbibment (Doran et al. 1983). Perhaps the seed rubbing treatment for A. horrida and A. nubica was not severe enough to abrade the seed coat. Doran (1983) recommends that the most effect abrasion for acacia seed is to scarify near the microphyle or near the cotyledon end.

The sandpaper rubbing treatment did improve the MGT for all three species. The MGT of A. horrida, A. nubica and I. tinctoria was reduced by the manual scarification. Even though this scarification treatment did not improve PG of A. horrida and A. nubica it still improved their MGT.

LITERATURE CITED

Blankership, I.O. and and D.R. Smith. 1967. Breaking seed dormancy in Parry's clover by acid treatment. J. Range Manage. 20:50.

Call, C.A. 1986. Storage life of Illinois bundleflower and western indigo seed. J. Range Manage. 38:500-503.

Doran,J.C., J.W. Trumbull, D.J. Boland, and B.V. Gunn. 1983. Handbook of seeds of dry-zone acacias. Food and Agriculture Organization of the United Nations, Rome, Italy. 92 pp.

Gulliver, R.L. and W. Heydecker. 1973. Establishment of seedlings in a changeable environment. p 433-462 In W. Heydecker (ed.), Seed ecology. Pennsylvania State University Press, University Park.

McDonough, W.T. 1977. Seed physicology. p 155-184 In R.E. Sosebee (ed.), Rangeland plant physiology. Society for Range Management, Denver, CO.

Quinlivan, B.J. 1966. The relationship between temperature fluctuations and the softening of hard seeds of some legume species. Aust. J. Agr. Res. 17:625-531.

Villiers, T.A. 1972. Seed dormancy. p. 220-281 In T.T. Kozlowski (ed.), Seed biology, Vol. II, Germination, control, metabolism, and pathology. Academic Press, New York.

RESPONSE OF VEGETATION OF THE ACACIA REFICIENS/DICHROSTACHYS SP. SHRUBLAND RANGE SITE TO LAND USE INTENSITY, CEEL DHERE DISTRICT, SOMALIA

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

Little is known about the ecology of Somalia's central rangelands, yet basic information about community dynamics is needed to understand the short-term and long-term vegetation responses that may be associated with rangeland projects. Such information is needed to determine whether the potential for improvement justifies a range development investment. It is then used to predict the results of a proposed development and to monitor its effectiveness. A considerable time period (years) is needed to document and describe vegetation community dynamics and their relationship to land use, climate, etc. In the meantime, however, decisions need to be made regarding current development programs. These decisions should be based on at least a preliminary understanding of rangeland vegetation dynamics. One way to obtain an initial understanding is to study vegetation community response to a gradient of land use intensity such as extends out from a major watering point (Graetz and Ludwig 1978, Foran 1980).

An objective of this research was to document vegetation community change along a continuum of land use intensity associated with distance from permanent water. The changes in plant community structure and composition approximate a retrogression sequence associated with increasing land use intensity. These data provide information on individual species responses that are needed to understand changes in range condition, trend and carrying capacity. The shortcomings of this approach are that past land use history is often not well documented nor is intensity of use necessarily a linear relationship with distance from the initial starting point. Nevertheless, until a long-term monitoring program begins to yield more precise data, gradient analyses are a useful starting point for building an understanding of the vegetation community dynamics associated with land use intensity.

STUDY AREA

The study site was a level to gently undulating shrubland dominated by Acacia reficiens and Dichrostachys sp. and located in the Ceel Dhere District of central Somalia (4°N, 47°E) (Fig. 1). The soil is very fine to fine, mildly alkaline reddish yellow sand (Tubea 1986). Soil depth ranged from 0 to 1.5 m overlying a limestone substrate (RMR 1979a). Rainfall averages about 250-300 mm/yr and is restricted to two seasons (April-May and November) (RMR 1979a). Annual precipitation amounts to only 3-20% of evaporative demand. Mean annual temperature is 20-30°C (UNESCO 1979). The wind system is monsoonal and is of great environmental importance, particularly the strong, dry southwestern wind of the Xagaa season (June-October) (UNSO 1984). Wind is the major erosive factor. Sand dunes and blow outs may consequently develop when vegetation is removed (Hemming 1972).

Pastoralism and farming were the two main land uses, with many people being engaged in both forms of land use (agropastoralism) (RMR 1979a, Holt 1985). Cattle, sheep, goats and camels were present on the rangeland; goats and camels were the most common livestock species in the dry season and goats and cattle were the most common livestock species in the wet season. The overall livestock stocking rate was about 3000 kg/km^2. Livestock density was 1.3-1.7 times greater in the wet season than in the dry season (RMR 1979b). Farms and enclosures fenced with cut thorn bushes occur throughout the range site but are most dense near Galcade, the only village in the study area. Cultivated fields were several hectares large and were used to produce primarily cow peas or sorghum. The duration of cultivation is approximately 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

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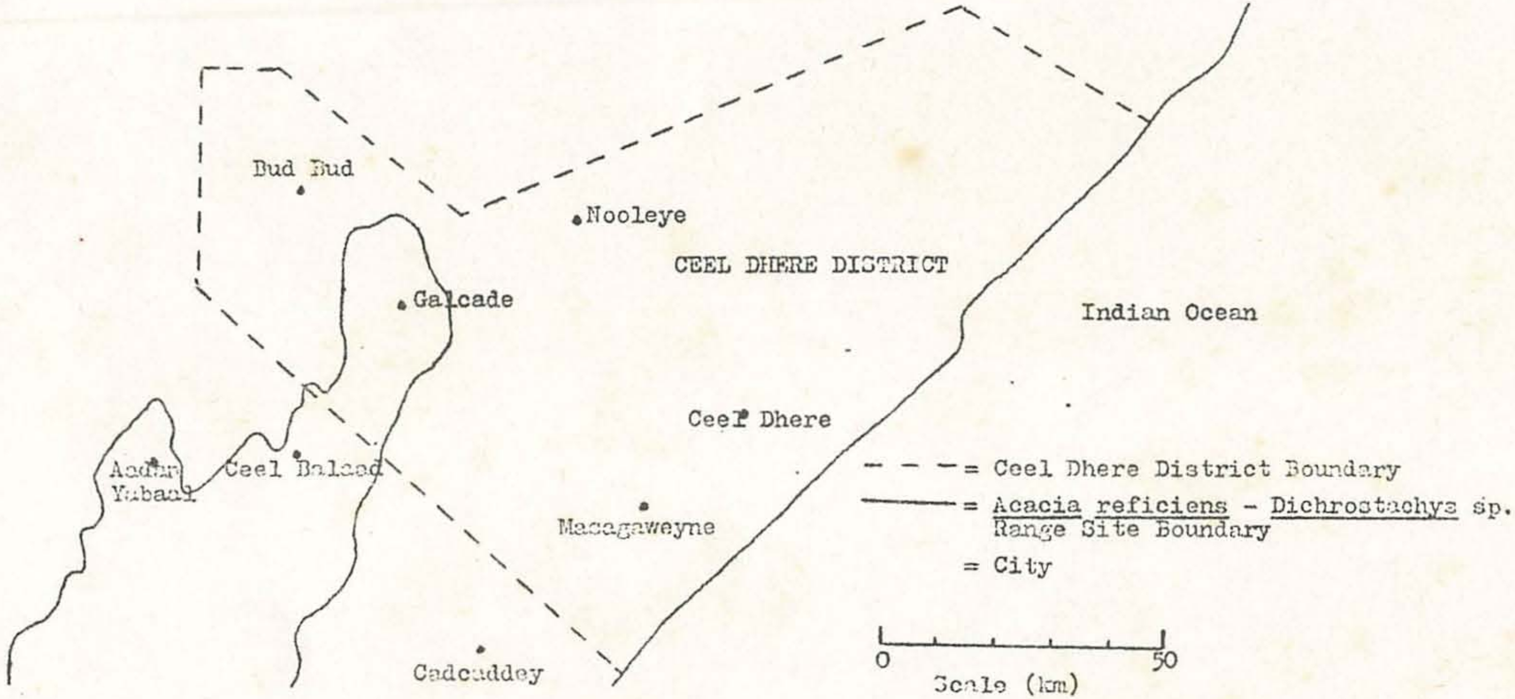

Figure 1. Map of the Ceel Dhere district and the <u>Acacia</u> <u>reficiens</u>/<u>Dicrostachys</u> sp. range site.

the specific history of use for any particular piece of land was often unknown. A successful water borehole was drilled in 1970 at Galcade, after which intensity of land use probably increased significantly. Two hand dug wells were also at the village. No other wells were present on the study site.

METHODS

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 0.2 to 3 km. Shrubs and dwarf shrubs were sampled by using 100 m^2 and 10 m^2 sized plots respectively. The plant height and crown diameter of each individual within the plot was measured and recorded by species. Species composition and foliage (aerial) cover of herbaceous vegetation were measured using a 10 m long point 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%).

Palatability ratings were estimated for many plant species by questioning nomads. All palatabilities referred to in this paper are from Herlocker and Kuchar (1986) unless otherwise stated. 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, herbaceous growth form and accumulated utilization rather than botanical criteria. This approach allows subsequent conclusions regarding botanical/land use relationships to be free of circular reasoning. Plots and transects were placed in a nested fashion approximately 50 m away from vehicle tracks to reduce the influence of passing traffic (human, vehicular and livestock) on the vegetation and soils. Intervals between sampling stations reflected observed man and/or livestock induced changes in vegetation and soils within the range site. Stations were placed closer together near Galcade where change was sharpest.

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 steadily improved with distance from permanent water at Galcade (Fig. 2). Range condition was lowest at the village but improved quickly out to about 1.5 km from the village. Subsequently, range condition improved slowly but steadily throughout the remainder of the 23 km distance.

Shrub cover generally increased with distance from the village but showed two distinct peaks, at 7 km (48.7%) and at 18-22 km (69-80%). Shrub cover was particularly low, however, between about 10 and 17 km from the village (12.5-29.3%) (Fig.3). Dwarf shrub cover remained fairly uniform out to about 13 km but did not occur beyond this point (Fig. 3).

Grass cover showed a very similar pattern to shrub cover except that the peaks occurred closer to the village (5 km and 15-19 km respectively) than those of shrub cover (Fig. 4). Total herbaceous cover also showed two peaks, at 2-3 km (8.8%) and 15-19 km (7.0-9.3%) but no overall trend in cover could be seen outward from the village (Fig. 5). Forb cover increased sharply from 0.8% at 0.2 km to 5.1% at about 2 km from the village but then generally decreased with distance from the village. Litter cover increased to a

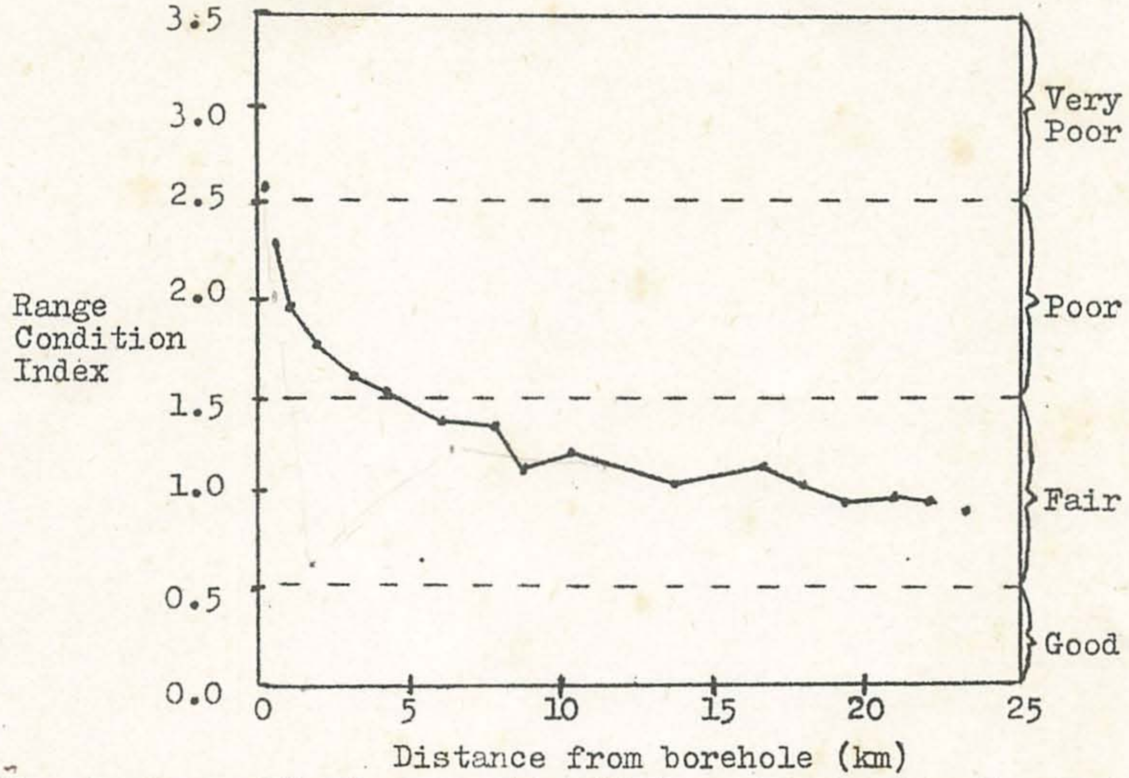

Figure 2. Range condition changes associated with changes in land use intensity which is a function of distance from the borehole.

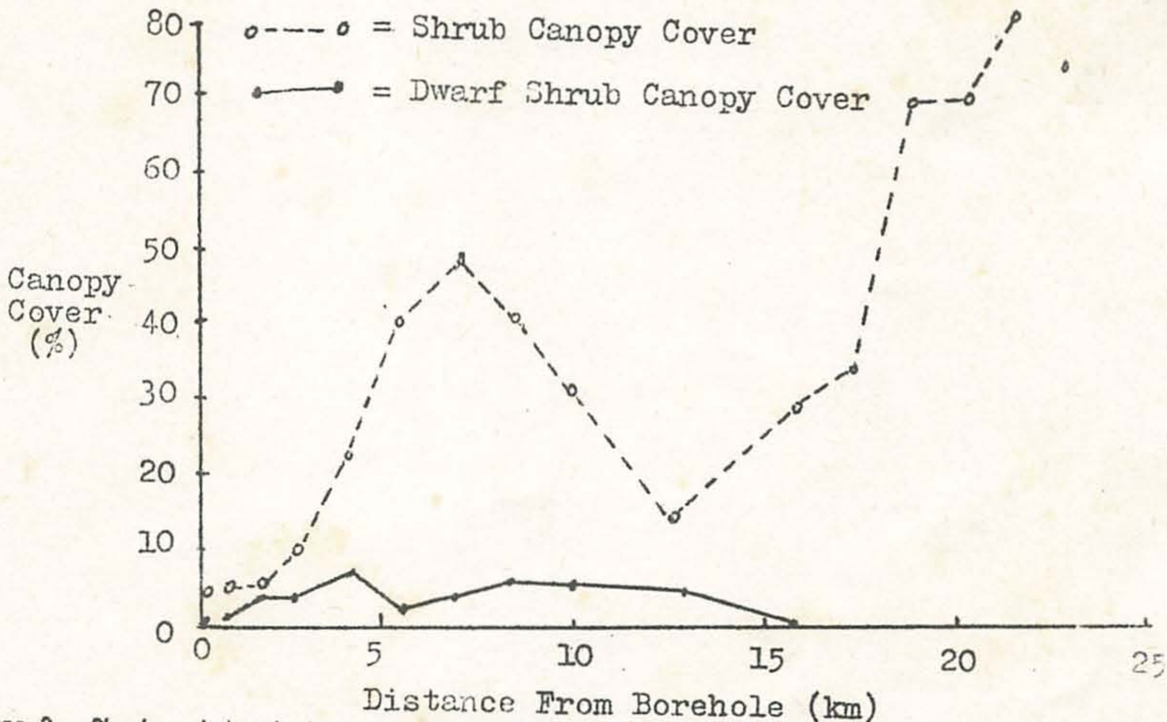

Figure 3. Shrub and dwarf shrub canopy cover changes associated with changes in land use intensity which is a function of distance from the borehole.

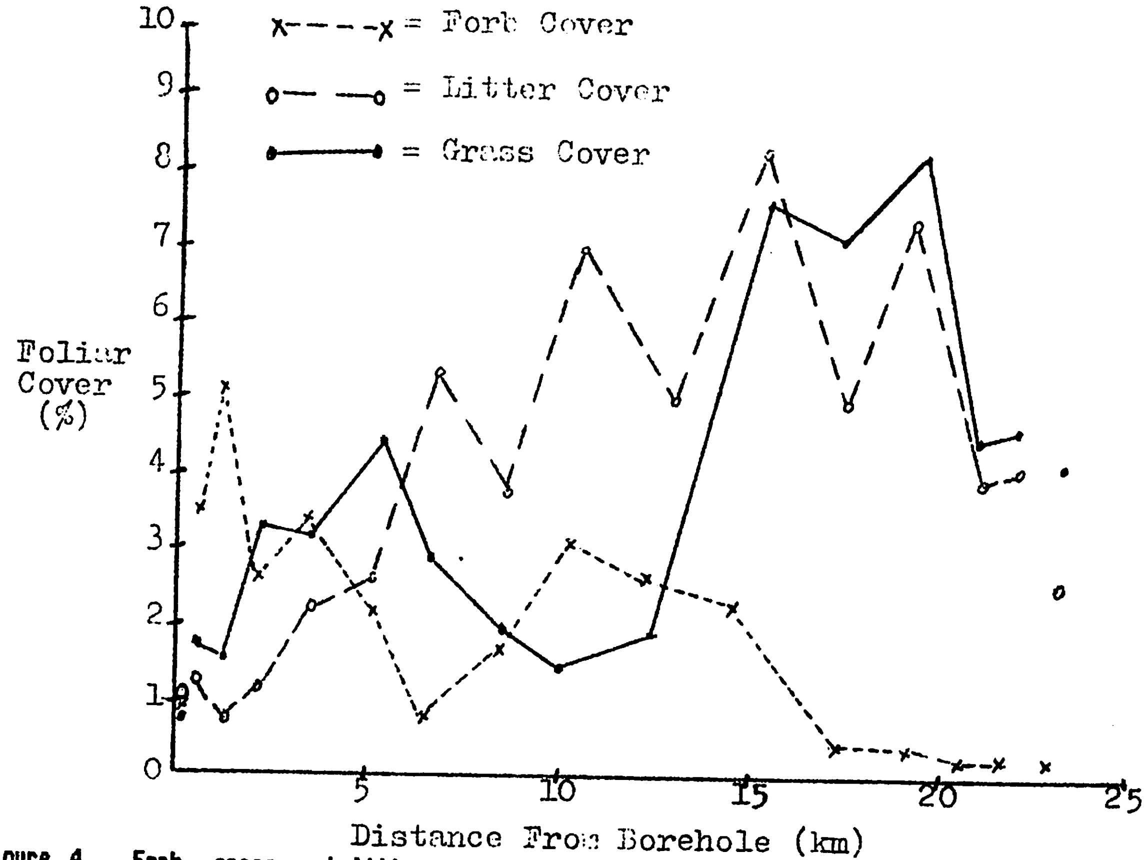

Figure 4. Forb, grass and litter cover changes associated with changes in land use intensity which is a function of distance from the borehole.

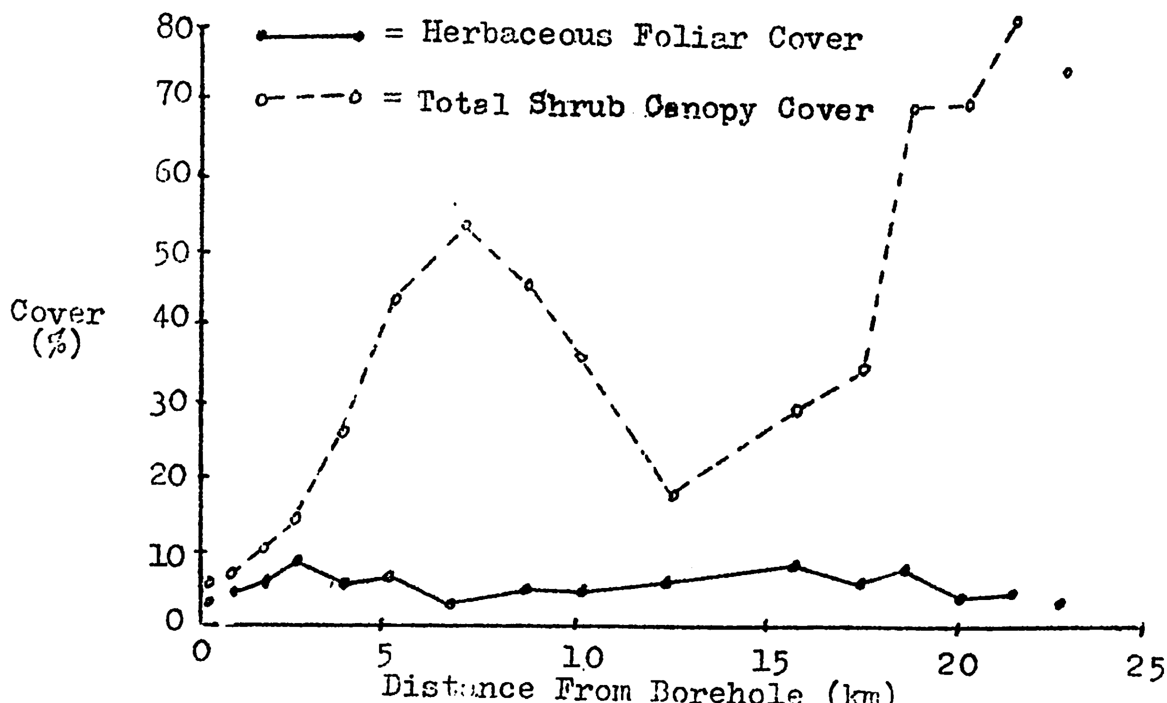

Figure 5. Herbacious and total shrub canopy cover changes associated with changes in land use intensity which is a function of distance from the borehole.

maximum of 8.2% over at about 15 Km from the village but generally decreased thereafter (Fig. 4).

Eighty five plant species were recorded on the vegetation transects. most of these species, however, were rarely encountered and were of little importance in terms of relative cover. The three most common shrub species dominated at different distances from the village (Fig. 6). Acacia reficiens dominated beyond 17 km and was absent within 5 km of the village. Acacia nilotica was the most common shrub cover between 5 and 16 Km and Dichrostachys sp. dominated between 2 and 9 Km from the village. Three species of Dichrostachys were present on the study site, the most common being Dichrostachys cinerea. Both Solanum jubae and Cordia suckertii peaked near the village (1 and 2 Km respectively) (Fig 7). The dwarf shrub Solanum incanum occurred only within 2 km of the village and was greatest in cover near the village. Indigofera ruspolii, another dwarf shrub, occurred only between 2 and 14 km (Fig. 7).

Of the grass species, Dactyloctenium scindicum dominated out to about 6 Km from the village after which Leptothrium senegalense and Aristida sieberiana alternated in dominance out to about 20 Km. Beyond 20 Km Aristida sieberiana and Afrotrichloris hyaloptra were dominant (Figs. 8 and 9). Dactyloctenium scindicum peaked very close to the village (within 0.2 Km) but percent cover dropped very quickly (within 2 km) and leveled off at about 13 Km from the village. Cenchrus ciliaris was abundant only near the village but was present at a low density throughout the range site. Cynodon dactylon was found only on the disturbed sites near the village. Both Leptothrium senegalense and Aristida sieberiana increased in percent cover with distance from the village (Fig. 8). Leptothrium senegalense began to increase about 4 km from the village and Aristida sieberiana cover suddenly increased about 7 Km from the village. These species remained co-dominant until at 20 Km where Leptothrium senegalense cover rapidly declined. The rapid decline in Leptothrium senegalense cover coincided with the rapid increase in Afrotrichloris hyaloptra cover which did not occur within 11 Km of the village and was rare within 20 Km. Crotalaria dumosa and Tephrosia sp. occurred primarily between 2-6 Km (where they both peaked).

Species diversity was calculated using the Shannon-Weiner diversity index (Krebs 1972). Herbaceous diversity rose sharply to a peak at 2-3 Km from the village and then declined steadily. Shrub diversity generally decreased outward except for a very significant drop between about 2 and 8 Km (Fig 10).

DISCUSSION

The vegetation patterns extending out from Galcade were assumed to reflect the impact of human and livestock use which was assumed to increase with proximity to permanent water at the village. It was also assumed that composition and structure of the vegetation would reflect the relative intensity of land use impact. We speculate that the changes outward from the village in range condition would also occur through time at any one point along the distance transect as land use impact increased from light to heavy. An estimate of relative plant responses to land use impact, successional patterns and useful indicators of range condition can be obtained from such a pattern of vegetation change. The assumed gradient of decreasing land use intensity outward from permanent water, and the subsequent decreasing impact on vegetation and soils, was demonstrated to exist by the trend of range condition, which increased with distance from the village (Fig. 2).

The pattern of shrub cover was related to growth form competition and cutting intensity. Shrub cutting activity extended to about 17 Km from the village. Acacia

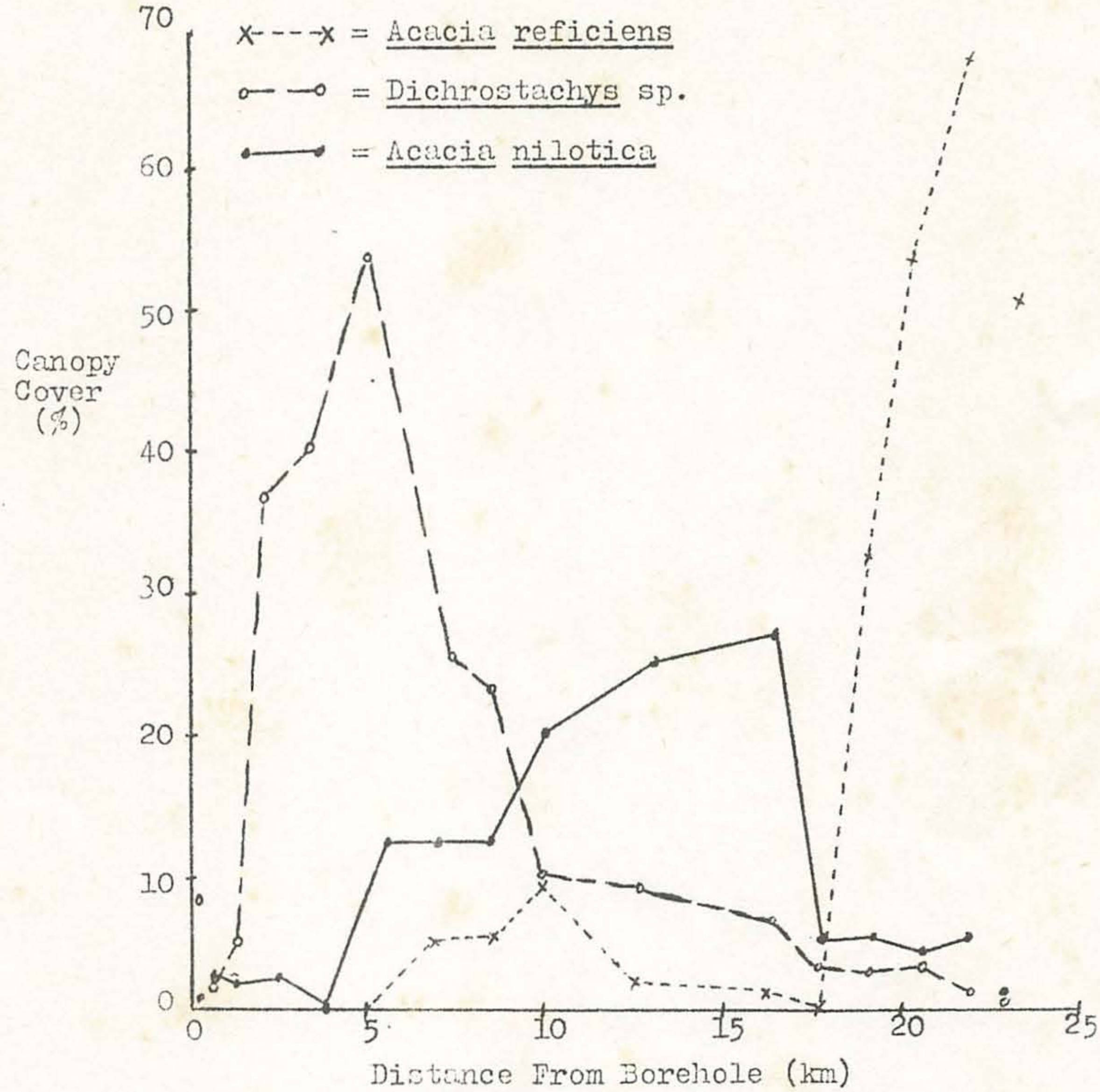

Figure 6. Changes in canopy cover of dominant shrub species associated with changes in land use intensity which is a function of distance from the borehole.

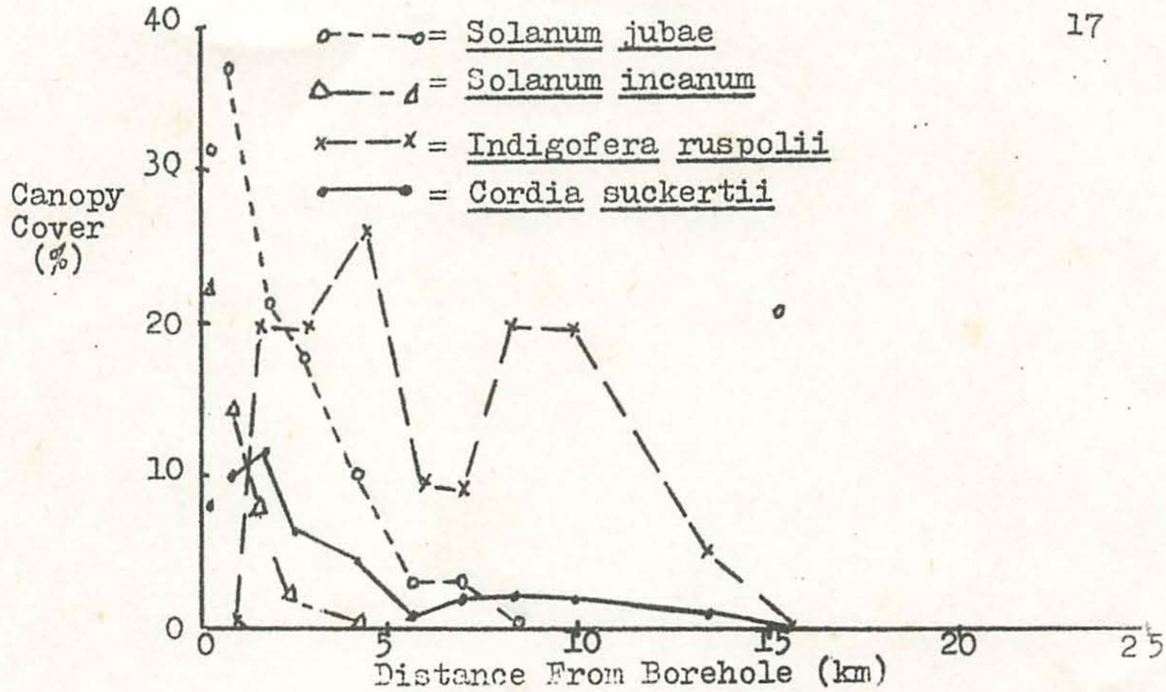

Figure 7. Changes in canopy cover of shrub species associated with changes in land use intensity which is a function of distance from the borehole.

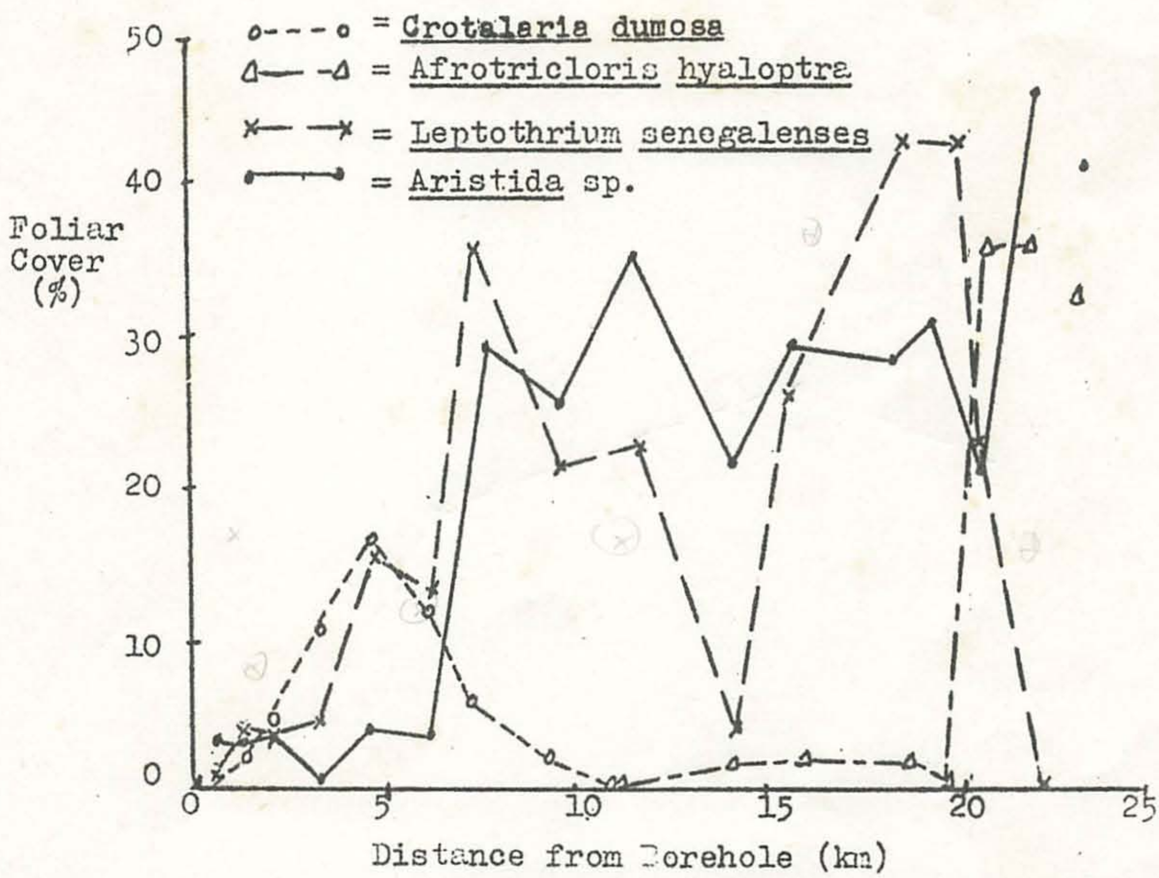

Figure 8. Changes in foliar cover of herbaceous species associated with changes in land use intensity which is a function of distance from the borehole.

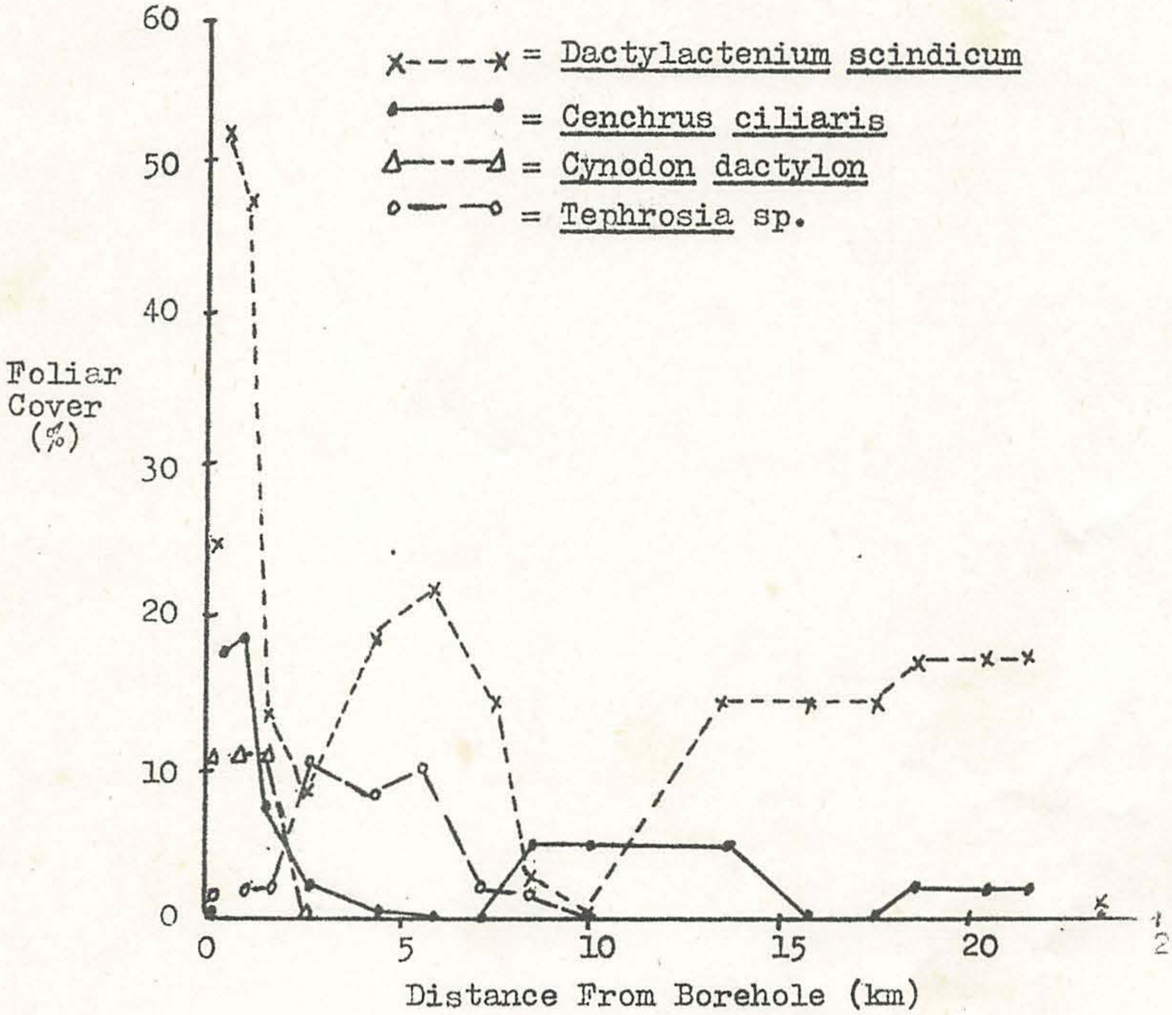

Figure 9. Changes in foliar cover of herbaceous species associated with changes in land use intensity which is a function of distance form the borehole.

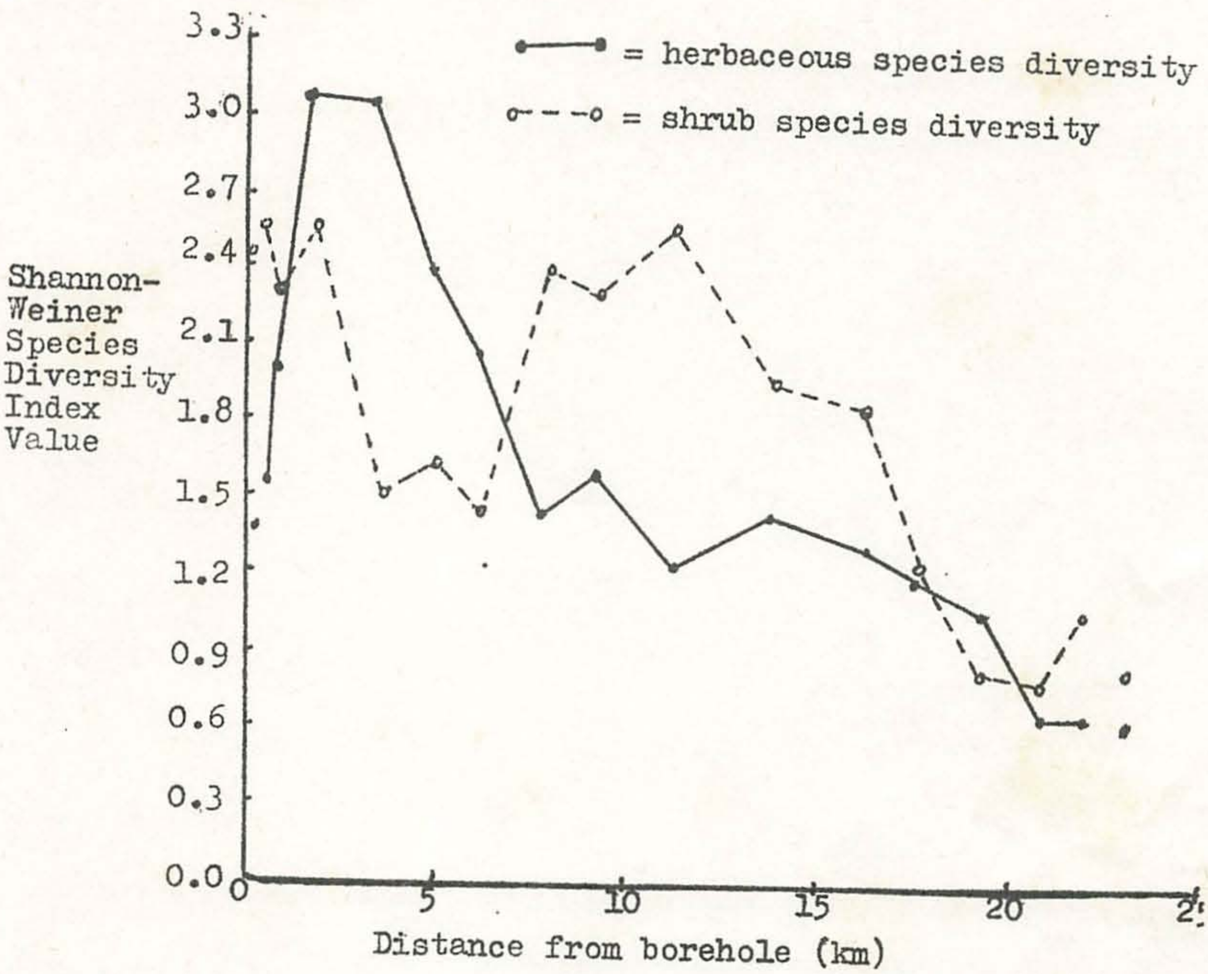

Figure 10. Shannon Weiner species diversity index trends of herbaceous and shrub diversity associated with changes in land use intensity which are a function of distance from the borehole.

reficiens was the dominant shrub, overtopping all other shrubs on rangeland unaffected by shrub cutting. This single species dominance reduced shrub species diverstiy to its lowest levels. Acacia reficiens yields good fuel wood and fencing material, therefore cover of this species decreased abruptly wherever cutting occurred (Fig. 6). Acacia nilotica was released from competition once Acacia reficiens had been removed and consequently became the major dominant. Acacia nilotica is also used for fuel, timber and fencing material, thus cutting pressure remained great. Also, it is highly palatable and therefore heavily browsed. Cutting and browsing pressure on Acacia nilotica intensified closer to the village reducing the dominance of this species. The decrease in competition allowed Dichrostachys sp. to dominate resulting in a drop in shrub species diversity. Dichrostachys is not good for timber or fencing use and was therefore left uncut. The lack of cutting pressure allowed total shrub cover to increase. Near the village Dichrostachys sp. cover declined in response to the increasingly heavy browsing pressure. This retrogression of shrub growth form associated with changes in cutting and browsing pressure explains the pattern of shrub canopy cover shown in Fig. 5.

The apparent successional relationship in which Acacia reficiens and Dichrostachys sp. occupy the successionally highest and lowest positions respectively requires some explanation. The literature and the authors experience indicates that Acacia reficiens, Acacia nilotica and Dichrostachys cinerea (the only Dichrostachys species for which information exists) seldom occur together in the same community. The occurance of each of these species usually reflects significantly different levels of available moisture. Acacia reficiens generally occupies the driest sites (arid to semi-arid) and Dichrostachys cinerea the most mesic with Acacia nilotica intermediate between the two (Langdale-Brown et al. 1964, Trapnell and Langdale-Brown 1969, Lind and Morrison 1974, Bogdan and Pratt 1974 and Herlocker 1979).

The strong dominance of large, mature Acacia reficiens shrubs (small trees) beyond 18 km from the village indicates that this species is probably the major dominant of mature, undisturbed vegetation on this range site. Acacia reficiens, with its well developed shallow lateral root system (Glover 1951b, 1951c) is well adapted to effectively compete with other shrub species for the limited precipitation by effectively harvesting all available water near the soil surface. It is hypothesized that this is why Acacia reficiens generally dominates arid sites. On more mesic sites, all water cannot be caught by a shallow root system and thus a deeper rooted species with an ability to penetrate limestone substrate fractures would have the advantage in harvesting water. Thus, Acacia nilotica, with its hypothetically deeper root system, generally dominates on more mesic sites. It also dominates portions of this study site because its root system is able to harvest water that percolates into the soil after Acacia reficiens has been removed. As cutting and browsing intensity increases Acacia nilotica is eventually removed. It is replaced by Dichrostachys sp. which has a low stature (2-2.5 m maximum) and narrow diameter, multi-stemmed growth form which make it poor fencing and building material. However, it is palatable and is increasingly heavily browsed with proximity to the village. Certain levels of browsing may actually cause Dichrostachys cinerea to increase in abundance which could also contribute to explaining the shrub cover peak which occurs at about 5 km from the village. However, as grazing intensifies Dichrostachys is eventually killed off. Strong dominance by a single shrub species causes species diversity to drop significantly between 2 and 8 km (where Dichrostachys sp. dominates) and again beyond 12 km (where Acacia nilotica and Acacia reficiens dominate).

Cordia suckertii is also a multiple stemmed understory shrub of about the same height as Dichrostachys sp. However, it is unarmed, has somewhat thicker stems and is highly palatable. Not being good fencing or building material it is affected primarily by heavy browsing under which it is able to grow despite being heavily hedged. This would explain the relatively high cover of this species so close (within 2 km) to the village.

There were two principal dwarf shrub species. Indigofera ruspolii is a highly palatable plant whose distribution coincided with that of Dichrostachys sp. Indigofera ruspolii appears to be limited by overgrazing and trampling near wells and by competition with overtopping Acacia species. It is associated with overgrazing in parts of northern Somalia (Hemming 1966). Glover (1951a) and Hemming (1966) found Indigofera ruspolii to be tolerant of grazing, trampling and exposure even though it was heavily browsed.

Solanum incanum is an unpalatable plant (Pratt and Gwynne, 1977) which occurs only on highly degraded poor and very poor range condition areas near the village. It is a well known invader in highly degraded soils and overgrazed rangeland (Pratt and Gwynne, 1977) which, once established, is difficult to eradicate (Ivens, 1967).

The distribution pattern of Solanum jubae can be explained by the fact that this species is influenced primarily by farming. Solanum jubae is a shrub of low palatability which invades recently abandoned farms where it often becomes the major dominant. It is of no value for fencing, firewood or building material because it is unarmed and has soft, easily perishable wood. Therefore, it persists for many years as a major component of vegetative regrowth following farming. It may eventually attain a height of 3-4 m. It is, however, eventually overtopped by large mature Acacia spp. and dies out. The peak in percent canopy cover of this species near the village probably reflects an increased amount of farming - and subsequent abandonment and/or fallowing - on which Solanum jubae invades in large numbers.

Grasses, which are generally more palatable than forbs, decrease as grazing pressure increases nearer the village. As grasses are weakened and intensively grazed, forbs can compete and increase in cover. Eventually, grazing and trampling pressure become too heavy even for forbs and both forb and grass cover are reduced to low levels near the village.

From 0 to 2 km away from the village grazing and trampling intensity was so great that apparently only a few species that were very resistant to livestock impact could survive. A large variety of forb species greatly increased species diversity between 2-4 km from the village. Grazing here was heavy enough to weaken grass vigor and competitiveness yet not heavy enough to seriously affect the less palatable forbs. Other land use activities such as shrub cutting and abandonment of farms probably opened up further niches for forbs in this area. Beyond about 4 km herbaceous species diversity decreased as competition with larger shrubs intensified. On uncut shrub sites the herbaceous species diversity was low (Fig 10).

The decrease in litter, forb, grass and total herbaceous cover beyond about 15-18 km probably also reflects competition with the dominant shrubs. In fact, decrease in total herbaceous cover was more strongly negatively correlated with shrub cover than with distance from the village.

Afrotrichloris hyaloptera (palatable) and Aristida sieberiana (less palatable) cover decreased as grazing pressure increased. Both species appear to be part of mature, relatively undisturbed stands of Acacia reficiens shrubland. Leptothrium senegalense, a highly palatable bunchgrass with good seeding characteristics (Pratt and Gwynne, 1977) was less typical of these stands but greatly increased in relative cover as Acacia reficiens cover decreased. However, its cover then decreased as grazing pressure increased. This pattern is similar to its response to grazing on coastal plain grasslands of Ceel Dhere District where it acts as an increaser (Herlocker and Ahmed 1986, Barker et al. 1986). Although Afrotrichloris hyaloptera soon disappeared under grazing, Aristida sieberiana and Leptothrium senegalense were more persistant. Afrotrichloris hyaloptera and Aristida sieberiana act as decreaser indicator species according to the criteria of Dyksterhuis (1949) whereas Leptothrium senegalense is a probable increaser species. The decreaser status of Aristida sieberiana, which typically establishes by invading abandoned farms, reflects its persistance following establishment. It can apparently compete well with other plant species and will persist for many years but will decrease under grazing and trampling pressure.

Dactyloctenium scindicum is a probable invader, being abundant on degraded, heavily utilized rangelands but becoming less important out from the village where it is less able to compete with other herbaceous species. Dactyloctenium scindicum is stoloniferous and highly palatable, commonly colonizing sand dunes and other bare soil areas around villages. Hemming (1966) found this species to be an indicator of heavy grazing in Acacia bussei woodland in northen Somalia.

Cenchrus ciliaris, a highly palatable bunchgrass of high forage value (Pratt and Gwynne, 1977) is a codominant over extensive areas where rainfall averages 380 - 640 mm/yr in East Africa (Bogdan 1958, FAO 1972, AGROTEC 1974) and 250 - 350 mm/yr in Somalia (Naylor and Jama 1983, Herlocker and Ahmed 1986). It is not abundant on this range site possibly because of a combination of relatively low rainfall, shallow soils and competition with the dominant shrubs. However, it is highly persistant under grazing, trampling and erosion as was also found by Edwards and Bogdan (1951) and Herlocker and Ahmed (1986). Therefore, Cenchrus ciliaris remains longer under heavy use than the other original plant species and thus increases in relative cover once the original species no longer exist to compete with it. It, therefore, acts as a very late increaser.

Cynodon dactylon is a highly nutritious low mat forming grass that spreads by underground rhizomes and stolons (Pratt and Gwynne 1977). It is widespread throughout eastern Africa as a weed on agricultural land (Ivens 1967), colonizing disturbed but usually uncompacted soils and well manured cattle enclosures (Edwards and Bogdan 1951 and Turner 1967). It is a dominant regressional species immediately prior to soil erosion (Gilleland 1952). Once established, this species gives way to other plants only slowly (Edwards and Bogdan, 1951). The occurance of Cynodon dactylon on the study site fits the patterns shown in the literature. Therefore it is considered to be an invader species.

The distinct peak in the distribution of the forbs Crotalaria dumosa and Tephrosia sp., neither of which occurs beyond 8-9 km from the village, suggest they are probably invader species, occurring where grazing is moderately heavy.

CONCLUSIONS

The availability of water provided by a borehole (drilled 16 years ago) allowed concentrated human and livestock use of the study site. The impact of human and livestock use decreased in intensity away from permanent water and was reflected by a steady increase in range condition. Vegetation patterns along this gradient were studied to document plant responses to intensity of use.

By assuming a single integrated impact of shrub cutting, farming and livestock on the vegetation and applying the concepts developed by Dyksterhuis (1949) for grasslands to all plants, it is possible to identify certain woody plant species as indicators of (1) prevailing land use and (2) range condition class.

Mature, relatively undisturbed shrubland dominated by Acacia reficiens begin to be cut for wood and fencing materials during the first stages of human induced land use pressure. This begins a regressional sequence of dominant shrub and dwarf species. Acacia reficiens is a decreaser, decreasing rapidly under shrub cutting. Acacia nilotica is an increaser, replacing Acacia reficiens. Under heavy cutting and browsing Acacia nilotica is replaced by the late increaser Dichrostachys sp. and the dwarf shrub Indigofera ruspolii. Cordia suckertii is an even later increaser under heavy browsing that eventually gives way to the unpalatable invader dwarf shrub Solanum incanum that is little browsed and can withstand considerable trampling. Solanum jubae, a shrub of low palatability and poor wood quality, is an invader of abandoned farms. Another reason for Acacia nilotica and Dichrostachys sp. supplanting A. reficiens is that they may have deeper root systems than the shallow rooted A. reficiens which allow penetration of the fractured limestone substrate to tap deeper soil water.

In the herbaceous layer, Afrotrichloris hyaloptera and Aristida sieberiana are decreasers. Afrotrichloris, in particular, decreases quickly under grazing. Leptothrium senegalense and Cenchrus ciliaris are an early and late increaser respectively. Dactyloctenium scindicum is an early invader and, Crotalaria dumosa, Tephrosia sp. and Cynodon dactylon are late invaders.

LITERATURE CITED

AGROTEC - CRG-SESES, 1974. Southern rangeland livestock development project. part 2, volume 1, Report to the Ethiopian Imperial Government Livestock Board. Addis Ababa. 87 p.

Barker, J.R., D.J. Herlocker and S.A. Young. 1986. The relationships of forage species along a grazing gradient within the coastal grassland range site, Ceel Dhere, Somalia. Colloquio "Produzione Foraggera in Somalia" Somali National University. Proceedings in prep.

Bogdan, A.V. 1958. A revised list of Kenya grasses. Government Printer. Nairobi, 73 p.

Dyksterhuis, E.J. 1949. Condition and management of rangeland based on quantitative ecology. J. Range Management. 2:104-105.

Edwards, D.C. and A.V. Bogdan. 1951. Important grassland of Kenya. Pitman, Nairobi, 124 p.

FAO, 1972. Range development in the East Kitui statelands, AGP:SP/KEN 66/55. Working Paper 11, Nairobi, 26 p.

Foran, B.D. 1980. Change in range condition with distance from watering point andits implications for field survey. Australian Rangeland Journal 2(1):59-66.

Gilleland, H.B. 1952. The vegetation of eastern British Somaliland. Journal of Ecology 40(1):91-124.

Glover, P.E. 1951a. The root systems of some British Somaliland plants II. The East African Agricultural Journal 16(3):154-173.

Glover, P.E. 1951b. The root systems of some British Somaliland plants III. The East African Agricultural Journal 16(4);205-217.

Glover, P.E. 1951c. The root systems of some British Somaliland plants. IV. The East African Agricultural Journal 17(1):38-51.

Graetz, R.D. and J.V. Ludwig. 1978. A method for the analysis of piosphere data applicable to range assessment. Australian Rangeland Journal. 1(2):126-136.

Hemming, C.F. 1966. The vegetation of the northern region of the Somali Democratic Republic. Proceedings of the Linnean Society of London. 177:173-248.

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.J. 1979. The vegetation of S.W. Marsabit District, Kenya. UNESCO/IPAL Technical Report. D-1 68 p.

Herlocker, D.J. and A.M. Ahmed, 1986. The vegetation of the coastal plain, Central Somalia. Somali Journal of Range Science. 1(2):6-34.

Herlocker, D.J. and P. Kuchar. 1986. Palatability ratings of range plants in Ceel Dhere and Bulo Burte Districts. CRDP Technical Report 9. 18 p.

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

Ivens, G.W. 1967. East African Weeds And Their Control. Oxford University Press. Nairobi. 250 p.

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

Langdale-Brown I., H.A. Osmaston, and J.G. Wilson. 1964. The Vegetation Of Uganda And Its Bearing On Land Use. Government Printer, Entebbe, 159 pp.

Lind, E.M. and M.E.S. Morrison 1974. East African Vegetation. Longman, London. 257 p.

Nayler, J. and A. Jama. 1983. Ecological survey and initial management plans - Hobyo District, Somalia. CRDP Technical Report 2. 60 p.

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. (Eds.) 1977. Rangeland Management And Ecology In East African. Hodder and Stroughton, London.

Resource Management and Research. 1979a. Static Range Resources, Vol. I. Part 2. Maps. Central Rangelands Survey. Somali Democratic Republic.

Resource Management and Research. 1979b. Vol I, Part 3. Summary Maps at 1:2,700,000 for Vol I. Part 1, and Vol 4. Central Rangelands Survey. Somali Democratic Republic.

Tubea, B. 1986. A reconnaisance soil survey of Ceel Dhere District. Unpublished misc. tables and notes.

Turner, B.J. 1967. Ecological problems of cattle ranching on Combretum savanna woodland in Uganda. East African Geographical Review. 5:9-19.

Trapnell, C.G. and I. Langdale-Brown. 1969. Natural vegetation. In:Morgon, W.T.W. (Ed.). East Africa : Its People And Resources. Oxford University Press. London. pp. 127-139.

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

United Nations Sahelien Office (UNSO) 1984. Inventory of sand movement in Somalia. UNSO/DES/SOM/80/001. 100 p.

SPECIES COMPOSITION AND RELATIVE HARVEST OF POLE SIZED TREES CUT NEAR LUUQ, SOMALIA

Ronald Wieland

Harvest of trees cut as poles for use as construction material is one of the products derived from Somalia's rangeland. Demand for these locally produced poles is great since transportation logistics and cost limit the availability of substitute construction material. The semi-arid climate and the shrub-like growth characteristics of most of the rangelands woody species limit the number of pole quality trunks available. A wide variety of tree species are harvested but only a few species have a growth form and wood quality that regularly produce useable pole quality timber. The objective of this paper is to document the species composition and relative harvest of pole sized trees cut on shrubland and riverine woodland about 15 Km southeast of Luuq, Somalia (3^{0} 80'N, 42^{0} 50'E).

The sample consisted of 1320 poles. The average pole was 2.4 m long and 0.1 m diameter. The straightness and diameter of the poles varied considerably. The composition and relative harvest of the species used for poles is shown in Table 1.

Table 1. Relative harvest of species used for building poles.

Species	Somali Name	Relative Harvest (%)
Burseraceae		
Commiphora ciliata	Eynot	.2
Commiphora sp.	Afgub	.2
Commiphora sp.	Hadi	.1
Commiphora sp.	Hothi	.1
Commiphora sp.	Gumrei	.1
Commiphora sp.	Shunfarodey	.1
Capparidaceae		
Boscia coriaceae	Degayeri	5.1
Boscia minifolia	Megag	.7
Boscia tomentella	Towsi	.2
Boscia sp.	Lamaloshi	.1
Maerua sessiliflora	Jiiq	4.4
Combretaceae		
Combretum hereroense ssp. volkensii	Qoqone	4.3
Terminalia orbicularis	Bisiq	6.2
Terminalia polycarpa	Hereri	.5
Terminalia parvula	Harar	.1

Author currently range ecologist for Central Rangelands Development Project. These data were colected in 1984 when employed by Interchurch Response forestry program.

Table 1 (con't)

Species	Somali Name	Relative Harvest (%)
Leguminosae		
Acacia horrida (tall variant)	Sarmaan Dup	1.8
Acacia reficiens ssp. misera	Qonsa	.7
Acacia senegal	Idat	.1
Acacia senegal var. leiorhachis	Faryer	4.3
Acacia seyal var. fistula	Folai	.2
Acacia tortilis var. spirocarpa	Kora	18.1
Albizia anthelmintica	Raidop	36.7
Caesalpinia erianthera	Qoodi	.6
Delonix baccai	Baccal	2.9
Delonix elata	Lebbi	.3
Delonix sp.	Masarijebis	.3
Celastraceae		
Elaedendron aquifolium	Megag	.6
Lythraceae		
Lawsonia inermis	Illan	2.6
Rhamnaceae		
Ziziphus hamur	Hamur	.1
Rubiaceae		
Gardenia fiorii	Matha-ha-madel	.4
Salvadoraceae		
Dobera glabra	Garas	5.0
Salvadora persica	Ady	1.5
Simaroubaceae		
Kirkia tenuifolia	Dofar Qot	1.2
Tiliaceae		
Grewia bicolor	Debbi	.2
Zygophyllaceae		
Balanites aegyptica and Balanites orbicularis	Qolon	.4

Three species comprised almost two-thirds of the poles harvested (Albizia anthelmintica (36.7%), Acacia tortilis spirocarpa (18.1%), and Terminalia orbicularis (6.2%)). The poles of each of these species were consistently the straightest and roundest of all species examined. These species in particular merit further study in terms of their agroforestry and reforestation potential.

Harvest pressure on woody species near Luuq has rapidly increased due in part to a large influx of refugees into the region. In addition to timber harvest, woody species are in high demand for fuelwood and fodder. Large trees are usually not harvested for fuelwood because it is inconvient to cut a large tree into fuelwood size using convential tools. However, as land use pressure intensifies the trees tend to be cut before reaching pole size. The aridity and heavy grazing which characterizes much of Somalia's rangeland causes a very slow regeneration and growth rate. If current trends continue the more important pole quality timber will likely become scarce in the future. Re-establishment techniques, growth rates and management policies need to be determined so that Somalia's rangelands can continue to produce at least some of the pole quality timber which is in great demand for constuction material.