J. Range Manage.
46:487-492, November 1993

White-tailed deer and cattle diets at La Michilia, Durango, Mexico

SONIA GALLINA

The author is a research scientist on the Project Ecología y Comportamiento Animal of the Instituto de Ecología, A.C. Apartado Postal, 63, C.P. 91000 Xalapa, Veracruz, México.

Abstract

Fecal analysis was used to determine the relationships between white-tailed deer (*Odocoileus virginianus couesi* [Coues and Yarrow]) and cattle diets (Beef Master, Hereford and criollo), in Durango, Mexico. Deer preferred shrub and tree species (85% of the diet), whereas cattle preferred grasses (61%). Although diets varied seasonally, as did forage availability and quality, the same selective forage pattern was maintained throughout the year. There was a significant difference in the use of different plant groups between the 2 herbivores. The diet overlap index (50.51%) suggested competition during the wet season, but forage was abundant (628 kg/ha dry weight biomass compared with 380 kg/ha in the dry season), thus reducing potential conflicts. Deer and cattle can simultaneously forage in this area without detriment to either species. The vegetation can maintain a stable composition under higher utilization levels when used by 2 herbivores with different forage patterns than when used by only 1 herbivore.

Key Words: deer, *Odocoileus virginianus couesi*, cattle, Michilia Biosphere Reserve, Durango, diets, microhistological techniques, biomass

Deer and cattle diets have been studied extensively, and information on diet overlap and potential competition is necessary to adjust habitat management at the local level. This is particularly important in a Biosphere Reserve where the main economical activity is cattle management. Our objectives in this study were to determine deer and cattle diets, intensity of competition for food, seasonal changes, dietary similarity and overlap at the La Michilia Biosphere Reserve, Durango, Mexico. Forage availability and utilization were also determined to clarify resource use in a mixed oak-pine forest.

The microhistological analyses of fecal samples has been used extensively to determine herbivore diets (Storr 1961, Sparks and Malechek 1968, Zyznar and Urness 1969, Ward 1970, Todd and Hansen 1973, Anthony and Smith 1974, Goodwin 1975, Holechek et al. 1982, and Elliott and Tanner 1985). Although not without flaws, the technique has proven to be reasonably reliable for studying herbivore diets (Holechek et al. 1982).

Study Area

This study was carried out at the La Michilia Biosphere Reserve, which is located in the southeast of the State of Durango, Mexico, between 23° 30′ and 23° 25′ N Lat and 104° 21′ and 104° 15′ W Long. The Reserve is located on the foothills of the Sierra Madre Occidental, 145 km south of Durango. The altitude varies from 2,250 to 2,850 m.a.s.l. The dominant species in the mixed oak-pine forest are the following: *Quercus rugosa* Née, *Q. sideroxyla* H.&B., *Q. chihuahuensis* Trel, *Pinus engelmanni* Martínez, *P. chihuahuana* Engelm. and *P. arizonica* Engelm. Chaparral and grasslands are also present. The chaparral is characterized by *Q. potosina* Trel, *Juniperus durangensis* Martnez, *P. lumholtzii* Rob. et Fern. and *Q. urbanii* Trel. The grassland is an association of *Muhlenbergia rigida* [H.B.K.] Kunth, *M. montana* [Nutt] Hitch, *Bouteloua gracilis* [H.B.K.] Lag and *Aristida schiedeana* Trin. et Rapr. (Gallina 1981). There are 2 well-defined seasons: the dry season from February to May and the rainy season from June to September. Light winter rains occur in December and January, providing less than 5% of the total annual precipitation, and occasionally it snows (Gallina 1981). The climate varies between semiarid temperate and subhumid temperate (Garcia 1964). The temperature fluctuates between 17.4° C and 20.7° C. The mean annual precipitation is 609 mm at meteorological stations Mezquital and Chalchihuites (1963–1975). The records from 1980–1985 at La Michilia show annual precipitation of 600 to 860 mm.

Materials and Methods

In 1975, plant material and deer fecal samples were collected during April (3 mixed fecal samples that consist of a pellet of each fresh group collected), May (12), August (6), late September and October (13), and November–December (13), at the La Michilia Biosphere Reserve. A total of 47 mixed fecal samples were analyzed (Gallina et al. 1981). In 1980–1981, the collection methodology was changed by Morales (1985), and the pellets collected were counted. A total of 866 pellets of individual deer fecal groups were collected [June (140), August (118), November (336), January (225) and May (47)]; as were 751 individual cattle fecal samples: June (116), August (99), November (153), June (215), May (104), July (64) in order to quantitatively compare both diets (Morales 1985).

The identification of the botanical composition of the diet was based on the fecal analysis by microhistological techniques (100 fields for each mixed sample). Five slides of 8 different collecting areas were made on each sampling occasion, and 20 fields on each slide were examined. A total of 4,700 fields were examined in 1975, and 6,800 fields in 1980–81. Epidermal identification requires reference slides of plant material; these were made and studied, prior to fecal analysis, by 3 observers in 1975 and 1 observer in 1980–81.

Frequency of each species identified in each location (microscopic field using 100 power magnification) was recorded. Percentages were converted to density using a table developed by Fracker and Brischle (Sparks and Malechek 1968), and the relative density, expressed as a percentage of each species in the sample, was calculated. Relative density was used to estimate the percentage dry weight of the species in the sample. The epidermal material not

This research was funded in part by the Consejo Nacional de Ciencia y Tecnología de México.
Manuscript accepted 15 May 1993.

identified constituted 5% on deer fecal samples and 20% on cattle fecal samples.

The diets of the 2 ruminants (deer and cattle), between deer diet in different years (1975 and 1980–81) and their seasonal variation were compared using a 3 way ANOVA (Sokal and Rohlf 1969) to see if observed foraging patterns were affected by changing conditions.

In this paper the diet similarity was analyzed using the Sorensen Index

$$S = \frac{2a}{2a+b+c}$$

where

a = number of plant species used by both herbivores

b = number of plant species consumed by deer

c = number of plant species consumed by cattle

Diet overlap was obtained by Pianka's formula (1975), where p_{ij} and p_{ik} are the proportions of i resources used by the j

$$O_{jk} = O_{kj} = \frac{\Sigma p_{ij} p_{ik}}{\sqrt{\Sigma p_{ij}^2 \; \Sigma p_{ik}^2}}$$

species (deer) and the k species (cattle).

The availability of forage was obtained with the Pechanec and Pickford method (1937). A double sample technique was used in the same areas where the fecal samples were collected from 1978 to 1980, in 14 transects with 10 sample areas of 1 m^2 separated by 40 m. Available aerial biomass to a height of 1.8 m was estimated during the wet season, i.e., November 1978, October 1979, October 1980 (n = 420) when biomass values are highest, as well as during the dry season, May 1979, June 1980 (n = 280) when biomass is lowest (Gallina 1990). During the biomass estimation the percent of the resource used in the field by herbivores was also determined.

Results and Discussion

Global Diets

Shrub and tree species constituted more than 85% of the annual diet of white-tailed deer. Gramineous species were the most important food in cattle diets, (>60%; Fig. 1). These results are supported by those of other studies reported by Van Dyne et al. (1980).

The total number of plant species consumed by deer was 135 in 1975 (Gallina et al. 1978) and 99 in 1980–1981 (Morales 1985). However, in general, the deer depend on few shrub and tree species. For deer, the most important of these species were: mistletoe (*Phoradendron bolleanum* [Seem] Eichl and *P. villosum* Nutt), oak (*Quercus* spp.), juniper (*Juniperus deppeana* Martínez and *J. durangensis* Martínez), and *madrone* (*Arbutus* spp. and *Artostaphylos* spp.). These species represented the highest percentage of deer diet in both studies (Table 1).

Cattle consume 84 species (Morales 1985), and of these more than 50% are gramineous (46 species). This indicates a high selectivity for grasses at La Michilia, mainly of the genera *Muhlenbergia* (22% of the diet) and *Aristida* (Table 2). Holechek et al. (1982b) reported that cattle grass consumption ranged from a low of 54% in late spring of 1978 to 91% in the fall of 1977. Many investigators have reported grasses to be the most important component of cattle diet (see Van Dyne et al. 1980). Beck (1975, cited by Holechek et al. 1982b) reported that plant phenology was the primary factor influencing cattle diet selection in southeastern Colorado.

Seasonal Variation in the Diets

White-tailed deer and cattle diets changed throughout the year (Table 1 and 2). These changes were related to forage availability, i.e., to the phenological stage and nutritive value of the species. These changes are more evident in the forbs, the majority of which are annual species that appear during the wet season when their diversity and abundance are high.

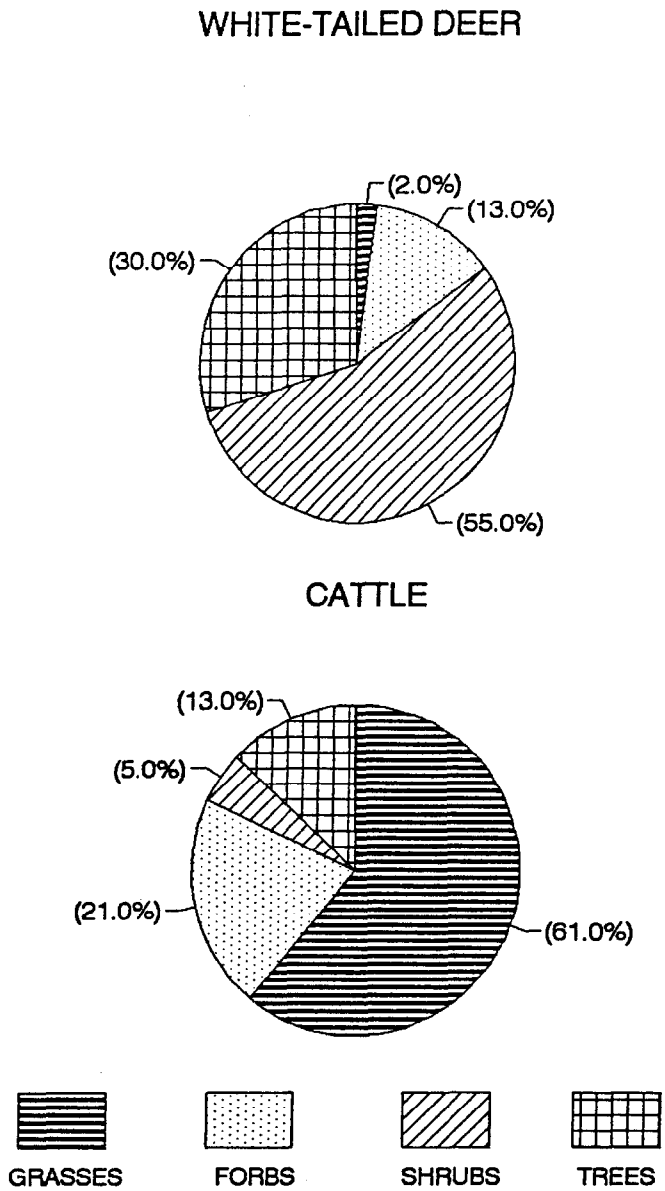

Fig. 1. Annual diets of white-tailed deer and cattle showing the different foraging patterns.

There were significant differences in (i) the use of the different plant groups by each herbivore ($F = 79.361$, $P<.001$) and (ii) in the preferences for the different plant groups by both herbivores ($F = 35.551$, $P<.001$; 3 way ANOVA).

During the dry season, cattle consumption of tree species increases, perhaps as a strategy for complementing their diet when other forage is scarce. The same pattern occurs in other regions, as has been shown by Holechek et al. (1982b). In spite of this, the basic diet of cattle is grass (more than 50%). The same pattern is observed for deer with respect to shrub species.

There were no significant differences ($F = 0.055$, $P>0.05$) in the seasonal use of forage by deer, when the diets in 1975 and 1980–81 are compared. This indicates a similar foraging pattern throughout the year, independent of weather conditions that can affect forage availability, and a preference for shrubs and trees that characterizes a browser. The same pattern was observed by Clemente-Sanchez (1984) in a forest of the State of Aguascalientes, Mexico, where shrub species constituted 45% of the summer diet, 39% of the fall diet and 61% of the winter diet.

Table 1. Important plant genera in the white-tailed deer diet. The values represent the percentages. The information was obtained from Gallina et al. (1978) and Morales (1985).

	1975					1980			1981	
	Apr.	Jun.	Aug.	Sep.	Nov.	Jun.	Aug.	Nov.	Jan.	May
Trees	(%)									
Arbutus (3 spp)	9	6	6	20	7	10	6	22	10	8
Quercus (8 spp)	20	19	16	8	9	30	20	4	5	23
Pinus (5 spp)	1	0	0.4	1	1	0.3	1	1	1	1
Total	30	25	22	29	17	40	27	27	16	32
Shrubs										
Ceanothus	4	2	1	1	2	14	12	9	14	14
Juniperus (2 spp)	13	19	8	8	13	11	14	16	31	26
Phoradendron (2)	18	22	24	15	23	23	21	17	23	23
Total	35	43	33	24	38	48	47	42	68	63
Forbs										
Lupinus ehrenbergii	0	0	0	3	2	0.05	1	0.15	0	0
Polygala (3 spp)	0	2	0	1	1	0.05	1	2	0.04	0.14
Dalea (2 spp)	0.3	0	1	1	0.4	0	0	0.1	0	0
Oxalis	0.3	0	0.4	3	1	0	0	.05	0	0
Total	1	2	1	8	4	5	5	5	2	1
Grasses	0	1	11	2	1	1	3	2	2	1

Table 2. Important plant genera in cattle diet. The values represent percentages, and were obtained from Morales (1985).

	1980			1981		
	Jun.	Aug.	Nov.	Jan.	May	Jul.
	(%)					
Grasses						
Muhlenbergia spp	32	17	25	24	22	11
Aristida spp	7	11	9	7	13	9
Trisetum spp	2	1	2	3	2	2
Panicum spp	1	1	1	1	0.3	1
Lycurus phleoides	1	1	0	2	2	1
Bromus spp	2	0.3	4	1	0.4	0.2
Not Identified	21	17	20	21	20	11
Total	66	48	61	59	60	35
Forbs						
Halimium spp	4	15	11	7	12	5
Zexmenia hispida	0	3	13	0.4	0.3	2
Cyperus spp	1	4	1	1	0.1	10
Cologania spp	0	3	3	2	2	10
Not Identified	5	2	2	1	1	1
Shrubs and Trees						
Phoradendron spp	2	1	1	4	3	3
Arbutus spp	4	7	0	2	2	3
Quercus spp	5	6	1	9	14	9

At La Michilia deer prefer different species of oak in April and June (dry season), and foraged on oak to a lesser extent during the wet season (Table 1). According to Klein (1970), this occurs because the deer can select plants and part of plants with the highest nutritive value. Thus, the observed foraging pattern can be explained by the fact that oaks are deciduous and they produce shoots with a high nutritive value in the spring (Gallina et al. 1981). In addition, the increase in the consumption of forbs coincides with the growing season of these plants. During the growing season forage is more digestible and has a higher nutritive value in protein, phosphorus, and potassium, as described by Church (1975) and Vangilder et al. (1982).

Among the most important shrub species in the deer diet are: *Phoradendron bolleanum* and *P. villosum*. These plants are consumed throughout the year (20% of the diet). Although mistletoe biomass in the study area represents only 4.3% of the total standing crop, the preference index reveals that white-tailed deer actively search for this resource (Gallina 1988). Ashcraft (1981) has reported a high energetic value in the mistletoe species of Arizona which have 12% crude protein and are 96% digestible. Mistletoe species are an excellent food resource that undergoes no changes in quality over the year (Gallina 1988).

Summer and fall food are the most important for deer since they provide the energy for the fat reserves which are necessary for survival through the critical period (Mautz 1978). At La Michilia the critical period is the dry season (from February to May).

Everitt and Gonzalez (1981) found high protein levels (17.4%) in the shrub species eaten by deer throughout the year in south Texas Plains. Clemente-Sanchez (1984) reported that the important factor regarding the consumption of plants by deer was not the food availability but rather the nutritive value. He found that the Leguminosae and Convolvulaceae families of plants had more than 10% crude protein in a similar forest. Grasses have the highest proportion of cell walls (almost 90%) and lowest digestibility.

The plant species with high crude protein, a low proportion of cell walls and high digestibility were consumed by deer. It seems that the changes in diet preferences were directly related to changes in the chemical composition of available plants (Clemente-Sanchez 1984). In another study, Gallina and Chargoy (1987) found that shrub species had higher digestibility values throughout the year, while grasses had drastic changes in the dry season (very low values, see Table 3). Cattle would therefore be more susceptible to

Table 3. Digestibility in vitro of dry matter (%) of different plant groups and seasonal variation.

	Aug. 84	Oct. 84	Mar. 85	May 85	Jul. 85	Oct. 85	May 86	Aug. 86
	(%)							
Trees	42.6	—	35.0	27.3	26.7	35.7	54.0	38.3
Shrubs	63.7	39.9	51.2	57.7	26.9	53.1	70.3	70.1
Herbs	55.2	56.4	63.0	29.1	48.1	50.2	—	58.4
Grasses	52.6	54.9	22.2	12.5	30.9	34.1	—	58.6

and could suffer during the dry season, whereas deer, which depend on plants of high digestibility levels with fewer seasonal changes, would be less vulnerable.

Seasonal Variation in the Biomass Availability and Utilization

It is also necessary to consider the seasonal variation in forage

Table 4. Seasonal variation in the mean dry weight biomass availability (kg/ha) ± standard deviation, and utilization by ruminants. The percentage of utilization of each group of plants is given in parenthesis.

	Nov. 78 N = 140	May 79 N = 140	Oct. 79 N = 140	Jun. 80 N = 140	Oct. 80 N = 140
	(kg/ha)				
Grasses	213 ± 89	171 ± 33	121 ± 35	192 ± 96	124 ± 39
	18 ± 24	41 ± 32	4 ± 8	100 ± 95	0.3 ± 0.5
	(8.45%)	(23.98)	(3.31)	(52.08)	(0.24)
Forbs	241 ± 180	32 ± 22	339 ± 282	31 ± 35	454 ± 365
	12 ± 9	2 ± 2	14 ± 14	10 ± 15	29 ± 39
	(4.98)	(6.25)	(4.13)	(32.26)	(6.39)
Shrubs	126 ± 155	122 ± 200	72 ± 100	125 ± 205	67 ± 90
	1 ± 2	0.4 ± 0.1	1 ± 3	10 ± 21	0.03 ± 0.1
	(0.79)	(0.38)	(1.39)	(8.00)	(0.04)
Trees	45 ± 43	58 ± 76	46 ± 56	28 ± 32	36 ± 32
	0.02 ± 0.1	—	—	0.4 ± 1	—
	(0.04)	—	—	(1.43)	—
Total	625	383	578	376	681
	(5%)	(11%)	(3%)	(32%)	(4%)

availability to be able to understand seasonal changes in deer and cattle diets (Table 4).

The total dry weight biomass in the wet season varied over the 3 years (1978–1980) from 578 to 681 kg/ha. Among the dry seasons changes were minimal: 376 to 383 kg/ha. These values were similar to those obtained by Clemente-Sanchez (1984) in a forested area: 632 kg/ha (496 kg/ha in winter and 887 kg/ha in summer).

The main changes occurred in forbs, which represent the highest available dry weight biomass during the wet season (October–November), with a mean value of 345 ± 107 kg/ha (65% of total biomass), and the lowest during the dry season (May–June): 21 ± 22 kg/ha (8%). The percentage of forb utilization varied from 4 to 32%.

Grasses represented the second most available forage with respect to biomass for herbivores, and they were mainly used by cattle. In the dry season grass utilization levels were higher than in the wet season, reaching values greater than 50%.

Shrub biomass was the third important group and the most important food available for deer. The utilization level was very low though, probably for 2 reasons: the deer population density was not very high, and second, it is very difficult to estimate shrub use.

In general, the utilization of plants in the wet season was not higher than 5% although in the dry season utilization reached more than 30%.

These results show that food availability for herbivores changes through seasons from year to year, and that the utilization levels were low when the food resources increased. Therefore, it appears that the area is not overgrazed and can maintain both herbivores at the population densities which existed during this study (21 ± 3 deer/km², Gallina, 1990 and approximately 3 head/km²).

Diet Similarity and Overlap

Diet similarity and overlap values varied throughout the year (Fig. 2). The highest similarity was noted in January (0.35), and indicates the use of common plant species in this period, but the overlap value was low (12.08) for the same period. That is, species which are consumed by both herbivores are consumed in different proportions.

This indicates that while deer consume a high proportion of a plant species, cattle consume them to a lesser extent, or viceversa. As such, competition potential is reduced.

The greatest value in the overlap index was recorded in August

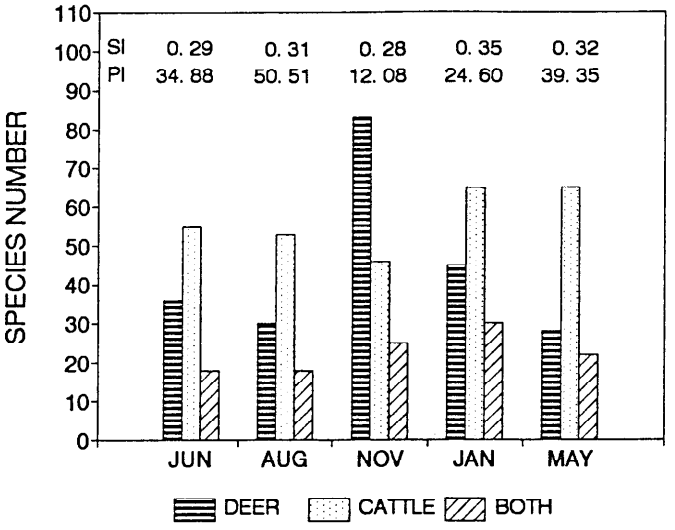

Fig. 2. Seasonal dietary similarity (SI = Sorensen Index) and overlap (PI = Pianka Index) between the white-tailed deer and cattle.

(Ojk = 50.51) mainly owing to the increase in the use of forbs by both herbivores. The availability of this type of food resource during this period, recorded by Gallina (1984) (Table 4), indicates that the maximum biomass is available at La Michilia in August (mean dry weight biomass value of forbs from a period of 3 years was 345 ± 107 kg/ha). This decreases the possibility of competition, because both herbivores exploit the resource which is abundant at that time.

Thill and Martin (1989) found dietary overlap between deer and cattle under heavy yearlong grazing averaged 25.8, 11.8, 26.0, and 30.7% during spring, summer, fall, and winter. Diets of both animals were diverse and overlap generally resulted from sharing a small number of many plant taxa. Deer diets were dominated by a mixture of browse (49–83%) and forbs (11–47%) while cattle consumed mostly grasses during spring (67.8) and summer (73.7%) and 60 and 40% browse and herbage during fall and winter, respectively.

Results from Kie et al. (1991) suggest that competition occurred between mule deer and cattle on summer range, particularly at higher cattle stocking rates and during a year when precipitation was below average.

Bowyer and Bleich (1984) found that cattle may limit deer populations by means other than direct competition for food. They contend that cattle grazing probably eliminated valuable cover for does with fawns, increasing the probability of predation.

Ragotzkie and Bailey (1991) found that direct interference competition between cattle and desert mule deer on the Santa Rita Experimental Range, southeast of Tucson, Arizona, was minimal. Competition for forage may also have been minimal during their study, as palatable forage was abundant due to moisture conditions. Cattle grazing may actually enhance forage availability to deer owing to the difference in forage preference of these 2 herbivores (Wallace and Krausman 1984, Gavin et al. 1984, cited in Ragotzkie and Bailey 1991).

Carrying Capacity

To evaluate the carrying capacity, we considered the mean biomass dry weight obtained in the wet season. Mautz (1978) demonstrated that the summer and fall forage are critical to deer survival. The quantity and quality of the food in these seasons determines the accumulation of body fat, and therefore affects winter survival. At La Michilia Biosphere Reserve the winter is not as critical as the

length of the dry season (February–May).

Both cattle and deer used forbs as a common resource. Cattle exclusively used grasses, and deer used shrubs and trees exclusively. The utilization factor used was 0.60 (Avery 1975), and the grazing time was estimated at 6 months for cattle and 12 months for deer.

Carrying capacity for this area is therefore 20 deer/km^2 and 8 cattle head/km^2 (or 2.5 deer and 1 AU per 12.5 ha). The carrying capacity established for cattle in the State of Durango varied from 9–17 ha per AU (COTECOCA 1968).

Management Implications

One of the most striking features of these data is the marked difference in the flexibility of the pattern of forage use between deer and cattle over the course of the year.

Deer and cattle can coexist in a mixed oak-pine forest because there is a difference in food resource selection by these herbivores: deer prefer shrub and tree species, and cattle prefer grasses.

Diet varied seasonally with forage availability, but both herbivores maintained a characteristic foraging pattern.

Deer diet was more diverse than cattle diet, increasing in variety during the wet season. This implies that deer can optimize the utilization of food resources. Deer evolved in this habitat and appear to be adapted to its environmental changes. Cattle, which were introduced to this area approximately 3 centuries ago, show relatively little flexibility in feeding habits over the year, in spite of the availability of better quality forage in the wet season. Thus, cattle are more susceptible to illness, starvation, and mortality under dry conditions than are deer.

The diet overlap index reveals apparent competition during the wet season, but over this period common forage resources (forbs) are abundant, hence potential competition is reduced. As stated by Mackie (1981) "...wherever deer and livestock share a range, some overlap in uses of food and other resources is inevitable. And as livestock numbers and forage utilization increase the probability of overlaps in the use of basic resources and the likelihood of impact on deer also increases."

In conclusion, these 2 herbivorous species can coexist in the same habitat, owing to differences in their feeding strategies. In fact, common use grazing may be beneficial to the deer because cattle grazing may cause an increase in the forb component which is preferred by deer.

The advantage of common use, as stated by Ruyle and Browns (1985) is that the vegetation can maintain a stable composition under higher foraging pressure when 2 herbivores graze, than when only 1 species grazes.

This is significant because local people prefer to clear forest and raise cattle, not realizing that they can exploit a wildlife resource, such as deer, at the same time. The modification of management practices could result in greater overall productivity.

Literature Cited

Anthony, R.G., and N.S. Smith. 1974. Comparison of rumen and fecal analysis to describe deer diets. J. Wildl. Manage. 38:535-540.

Ashcraft, G.C. 1981. Deer use under black oaks with and without mistletoe. California Fish and Game 67:257–260.

Avery, T.E. 1975. Natural resources management. 2nd Edition. McGraw Hill Book Co. N.Y.

Bowyer, R.T., and V.C. Bleich. 1984. Effects of cattle grazing on selected habitats of southern mule deer. California Fish and Game 70:240–247.

Clemente-Sanchez, F. 1984. Utilización de la vegetación nativa en la alimentación del venado cola blanca (*Odocoileus virginianus* Hays) en el Estado de Aguascalientes. Tesis de Maestría. Colegio de Postgraduados. Chapingo, México.

Elliott, H.W., and G.W. Tanner. 1985. Dietary overlap among axis, fallow and black-tailed deer and cattle. J. Range Manage. 38:436–439.

COTECOCA. 1968. Coeficientes de Agostadero de la República Mexicana. Comisión Técnico Consultiva para la determinación Regional de los Coeficientes de Agostadero.

Church, D.C. 1975. Digestive physiology and nutrition of ruminants. Vol I. Digestive physiology. 2nd Ed. O & B Books, Oregon.

Ezcurra, E. 1980. Una nota acerca de la diversidad. Ecologia. Argentina 4:141–142.

Gaare, E., A. Sorensen, and R.G. White. 1977. Are rumen samples representative of the diet?. Oikos 29:390–395.

Gallina, S. 1981. Forest ecosystems in Northwestern Mexico, p. 27–56. *In:* P.F. Ffolliott and S. Gallina (eds.), Deer biology, habitat requirements, and management in western North America. Instituto de Ecologia. Mexico.

Gallina, S. 1984. Ecological aspects of the coexploitation of deer *(Odocoileus virginianus)* and cattle. Acta Zool. Fennica 172:251–254.

Gallina, S. 1988. Importancia del injerto (*Phoradendron* sp) para el venado. Southwest. Natur. 33:21–25.

Gallina, S. 1990. El venado cola blanca y su habitat en La Michilía, Durango. Ph.D. Thesis. Facultad de Ciencias. Universidad Nactional Autónoma de México.

Gallina, S., and C. Chargoy. 1987. Calidad forrajera y capacidad de carga de la vegetación nativa de la Reserva de la Biosfera La Michilía, para venados y bovinos. UACH-CONACYT-IE (Informe Técnico).

Gallina, S., M.E. Maury, and V. Serrano. 1978. Habitos alimenticios del venado cola blanca (*Odocoileus virginianus* Rafinesque) en la Reserva de La Michilia, Estado de Durango, p. 57–108. *In:* G. Halffter (ed.), Reservas de La Biosfera en el Estado de Durango. Instituto de Ecologia. Mexico.

Gallina, S., M.E. Maury, and V. Serrano. 1981. Food habits of white-tailed deer, p. 133–148. *In:* P.F. Ffolliott and S. Gallina (eds.), Deer biology, habitat requirements, and management in western North America. Instituto de Ecologia. Mexico.

Garcia, E. 1964. Modificaciones al Sistema de Clasificacion Climatica de Koppen (para adaptarse a las condiciones particulares de la Republica Mexicana). Segunda Edicion. Instituto de Geografia. UNAM. Mexico.

Goodwin, G.A. 1975. Seasonal food habits of mule deer in Southeastern Wyoming. USDA Forest Serv., Res. Note RM-287.

Hanley, T.A. 1982. The nutritional basis for food selection by ungulates. J. Range Manage. 35:146–151.

Hanley, T.A., and K.A. Hanley. 1982. Food resource partitioning by sympatric ungulates on Great Basin rangeland. J. Range Manage. 35:152–158.

Holechek, J.L., B. Gross, S. Mady Dabo, and T. Stephenson. 1982. Effects of sample preparation, growth stage, and observer on microhistological analysis of herbivore diets. J. Wildl. Manage. 46:502–505.

Holechek, J.L., M. Vavra, J. Skolvin, and W.C. Krueger. 1982. Cattle diets in the Blue Mountains of Oregon, I. Grasslands. J. Range Manage. 35:109–112.

Kie, J.G., C.J. Evans, E.R. Loft, and J.W. Menke. 1991. Foraging behavior by mule deer: the influence of cattle grazing. J. Wildl. Manage. 55:665–674.

Klein, D. 1970. Food selection by North American deer and their response to overutilization of preferred plant species, p. 25–44. *In:* A. Watson (ed.), Animal population in relation to their food resources. Blackwell Scientific Publ. Oxford.

Mautz, W.W. 1978. Nutrition and carrying capacity, p. 321–348. *In:* J.L. Schmidt and D.L. Gilbert (eds.), Big game of North America, ecology and management. Stackpole Books, Harrisburg, Penn.

Morales, A. 1985. Analisis cuantitativo de las dietas de ganado vacuno y venado cola blanca en La Michilia, Durango. Tesis de Licenciatura. Facultad de Ciencias. Universidad Nacional Autonoma de México.

McInnis, M.L., M. Vavra, and W.C. Krueger. 1983. A comparison of four methods used to determine the diets of large herbivores. J. Range Manage. 36:302–306.

Pianka, E.R. 1975. Niche relations of desert lizards, p. 292–314. *In:* M.L. Cody and J.M. Diamond (eds.), Ecology and evolution of communities. The Belknap Press of Harvard Univ. Press.

Ragotzkie, K.E., and J.A. Bailey. 1991. Desert mule deer use of grazed and ungrazed habitats. J. Range Manage. 44:487–490.

Ruyle, G.B., and J.E. Bowns. 1985. Forage use by cattle and sheep grazing separately and together on summer range in southwestern Utah. J. Range Manage. 38:299–302.

Sokal, R.R., and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Co. San Francisco.

Sparks, D.R., and J.C. Malechek. 1968. Estimating percentage dry weight in diets using a microscopic technique. J. Range Manage. 21:264–265.

Storr, G.M. 1961. Microscopic analysis of faeces, a technique for ascertaining the diet of herbivorous mammals. Australian J. Biol. Sci. 14:157–164.

Thill, R.E., and A. Martin, Jr. 1989. Deer and cattle diets on heavily grazed pine-bluestem range. J. Wildl. Manage. 53:540–548.

Todd, J.W., and R.M. Hansen. 1973. Plant fragments in the faeces of bighorns as indicator of food habits. J. Wildl. Manage. 37:363–366.

Vangilder, L.D., O. Torgerson, and W.R. Porath. 1982. Factors influencing diet selection by white-tailed deer. J. Wildl. Manage. 46:711–718.

Van Dyne, G.M., N.R. Brockington, Z. Szocs, J. Duek, and C.A. Ribic. 1980. Large herbivore subsystem, p. 269–537. *In:* I. Breymeyer and G.M. Van Dyne (eds.), Grassland systems analysis and man. IBP No. 19. Cambridge Univ. Press.

Vavra, M., R.W. Rice, and R.M. Hansen. 1978. A comparison of esophageal fistula and fecal material to determine steer diets. J. Range Manage. 31:11–13.

Ward, A.L. 1970. Stomach content and fecal analysis: methods of forage identification, p. 506–510. *In:* Range and wildlife habitat evaluation—a research symposium. USDA Forest Serv., Misc. Pub. 1147.

Zyznar, E., and P.J. Urness. 1969. Qualitative identification of forage remnants in deer faeces. J. Wildl. Manage. 33:506–510.