HABITAT RELATIONSHIPS OF THE UTAH PRAIRIE DOG

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ABSTRACT

The Utah prairie dog (*Cynomys parvidens* Allen) inhabits five south-central Utah counties and presently is considered as a species in danger of becoming extinct (U.S. Fish and Wildlife Service, 1977). Utah prairie dog colonies are of three types: (1) High elevation (above 2,200 m or 7,200 feet), (2) low elevation (below 2,200 m) (Collier 1975), and (3) low elevation associated with alfalfa.

Two representative Utah prairie dog colonies—a high elevation colony (HC) near the Bryce Canyon airport and a low elevation colony associated with alfalfa (AC) near the junction of Utah Highway 12 and the Sevier River—were intensively studied between February 1974 and September 1975. Comparative data also were collected at a low elevation colony lacking alfalfa (LC) near Hatch.

Aspects studied included the Utah prairie dog's life history, food preferences, and habitat relationships. The species' effects upon vegetation also were evaluated, and recommendations pertinent to the selection of prairie dog transplant sites and habitat management were developed.

Visually observed chewing times, along with the amounts of aboveground nonwoody biomass, showed that the order of food preference for Utah prairie dogs was cicada insects, alfalfa, grasses, forbs other than alfalfa, shrubs, and then dead vegetation. Plant parts ranked as follows: Flowers and seeds, young leaves, old leaves, then stems.

Prairie dogs in HC consistently weighed less ($P<0.01$), gained weight more slowly ($P<0.01$), and ingested less food than those in AC. Prairie dog densities on June 28 were 2.3/ha in HC, 16/ha in LC, and 36/ha in AC (0.9, 6.5, and 14.6/acre). HC did not increase in area nor population, whereas AC expanded rapidly. More alfalfa, more cool season palatable forage, lower elevation, and less predation result in greater body weight, population density, and expansion rate.

Prairie dogs reduced the potential aboveground biomass of grasses and forbs, including alfalfa, by 2 percent at HC, by 10 percent at LC, and by 90 percent at AC. Stunted growth accounted for most of the reduction at AC. Although prairie dogs at low densities may induce positive range trends, at high densities they cause a downward trend in perennial grasses and forbs.

Since 1870, much habitat of Utah prairie dogs has been lost to farms, houses, gullies, and vegetational shifts.

Basic habitat requirements for the Utah prairie dog include deep and well-drained soil, vegetation that prairie dogs can see over or through, and suitable forage. Except at low elevations, suitable forage always includes cool season grasses near the parturition burrows. Also, moist palatable forage must be available throughout the summer.

INTRODUCTION

The five extant species of prairie dogs, all of which are located in western North America and belong to the genus *Cynomys*, are divided into two groups on the basis of fur color and tail length. The black-tailed subgenus (the black-tailed and Mexican prairie dogs, *C. ludovicianus* and *C. mexicanus*, respectively) have black-tipped tails; whereas, the white-tailed subgenus (the white-tailed, Gunnison's and Utah prairie dogs, *C. leucurus*, *C. gunnisoni*, and *C. parvidens*, respectively) have shorter, white-tipped tails. The Zuni prairie dog (*C. g. zuniensis*) is a subspecies of the Gunnison's, and the Arizona prairie dog (*C. l. arizonensis*) is a subspecies of the black-tailed prairie dog (Figure 1).

The distribution of the Utah prairie dog (*C. parvidens* Allen) is limited to south-central Utah (Figure 2). Although this species previously inhabited nine Utah counties (Hardy 1937), it presently inhabits only five (Collier 1975 and Pizzimenti and Collier 1975). Its population declined from an estimated 95,000 individuals in 1920 (Collier and Spillett 1973), to about 8,000 in 1970 (U.S. Bureau of Sport Fisheries and Wildlife 1973), and to 3,300 in 1973 (Collier 1975).

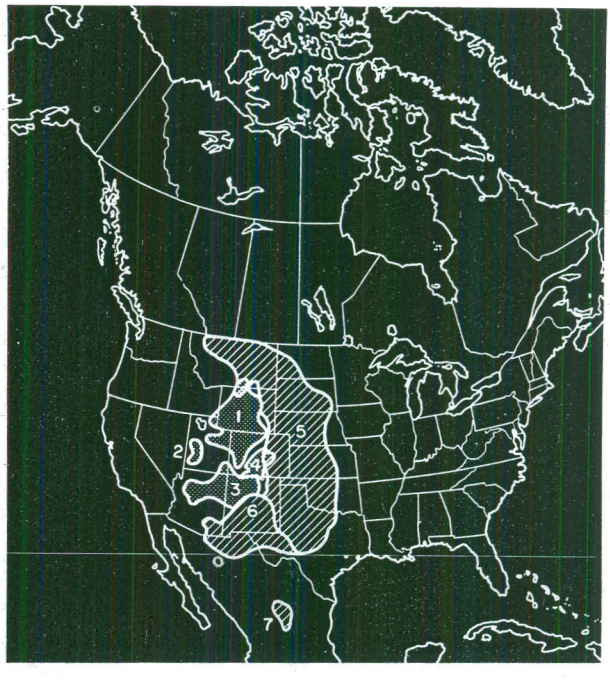


Figure 1. The distribution of the extant species and subspecies of prairie dogs:

(1) The white-tailed, (2) Utah, (3) Zuni, (4) Gunnison's, (5) black-tailed, (6) Arizona, and (7) Mexican (from Clark 1973).

Reductions in numbers of Utah prairie dogs resulted primarily from habitat changes and poisoning, which was more effective because of the reduced quantity and quality of habitat (Collier and Spillett 1973 and 1975). It is believed that the range of this prairie dog has been reduced by approximately 50 percent since 1920 (Collier and Spillett 1975). As a result, in 1973 the Utah prairie dog was officially designated as endangered or a species in danger of becoming extinct (U.S. Bureau of Sport Fisheries and Wildlife 1973). Since given protection in 1973, the population of Utah prairie dogs has increased dramatically, especially in areas associated with alfalfa (R. Hasenyager, Utah Division of Wildlife Resources, personal communication).

Various public agencies now are attempting to perpetuate the Utah prairie dog through reintroduction and management programs. However, little published information exists concerning this species, particularly in regards to its ecological requirements and habitat relationships.

Collier (1975) and Collier and Spillett (1975) determined the distribution and abundance of the Utah prairie dog. They also attempted to determine the Utah prairie dog's habitat requirements through correlation analyses. In contrast, direct observations and intensive sampling methods were used during this study to determine the animal's life history, food preferences, and habitat relationships, including its effects upon vegetation. Such information previously was lacking for the Utah prairie dog. Although other authors have published on prairie dog diets, only Fagerstone et al. (1977) presented dietary preference indices, and these were for the black-tailed prairie dog.

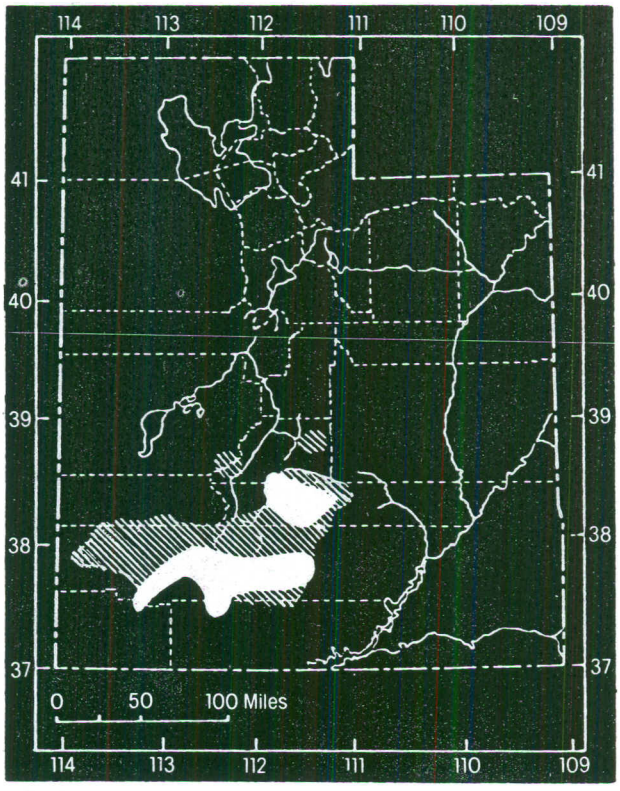


Figure 2. Approximate distribution of the Utah prairie dog (*Cynomys parvidens* Allen) in 1920 (diagonal lines) and 1970 (light portion) (from Pizzimenti and Collier 1975).

STUDY AREAS

Utah prairie dog colonies can be classified into three basic types: (1) High elevation (above 2,200 m or 7,200 feet), (2) low elevation (below 2,200 m) (Collier 1975), and (3) low elevation associated with alfalfa (*Medicago sativa*).

Two representative Utah prairie dog colonies were selected for intensive study: A high elevation (2,320 m) colony (HC) located 2 km north of the Bryce Canyon Airport (Plate 1) and a low elevation (2,070 m) colony associated with alfalfa (AC) located southeast of the junction of the Sevier River and Utah Highway 12 (Plates 2 and 3). Comparative data also were collected at a low elevation (2,160 m) colony lacking alfalfa (LC) located 3 km northeast of Hatch. In addition, visits were made to the other 28 colonies surveyed by Collier (1975) and his data for the 31 remaining colonies with more than 25 individuals were reanalyzed.

All three major study colonies were located near Panguitch in Garfield County. The mean annual precipitation for the three sites is 27 cm, most of which results from winter snows and late summer thunderstorms (U.S. Department of Commerce 1976).



Plate 1. The high elevation study colony (HC) included an upland area dominated by black sagebrush, crested wheatgrass and mat phlox, and a swale area dominated by bluegrasses and goldenweed.



Plate 2. The recently established, or newer portion, of the low elevation colony associated with alfalfa (AC) was dominated by alfalfa and western wheatgrass.



Plate 3. Bare ground, rubber rabbitbrush, European glorybind, and annuals such as Russian thistle replaced alfalfa and western wheatgrass on the older portion of the low elevation colony associated with alfalfa (AC). Stakes were used to determine mound growth.

Only the eastern ward (King 1955) of HC was studied. The dominant plants in the 19.6-ha (48 acre) upland portion were black sagebrush (*Artemisia arbuscula nova*), crested wheatgrass (*Agropyron cristatum*), and mat phlox (*Phlox muscoides*). Dominant plants in the 1.0-ha (2.5 acre) swale portion of HC were Nevada bluegrass (*Poa nevadensis*), Sandberg's bluegrass (*P. sandbergii*), and goldenweed (*Haplopappus apargioides*). HC typified high elevation Utah prairie dog colonies in aspects of elevation, vegetation, and density of prairie dogs; however, HC had more cool season grass and a higher population density than most highland colonies which were not seeded with crested wheatgrass (Collier 1975).

LC was located in a nearly pure stand of crested wheatgrass and was adjacent to a pure stand of rubber rabbitbrush (*Chrysothamnus nauseosus*). Although it was similar in population density to other low elevation Utah prairie dog colonies which lacked alfalfa, it differed from the average of such colonies by being 300 m higher in elevation and by having more cool season grass (Collier 1975). Dietary preference indices were not determined for LC, because available vegetation consisted almost entirely of crested wheatgrass and rabbitbrush.

Alfalfa and western wheatgrass (*A. smithii*) were cultivated on the AC site until the mid-1960's, and the prairie dog colony became established on it in the late 1960's (M. Hatch, personal communication). Stands of alfalfa and western wheatgrass still existed in recently established parts of AC, but were replaced by bare ground, rubber rabbitbrush, European glorybind (*Convolvulus arvensis*), and annuals such as Russian thistle (*Salsola kali*) in the older portions of the colony. AC typified low elevation colonies associated with alfalfa in aspects of elevation, vegetation, and prairie dog density (Collier 1975 and our own observations).

METHODS

A total of 22 man-months was spent in the field from February to November 1974 and from March to September 1975. Although Utah prairie dogs are sometimes active between November and late March, they feed very little during this period. Data were divided into five seasons of feeding activity: (1) Early spring began when plants started to sprout, at which time intensive feeding replaced occasional nibbling; (2) late spring began when the young appeared aboveground; (3) summer began when the young were weaned; (4) early fall began when rubber rabbitbrush bloomed; and (5) late fall began when plant dormancy was complete and ended when the last prairie dog became dormant.

Primarily because of elevational differences, early and late spring feeding activity seasons began slightly earlier in the low elevation associated with alfalfa (AC) study colony than at the high elevation (HC) study colony (Figure 3).

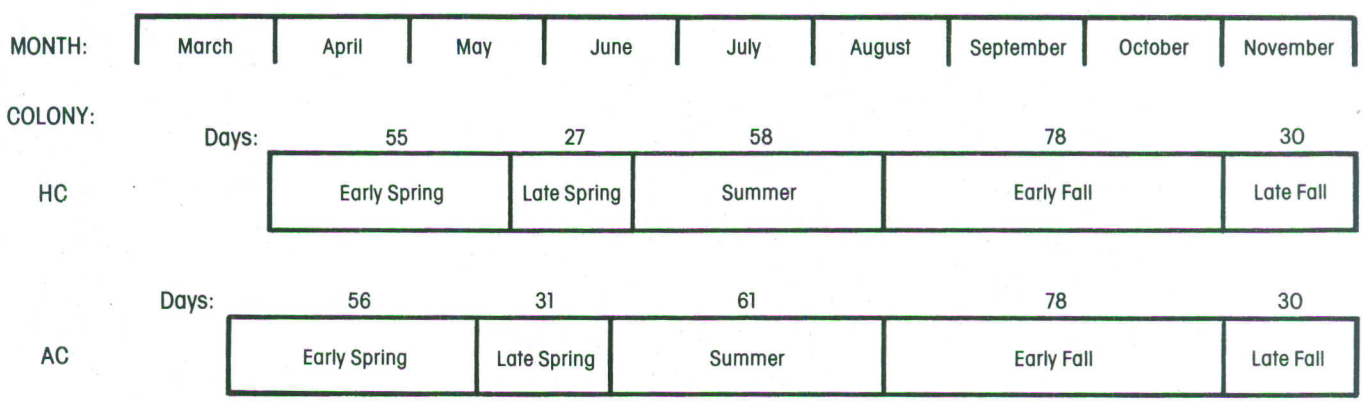


Figure 3. Chronology of feeding activity seasons for representative high elevation (HC) and low elevation associated with alfalfa (AC) Utah prairie dog colonies.

Preference indices for forage categories during a given season of feeding activity were calculated as the percentage of chewing time spent on a category divided by the percentage of the total availability contributed by that category. Time spent chewing on each category was computed from 2,320 visual observations, averaging 2.8 minutes apiece, of free-ranging animals. No animal was observed more than once during a 30-minute period. Plant parts eaten from each forage category also were recorded. During late spring, young were easily distinguished from adults and their chewing times differed significantly; thus, chewing times for these two age classes during late spring were first analyzed separately. Then we combined the results, adjusting for the fraction of the total forage intake consumed by each age class.

A modification of Pechanec and Pickford's (1937) method was used to estimate dry weight of aboveground, nonwoody plant tissue. Thus, for shrubs, only leaves, flowers, seeds, and new growth of stems were considered as available food. Basic sampling units were 1.0 m^2 (1.25 x 0.80 m quadrates). Forage was estimated in 1,673 quadrates and clipped in 375 quadrates.

The dry weight of cicadas (*Cicadidae*) available was developed by multiplying the number of emergence holes per unit area by the cicadas' mean dry weight.

Prairie dogs were weighed within 2 hours of capture. If an individual was trapped more than once during a month, only the weight for the capture nearest the middle of that month was used (Plate 4).

Mean energy budgets (kcal/day) for individuals of a given sex and age class were approximated on a seasonal basis by the formula: $(70\ W^{0.75} \times A) + C$, where W = body weight (kg), A = an activity factor, and C = the cost of growth (Klieber 1961). Based on data from Hansen and Cavender's (1973) black-tailed prairie dog feeding studies, we calculated four estimates of A ($\bar{x} = 1.35$, SD = 0.26). But, because Crocker-Bedford and Spillett (1977) demonstrated that Utah prairie dogs had larger home ranges than black-tailed prairie dogs, we used an activity factor of 1.4. Growth of nursing young costs 6.9 kcal/g, and growth of weaned young costs 3.0 kcal/g (Chew and Chew 1970) until the young begin to deposit mostly fat (J.A. Gessaman, personal communication). Growth above 700 g consists primarily of fat and water and costs about 7 kcal/g (J.A. Gessaman, personal communication). Based upon the amount of time the young spent foraging, we estimated that the young acquired two-thirds of their energy needs by foraging and one-third by nursing during late spring when they were aboveground but still nursing.

To transform metabolizable energy intake to consumption of forage in terms of dry weight, one needs an assimilation factor and the energy per unit of forage. The energy assimilation rate for Utah prairie dogs on their finely selected diets was assumed to be similar to the 80 percent rate found for black-tailed prairie dogs fed a composite diet of 16 percent protein, 2 percent fat, and 22 percent fiber (Hansen and Cavender 1973). Typically, a dry gram of forage contains 4.4 kcal of energy (Cook 1970:5).

Plate 4. Wire cones facilitated the sexing, tagging, and weighing of trapped prairie dogs.



Population sizes were estimated from mark-recapture data involving 886 live-captures, from visual counts during hours of peak activity, and from Lincoln indices based on visual counts of marked and unmarked animals.

The perimeters of HC and AC were determined by visual observations of prairie dog movements. LC was not observed as intensively; thus, its area of continuous burrows was assumed to equal its area of use.

The percentage of feeding time that prairie dogs spent in each portion of a colony was estimated by making several counts of foraging individuals in each portion. An equal number of observations was made for each hour of daylight.

The perimeters of all mounds at HC and AC were staked in April 1974. Mound perimeters then were reanalyzed in October 1974 and newly buried surface areas were computed.

Paired caged and uncaged plots of 0.5 m^2 were used to estimate primary production and utilization (Klingman et al. 1943). Utilization also was estimated by dividing the calculated amount of forage ingested by the primary production.

Canopy coverage at HC was ocularly estimated in 357 1-m^2 plots on mounds and in 374 1-m^2 plots off mounds.

Plate 5. Utah prairie dogs preferred insects over vegetation, but invertebrates were only seasonally available and often were difficult to catch.



RESULTS AND DISCUSSION

Dietary Preferences

Captive prairie dogs were fed whole fresh plants of six important foods. Ingestion rates varied little ($\bar{x}$ = 0.232 ± 0.027 air dry grams/minute of chewing); thus, percentage of chewing time approximated percentage of dry matter intake (Crocker-Bedford 1976). It was assumed the same was true for ingestion rates in the field. Figure 4 presents, by colony over the course of a year, the mean percentages of the total chewing time that were spent on different food categories, as well as the mean percentages of the total food availability that were comprised by different food types. Seasonal food preference indices ($\bar{x}$ percentage of chewing time for a food type or plant species divided by the $\bar{x}$ percentage of the total food availability comprised by that food type) are presented for each of the two intensive study colonies in Appendix Table 1.

Cicadas (insects) were the most preferred food type, but were available only at HC during the late spring season of 1974 (Plate 5). Adult prairie dogs ate most all cicadas which emerged (Crocker-Bedford 1976), but young prairie dogs were unable to catch cicadas. Inspections of feces showed that other insects were eaten, too. Kelso 1939, Longhurst 1944, and Smith 1958 reported that other prairie dog species also eat invertebrates.

Alfalfa and grasses were the only food types that were preferred during all seasons. Where they occurred together in the newer portion of AC, alfalfa was much preferred over grasses. Wheatgrasses (crested at HC and LC and western at AC) comprised about 90 percent of the available grasses on the three study sites.

During an average season, the preference index for grasses was 10 times that of all forbs other than alfalfa. At certain times, however, four range forbs had higher preference indices than did grasses. The high indices for leafy aster (*Aster frondosus*) and European glorybind during early spring were methodological artifacts, in that roots were ingested before aboveground biomass was measurable. Two wild buckwheats (*Eriogonum* spp.) were the only forbs that were ever actually preferred over

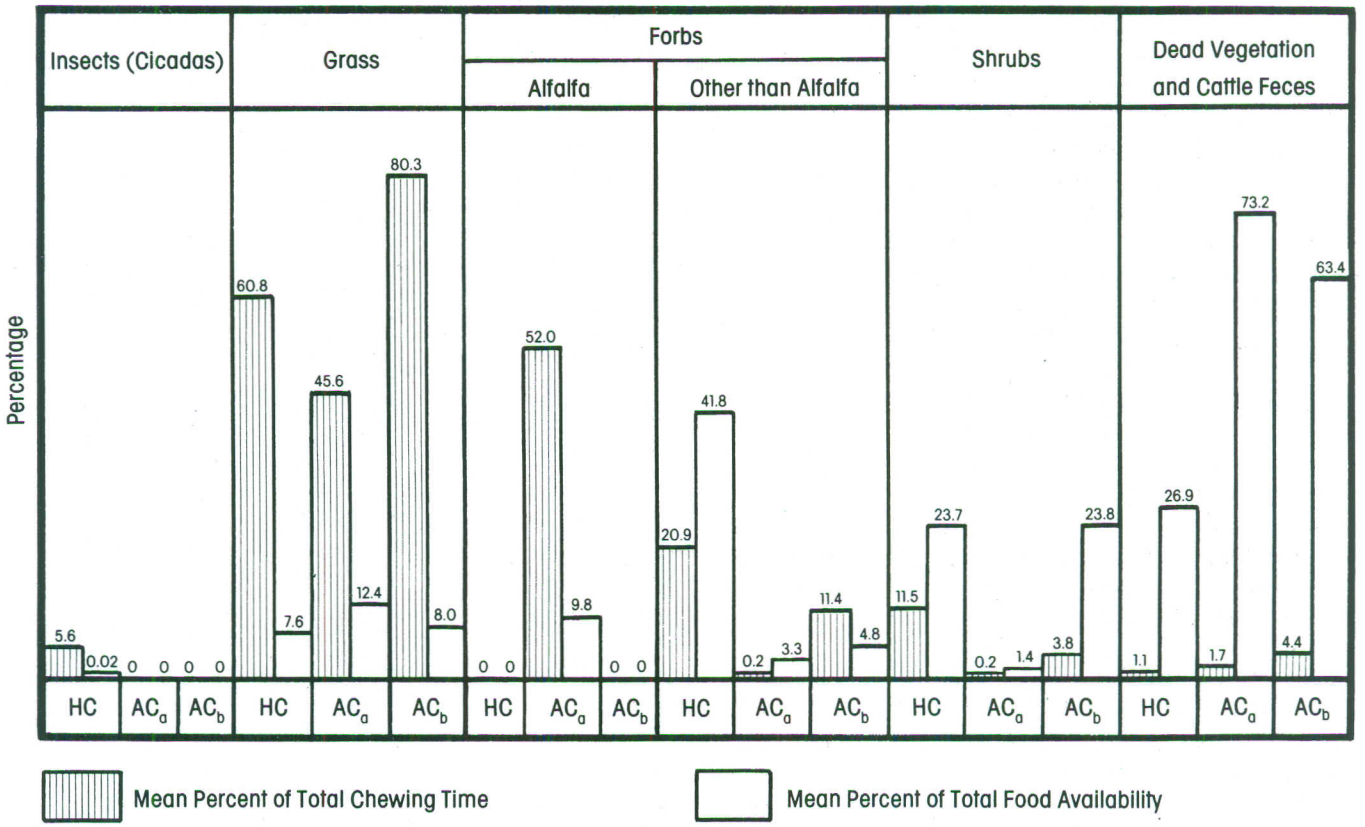


Figure 4. Mean percentage of total chewing time for a food type and the mean percentage of the total food availability comprised by that food type for two Utah prairie dog colonies.

HC = High elevation colony
AC$_a$ = Newer portion of low elevation colony associated with alfalfa (AC)
AC$_b$ = Older portion of low elevation colony associated with alfalfa (AC)

grasses, and this occurred only when these wild buckwheats were in seed. Still, Phil Mooney (U.S. Forest Service, personal communication) and Bonnie Turner (Utah Division of Wildlife Resources, personal communication) noticed that Utah prairie dogs in a mixed stand of mustard (*Chorispora tenella*) and wheat (*Triticum aestivum*) fed extensively upon the leaves of both plants during spring; however, Mooney and Turner did not develop dietary preference indices.

Black-tailed prairie dogs also prefer grasses over forbs and shrubs, and they prefer gramagrass (*Bouteloua* spp.) and bluegrass over wheatgrass (Fagerstone et al. 1977). Thus, the high preference for grasses demonstrated by Utah prairie dogs probably was not due to the most available grasses, crested wheatgrass and western wheatgrass, being exceptionally palatable grasses.

The generally low preference for forbs other than alfalfa questions the importance of forbs to Utah prairie dog densities suggested by Collier (1975:44). Collier (1975) demonstrated a correlation between forb abundance and high prairie density; however, our data indicate that forbs are common in high density colonies because they are not readily consumed. The low preference for forbs agrees with the findings of Fagerstone et al. (1977), wherein a reduction in forb availability was not detrimental to a population of black-tailed prairie dogs. Obviously, the percentage of forbs in the Utah prairie dog's diet increases with the availability of forbs relative to grass. However, an increase in the percentage of forbs other than alfalfa in the diet of the Utah prairie dog may result in decreased body weight gains (Crocker-Bedford, unpublished manuscript).

Low to very low preference indices were exhibited for shrubs, except when they were in

flower or seed. Flowers accounted for almost all of the ingested shrub biomass. Thus, the preference for leaves and new growth of shrub stems was negligible. Preference indices for shrubs would have been even lower if their woody parts had been computed into the availability estimates. Preference indices for shrubs at AC would have been still lower if the dense shrubs adjacent to AC had been included in the availability estimates. These shrubs were not included because their density and height prevented prairie dogs from entering them. Prairie dogs rarely enter vegetation they cannot see through or over (Koford 1958:63).

Dead vegetation and cattle feces were preferred over shrubs by young prairie dogs during late spring. Possibly, young were then exhibiting exploratory behavior or required fiber while nursing.

Given the opportunity, Utah prairie dogs usually selected a plant's flowers or seeds over its leaves. The highest preference indices for 17 of the 24 plant species listed in Appendix Table 1 occurred during seasons when the plants were in flower or seed. Flowers or seeds of at least six of the remaining seven plant species also were selected over leaves, but reproductive parts of these seven species were not abundant enough to greatly influence preference indices. In regards to the use of plant leaves, the youngest leaves consistently were selected. Stems rarely were eaten. Thus, through selecting flowers, seeds, and young leaves, prairie dogs obtained higher proportions of protein and digestible energy than would have been provided from older leaves and stems.

Both prairie dogs and cattle relish alfalfa. Cook et al. (1967) found that cattle preferred grasses over range forbs and forbs over shrubs, though their use of forbs and shrubs increased in late summer. Such selection also was true for Utah prairie dogs. However, cattle probably do not adversely compete for forage with prairie dogs, because Utah prairie dogs prefer the short, young leaves of plants which cattle cannot reach. In fact, livestock grazing is beneficial to Utah prairie dogs, at least on a short-term basis, because grazing induces a larger number of young, palatable leaves, and because prairie dogs have difficulty using vegetation that is so tall and dense that they cannot see over or through it (Koford 1958:63).

Body Weight and Energy Consumption per Prairie Dog

Adult prairie dogs at AC began to forage approximately 8 days prior to those at HC (Table 1). Juveniles at AC began foraging about 10 days earlier than those at HC (Plate 6). However, adult males and females at AC entered dormancy approximately 55 and 38 days, respectively, prior to those at HC. Juvenile females in both colonies averaged a total of about 137 foraging days, but juvenile males at AC foraged approximately 10 days longer than those at HC (178 total foraging days versus 168).

Table 1. Mean annual foraging seasons by sex and age class for those Utah prairie dogs surviving until dormancy on a high elevation colony (HC) and on a low elevation colony associated with alfalfa (AC).

	Mean Dates		
	Began Foraging	Entered Dormancy	Average No. Foraging Days/ Individual
HC:			
Adult ♂♂	3/28	9/3	160
Adult ♀♀	3/28	9/10	167
Juvenile ♀♀	6/1	10/15	137
Juvenile ♂♂	6/1	11/15	168
AC:			
Adult ♂♂	3/20	7/10	112
Adult ♀♀	3/20	8/3	136
Juvenile ♀♀	5/22	10/5	137
Juvenile ♂♂	5/22	11/15	178



Plate 6. Juvenile prairie dogs first emerge at an earlier date at lower elevations.

Because of differences in dates of emergence and entering dormancy between colonies, as well as between sexes and age classes, the aboveground population composition by sex and age class for both study colonies varied considerably from season to season (Figure 5).

AC prairie dogs weighed more and gained weight faster ($P<0.01$, t-test) than those in HC (Figures 6 and 7). Body weights for LC were taken only at the end of June, at which time they were intermediate to those in HC and AC. HC prairie dogs weighed less than those on other colonies in part because they began feeding 1 week later due to retarded plant growth at the higher elevation. However, forage being available earlier at AC than at HC still does not account for the continuously faster growth at AC. Genetic differences probably are not the cause, as AC prairie dogs were similar in weight to those from other colonies with alfalfa. HC prairie dogs likewise were similar in weight to animals from other high elevation colonies.

Better nutrition appears to be the reason that AC prairie dogs grew faster and weighed more than HC prairie dogs. AC had only one-fourth as much non-woody living phytomass available as did HC; thus, nutritional differences must have been due to plant species composition rather than to forage abundance. Because alfalfa was the only plant species extensively used by AC animals that was missing from the diets of HC animals, it probably was the nutritive factor.

Figure 8 shows the amount of forage and metabolizable energy eaten daily by the average foraging prairie dog at AC and HC, by season. Intake per individual was higher at AC than at HC. After algebraically adjusting for differences in lengths of seasons (See Figure 3) and differences in numbers of animals foraging during each season in 1974 (Figures 9 and 10), we calculated that the average foraging prairie dog at AC metabolized 126 kcal/day, as compared to an average of 97 kcal for a foraging prairie dog at HC. If the Utah prairie dogs assimilated 80 percent of their forage intake, as did the black-tailed prairie dogs studied by Hansen and Cavender (1973), then foraging prairie dogs at AC and HC injested an average of approximately 157 and 121 kcal per day, respectively, whereas, the average black-tailed prairie dog consumes about 110 kcal per day (Hansen and Cavender 1973).

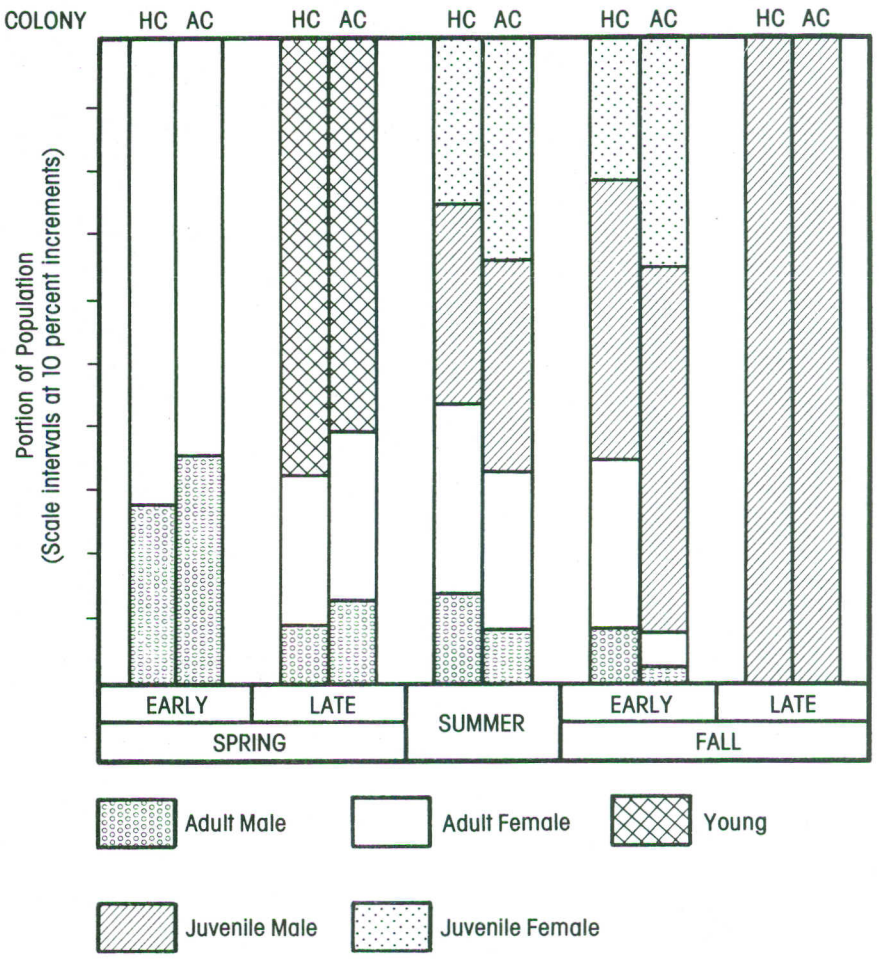


Figure 5. The above-ground population composition (percentage) by sex and age for a high elevation prairie dog colony (HC) and a low elevation prairie dog colony associated with alfalfa (AC) by season.

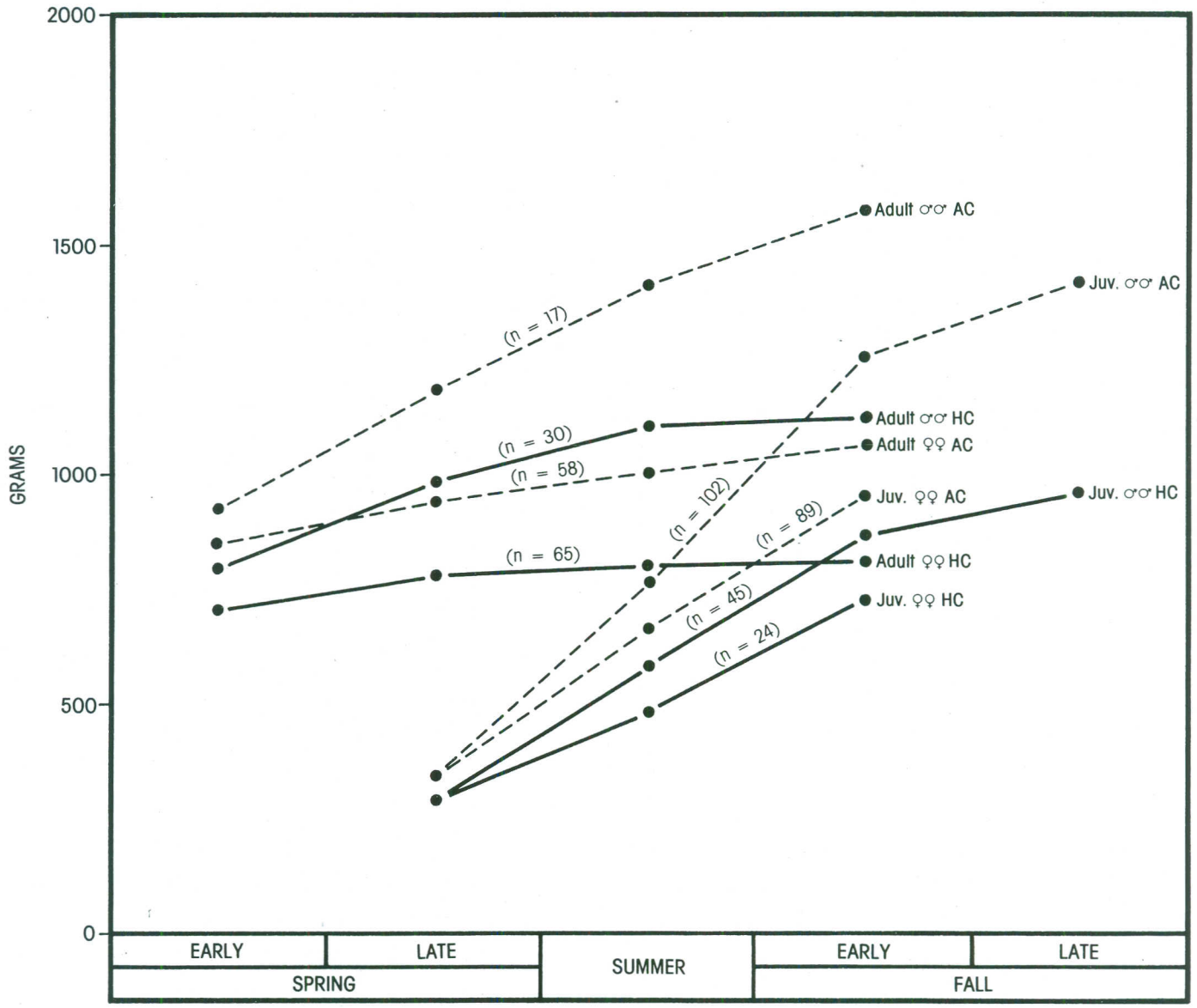


Figure 6. Mean weights (grams) by season, age class, and sex for Utah prairie dogs in a high-elevation colony (HC) and a low-elevation colony associated with alfalfa (AC).

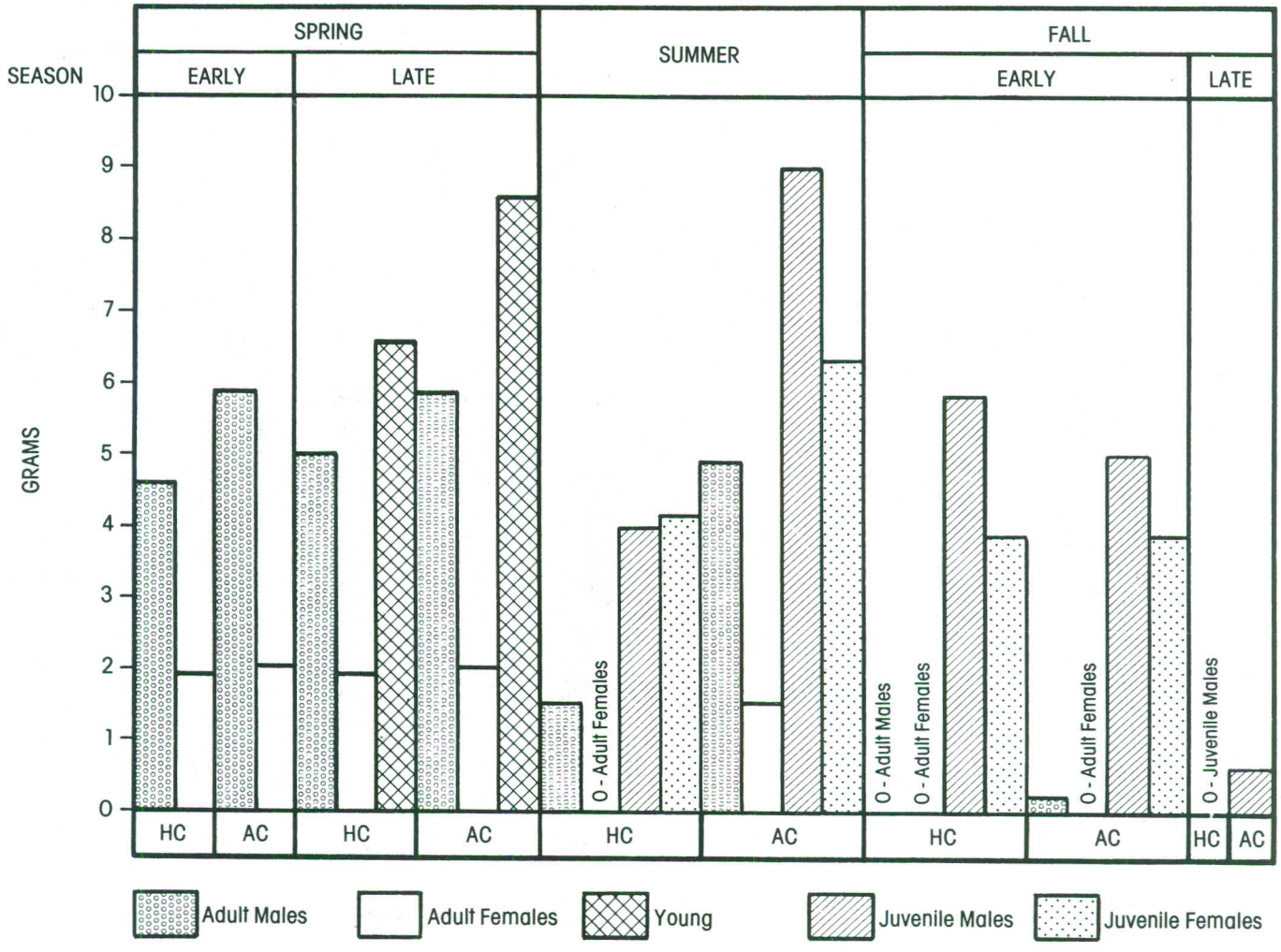


Figure 7. Mean daily weight gains* (grams) by season, age class, and sex for Utah prairie dogs in a high-elevation colony (HC) and a low-elevation colony associated with alfalfa (AC).

*Based on 164 weights of 93 individuals at HC, and 266 weights of 167 individuals at AC.

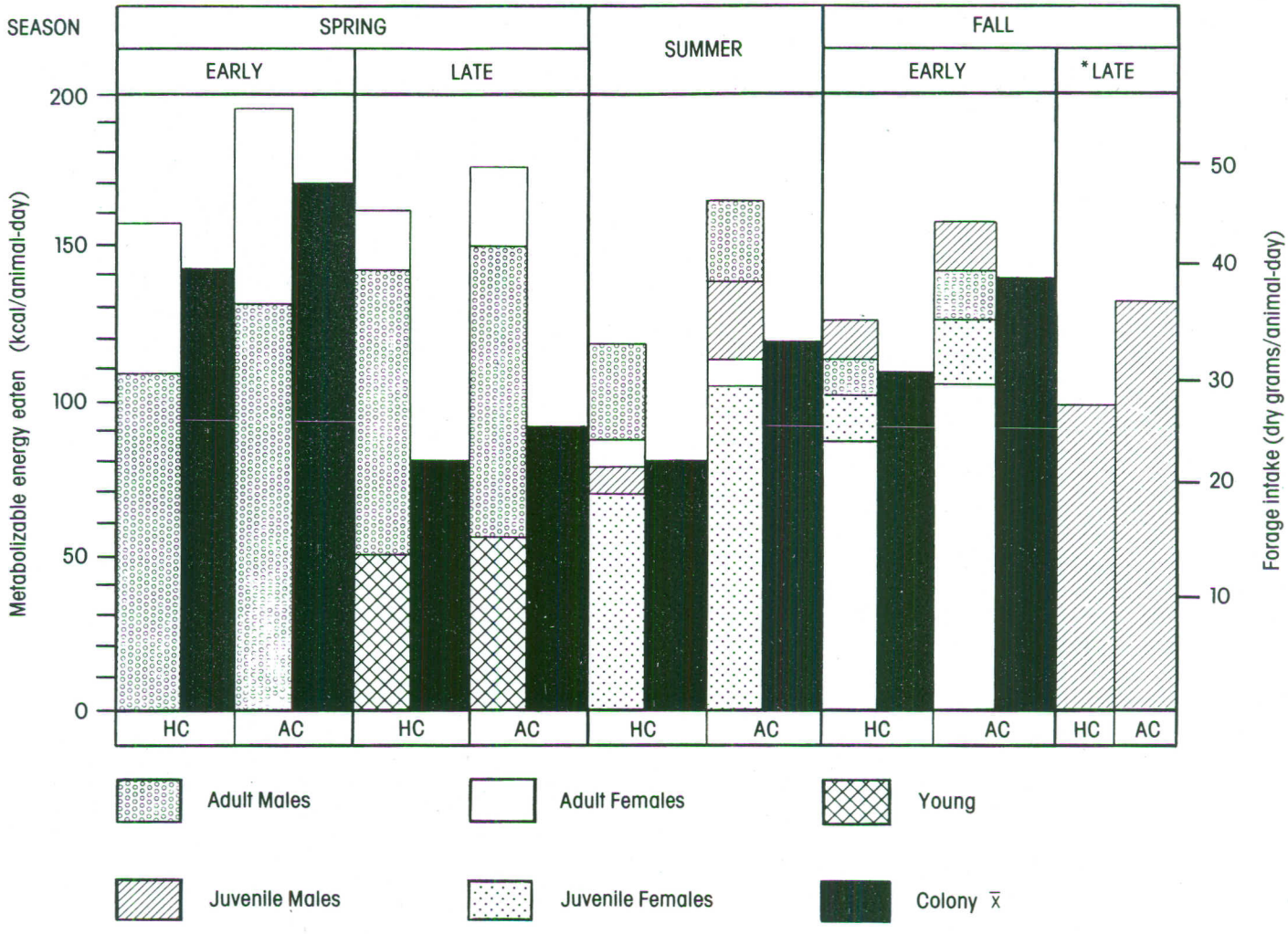


Figure 8. Mean daily metabolizable energy eaten (kcal/day) and forage intake (dry-grams/day) by the average foraging Utah prairie dog in a high-elevation colony (HC) and a low-elevation colony associated with alfalfa (AC).

* Also represents Colony $\bar{x}$.

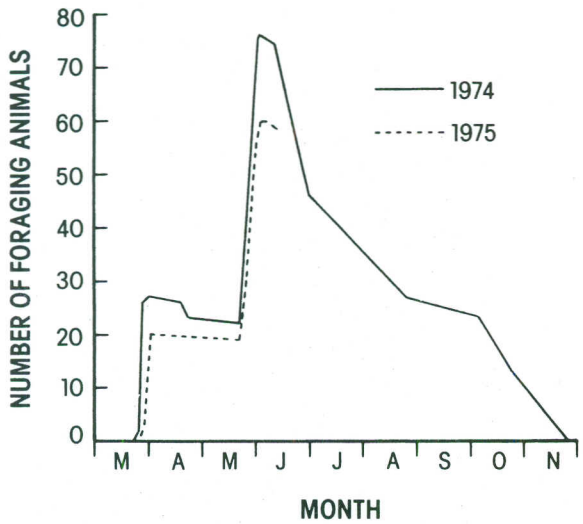


Figure 9. Mean numbers of foraging Utah prairie dogs on the 20.6-ha high elevation study colony (HC).

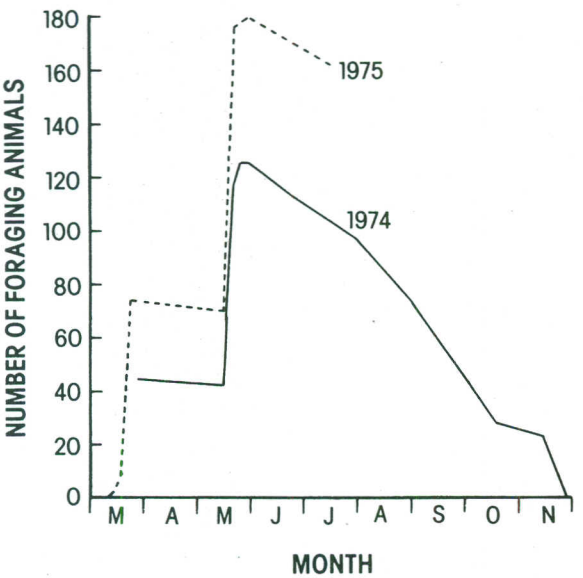


Figure 10. Mean numbers of foraging Utah prairie dogs on the low elevation study colony associated with alfalfa (AC), which expanded from 2.9 to 4.8 ha.

Forage contains about 4.4 kcal/dry-grams (Cook 1970:5); therefore, the average foraging Utah prairie dog injested 36 dry-grams of forage per day at AC and 28 dry-grams at HC, whereas the average black-tailed prairie dog (Hansen and Cavender 1973) consumes about 25 dry-grams of forage per day. Further, the average Utah prairie dog that survived until dormancy foraged slightly less than 5 months at AC and just over 5 months at HC (from data in Table 1 weighted by population structure). Thus, during one year the average prairie dog surviving until dormancy consumed a total of about 5.1 kg of dry-weight forage at AC and about 4.4 kg at HC.

Based on Cook's (1970) gross energy requirements for livestock, the mean number of feeding Utah prairie dogs constituting an average livestock unit at AC and HC, respectively, would be 380 and 490 per cow and calf unit, 300 and 390 per dry cow, 250 and 330 per steer, and 80 and 100 per ewe and lamb unit. These figures represent only feeding prairie dogs. Numbers of living (both foraging and dormant) Utah prairie dogs per livestock unit are about 2.4 (12 months/5 months) times greater because the average prairie dog surviving until dormancy forages only five months.

Population Density

Numbers of foraging prairie dogs varied from week to week (See Figures 9 and 10); thus, colonies were compared on the basis of their June 28 populations. All prairie dogs had emerged by this date and very few had entered dormancy.

On June 28, 1974, HC had a density of 2.3 prairie dogs/ha for the 20.6 ha observed to be used by the animals. The density would have been 45 percent lower if an outlying area which contained burrows, but where use was never observed, also was used by the prairie dogs under study. In June 1975, HC's density was slightly lower than in June 1974.

On June 28, 1975, LC had 16 animals/ha if the animals used only 9.3 ha. If an area for which use was questionable was included, the density would have been 20 percent lower. A paucity of new burrows indicated that LC's population and area were increasing slowly.

The density in AC on June 28 was similar in both years—38/ha in 1974 and 35/ha in 1975—though the June 28 population increased from 111 animals in 1974 to 169 in 1975. Density remained essentially constant because

the colony's surface area grew with the population. Between late June and August 1974, the area used by prairie dogs increased from 2.9 to 4.8 ha. An additional 0.5 ha was being used by June 1975 but so rarely that it was not considered in the calculations. AC's expansion in 1974 was not unusual, as this colony tripled in surface area between August 1971 (Collier 1975:73) and August 1974. We observed that other colonies with alfalfa also expanded rapidly.

Of the remaining Utah prairie dog colonies that had at least 25 individuals in 1972, 11 had population density indices at least as low as HC's, 11 had density indices higher than HC's but at least as low as LC's, 5 had indices greater than LC's but at least as low as AC's, and 4 had density indices greater than AC's (Collier 1975:23, 28). The same trends appeared to hold true in 1974 and 1975.

A white-tailed prairie dog colony (Tileston and Lechleitner 1966) and a Gunnison prairie dog colony (Fitzgerald and Lechleitner 1974) had densities intermediate to those of HC and LC. Breeding population densities of black-tailed prairie dog colonies in the central and northern Great Plains usually are between 3 and 12/ha (Koford 1958:10). In comparison, the breeding or early spring population density of Utah prairie dogs was 1/ha in HC and 15/ha in AC.

Different densities and expansion rates for the three study colonies indicate that AC provided better habitat than LC, which in turn provided better habitat than HC. AC had a higher winter survival rate than HC, possibly because AC prairie dogs entered dormancy when 35 percent heavier than animals at HC ($P < 0.01$ t-test). Alfalfa contributed to a more rapid weight increase at AC and, therefore, contributed to a higher over-winter survival rate. Also, of the 31 colonies studied by Collier (1975), we observed that 9 of the 11 highest density colonies contained alfalfa, while the 20 lowest density colonies lacked alfalfa.

Possibly because of nutritional differences, adults at AC rarely attacked young, whereas adults at HC bit and chased young frequently between 3 and 5 weeks after the emergence of young. Three dead young with large gashes, like those inflicted by adults, were found at HC (Plate 7). No wounded young were found at AC. Only half the young still were present at HC 6 weeks after their emergence in 1974, while 85 percent still were present at AC.



Plate 7. At the low density study colony (HC), young Utah prairie dogs (such as this one) were frequently attacked and sometimes killed by adults. In contrast, young rarely were attacked by adults of the AC study colony, possibly because of better nutrition afforded by alfalfa.

LC had a higher prairie dog density than HC, at least in part because LC had more food available during the early spring period of reproduction. The 160-m lower elevation of LC allowed forage to develop slightly earlier, but the major reason for more early spring food was that LC contained much cool season

palatable forage (a nearly pure stand of crested wheatgrass). Our analysis of Collier's (1975) data showed that the availability of palatable cool season forage was positively correlated with density ($P < 0.001$), whereas altitude was negatively correlated with density ($P < 0.001$). The combination of these two factors (palatable cool season forage and elevation) accounted for 72 percent of the variation in population densities for colonies lacking alfalfa. Furthermore, highland areas that lacked cool season palatable forage were devoid of dog towns.

Palatable early spring forage is an important factor in the life history of the Utah prairie dog. Breeding occurs in March and lactation continues into June (Plate 8). Adult females require almost twice as much energy per day from April to June as during summer. Warm season vegetation cannot meet a female's nutritional requirements during spring because it does not begin growth until June. Furthermore, low palatability, cool season plants may not be palatable enough to induce prairie dogs to eat sufficient quantities to meet their nutritional needs. Such plants also may be poisonous or indigestible. For example, a laboratory diet of pure mat phlox caused cecal bloat.

A scarcity of food in the older portion of AC possibly caused prairie dogs to forage in new areas; however, a paucity of predators contributed to the successful expansion of this colony. Badgers (*Taxidea taxus*) were eliminated from AC during both 1973 and 1974, and people residing near AC shot at coyotes (*Canis latrans*) whenever possible. Collier (1975:92) also observed little badger sign in cultivated areas, such as around AC. In contrast, a coyote den was adjacent to LC and another was 1 km from HC, and badgers frequently dug in the periphery of HC.

Coyote predation may be severe in areas into which prairie dogs are expanding. Four times in such areas the senior author was able to walk up to prairie dogs, as they froze rather than flee to their distant burrows. Most badger predation occurs in less developed peripheral burrows, thereby reducing colonial expansion (Koford 1958:31).

Plate 8. Adult female Utah prairie dogs require almost twice as much energy per day from April to June, during gestation and lactaction, as during summer. Forage availability during spring is a major factor limiting Utah prairie dog populations.



Use Per Unit Area

Feeding by prairie dogs at HC was confined to the 19.6-ha upland portion, except during summer when 108 visual scans of activity indicated that 39 percent of the colony's foraging occurred in the 1.0-ha swale. Prairie dogs at AC foraged more in the newer area and less in the older area as the seasons progressed (Figure 11).

Daily forage consumption per unit area was calculated for HC and AC by season (Figures 12 and 13). Each calculation was based upon the number of foraging animals (See Figures 9 and 10), the fraction of foraging occurring in each portion of a colony, the surface area of each

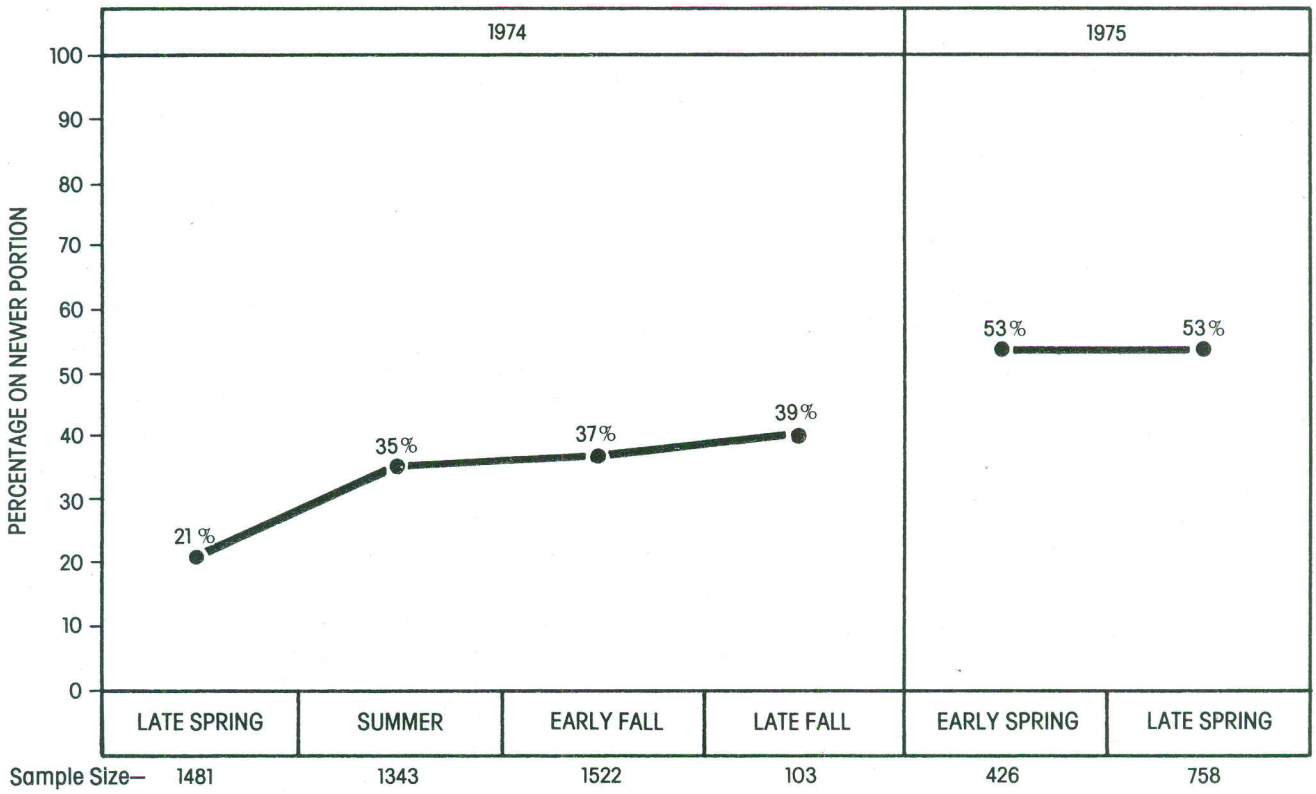


Figure 11. The percentage of total foraging time that Utah prairie dogs spent in the newer portion of the low elevation colony associated with alfalfa (AC).

portion, and food intake per foraging individual (See Figure 8). Daily forage consumption per unit area was highest during late spring when the most animals were feeding. During all of 1974, prairie dogs at HC consumed 9.6 kg/ha of dry forage on the 19.6-ha upland and 22 kg/ha in the 1.0-ha swale (Plate 9). HC's population density was slightly lower in 1975 than in 1974; thus, the population probably consumed less forage in 1975. Forage consumption at AC, from the summer of 1974 through late spring of 1975, was 220 kg/ha in the older 1.9-ha portion of the colony and 110 kg/ha in the newer 2.9-ha portion.

If annual food intakes per unit area were proportional to population densities in late June, then prairie dogs at LC consumed between 65 and 75 kg/ha/year.

Unlike black-tailed prairie dogs (Koford 1958:45), Utah prairie dogs ate almost all of the green vegetation that they cut. The largest waste by Utah prairie dogs was the accidental dropping of rabbitbrush flowers.

Prairie dog digging buried few plants, except in the newer area of AC. There, during the summer of 1974, prairie dogs dug 191 new burrows and buried 2.3 percent (670m^2) of the surface area.

Use Per Unit of Primary Production

Prairie dogs at HC consumed 6 kg/ha of crested wheatgrass during 1974 and 5 kg/ha during 1975. In 1974, 45 caged plots indicated that crested wheatgrass produced 160 (± 14 SE) kg dry weight/ha at HC. Samples from 24 caged plots during 1975 indicated that the crested wheatgrass yield was 270 (± 20 SE) kg/ha. Thus, Utah prairie dogs at HC consumed about 4 and 2 percent, respectively, of the colony's crested wheatgrass production for 1974 and 1975. Because crested wheatgrass was the most preferred plant on HC, use per unit of production for other plant species probably was less. In fact, prairie dogs consumed only 1.8 kg of forbs per ha (0.6 percent) from a forb standing crop of 320 kg/ha (Crocker-Bedford 1976:112). Thus, the total utilization at HC was less than 2 percent of the production of grasses and forbs.

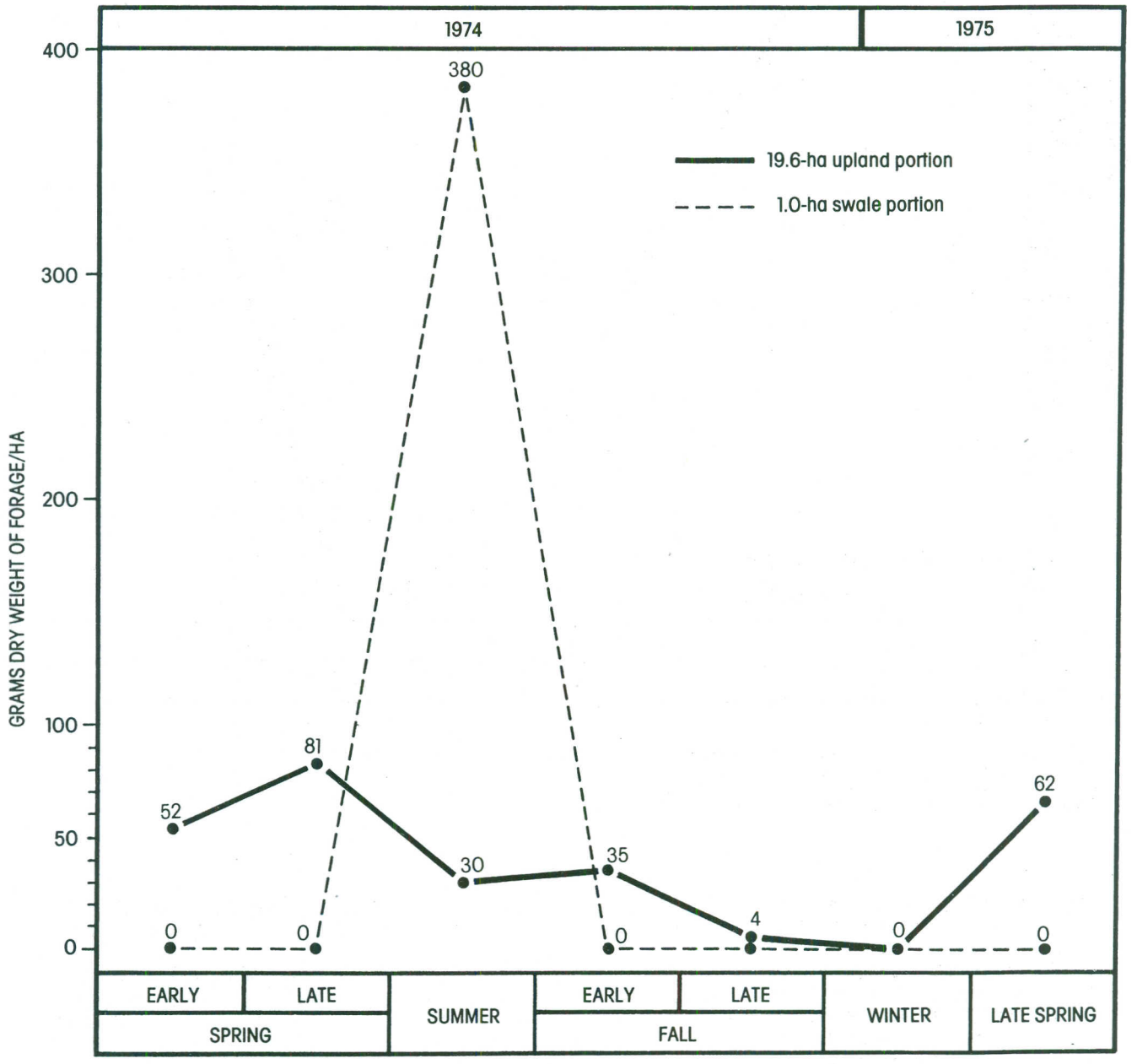


Figure 12. Mean daily forage intake (grams dry weight/ha) for a Utah prairie dog population at a high elevation colony (HC) by season and location within the colony.

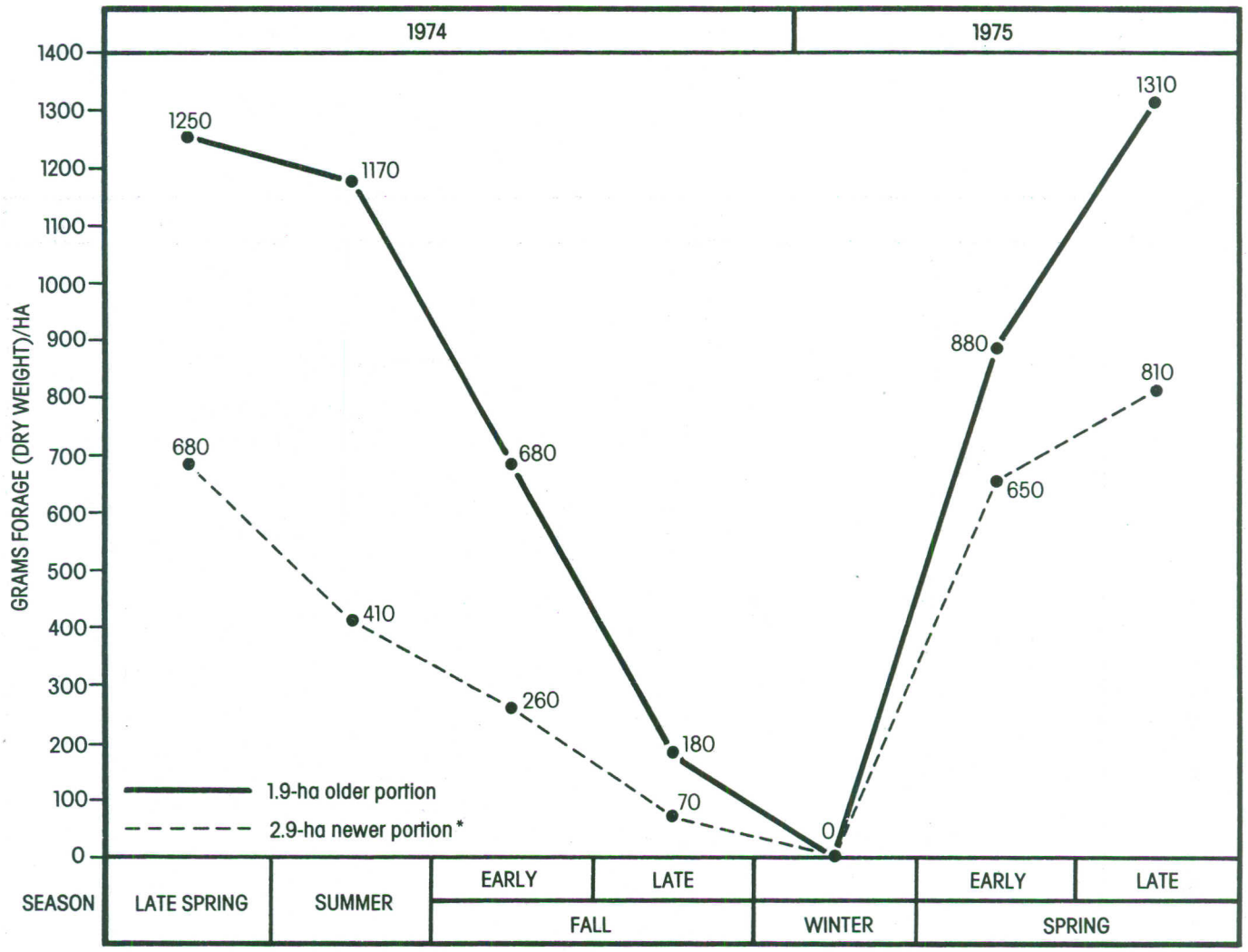


Figure 13. Mean daily forage intake (grams dry weight/ha) for a Utah prairie dog population at a low elevation colony associated with alfalfa (AC) by season and portion of the colony.

*Only 1.0 ha during late spring 1974.

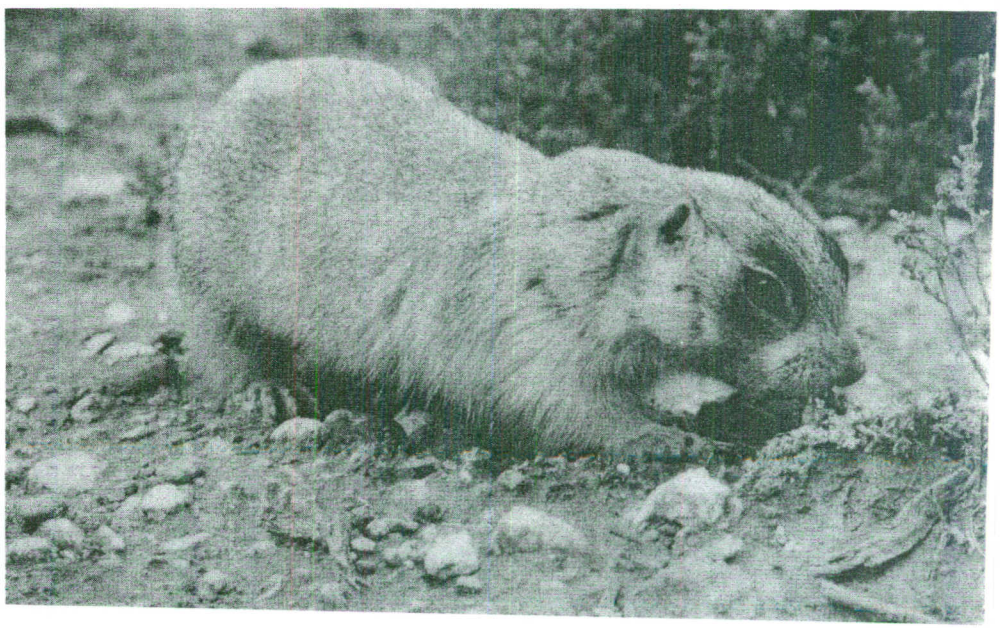


Plate 9. On the highland study colony (HC) in 1974, the population of prairie dogs (including this one) consumed only 9.6 kg (dry weight)/ha on the 19.6-ha upland and 22 kg/ha on the 1.0-ha swale. Because of larger body weights and higher density, the prairie dog population at the low elevation colony associated with alfalfa (AC) consumed 150 kg/ha.

On June 30, 1975, data from 50 uncaged plots in LC indicated a standing crop of herbs (mostly crested wheatgrass) of 325 (±37 SE) kg/ha. Prairie dogs already had ingested about 35 kg/ha, and pellet counts indicated that use by other mammals had been minimal. Therefore, LC probably had produced about 360 kg/ha prior to July, and prairie dogs had consumed about 10 percent of this primary production. Although prairie dogs also consumed vegetation after June 30, late summer rains produced forage which compensated for use during this period.

In the older portion of AC, prairie dogs annually consumed about 210 kg/ha of herbs—33 percent of the 1974 caged production of grasses and forbs including alfalfa, and 19 percent of the 1975 production (Table 2). Annual consumption of grasses and forbs including alfalfa was about 110 kg/ha in the newer portion of AC, or 18 percent of the herbal production in cages in 1974 and 8 percent of such production in 1975.

Table 2. Primary production and utilization of grasses and forbs including alfalfa in the two portions of a Utah prairie dog colony associated with alfalfa (AC) as determined by pairs of caged and uncaged plots.

Portion of dog town	Year	Number of pairs	Production in cages (dry kg/ha)	Utilization (percentage)
Older 1.9-ha	1974	25	640 ± 82[a]	94 ± 1[a]
Older 1.9-ha	1975	17	1100 ± 180	91 ± 4
Newer 1.0-ha[b]	1974	6	600 ± 83	86 ± 4
Newer 2.9-ha	1975	27	1400 ± 170	85 ± 3

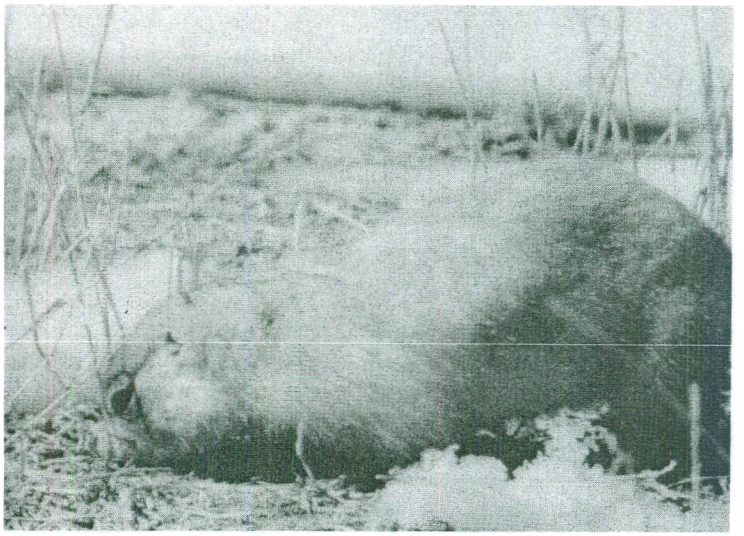
[a] Mean ± standard error.

[b] Does not include the 1.9 ha first grazed during summer 1974.

Forage use of herbs at AC, as determined by paired plots, was about 90 percent of their primary production (See Table 2), compared to the 8 to 33 percent use determined above by the amount ingested divided by the caged-plot yield. Pellet counts indicated that utilization at AC by herbivores other than prairie dogs was minimal. Therefore, prairie dogs must have stunted the primary production occurring outside the cages at AC.

Prairie dogs at AC usually clipped vegetation at or below ground level. Cook (1966) and White (1973) found that close clipping reduced primary production. Also, close clipping eliminates many vegetative buds, which can arrest growth in plants (Rechenthin 1956). In addition, prairie dogs began feeding in very early spring while snow was still present, and Cook (1966) found that early grazing reduced primary production (Plate 10).

Plate 10. At the low elevation colony associated with alfalfa (AC), Utah prairie dogs usually clipped vegetation at or below ground level, and prairie dogs began feeding in very early spring. Such feeding stunted the vegetation, apparently causing a 400 to 900 kg/ha decrease in primary production at AC. Data indicate that no stunting occurred in the highland colony (HC).



Prairie dogs at HC did not substantially reduce primary production. During 1975, 24 sets of paired plots inside the dog town showed 5 percent utilization of crested wheatgrass by both prairie dogs and a moderate population of jackrabbits (*Lepus californicus*). Twelve sets of paired plots outside of HC still indicated 5 percent utilization of grass by jackrabbits alone. Apparently, use by the low density of prairie dogs was insufficient to stunt grass production.

In summary, prairie dogs reduced the potential aboveground biomass of grasses and forbs, including alfalfa, by about 2 percent at HC, by about 10 percent at LC, and by 90 percent at AC. However, about 70 percent of the reduction at AC was due to stunting.

Vegetational Changes Induced by Prairie Dogs

In addition to prairie dogs stunting primary production at AC during the same year as forage use, they also decreased primary production of herbaceous perennials for the following or successive years. Vegetation on the "newer" and "older" portions of AC was similar during the late 1960's, prior to the establishment of this colony (M. Hatch, personal communication). Caged plots during 1975, however, indicated that the newer portion of AC produced twice ($P<0.01$, t-test) as much perennial grass and six times ($P<0.01$, t-test) the amount of forbs (including alfalfa) as the older portion of the colony. Similarly, more grass was produced adjacent to than on LC ($P<0.01$). Prairie dogs clipped vegetation short and began feeding very early in the spring, and Willard and McKell (1973) found less yield following 4 years of intensive clipping than after 4 years of light clipping, as well as less yield after 4 years of early clipping as compared to late clipping. Donart and Cook (1950) also found that early clipping reduced plant vigor.

During most years, cattle congregate on HC; thus, it is not valid to compare this colony with adjacent areas. It seems unlikely that such a low density of prairie dogs as inhabited HC could adversely affect primary production. Also, in most of HC, prairie dog mounds had higher vegetational canopy coverage than was present off mounds ($P<0.01$). Apparently, prairie dogs improve soil depth and possibly soil quality (Crocker-Bedford 1976).

Loss of Utah Prairie Dog Habitat

Prior to the planting of agricultural crops, prime Utah prairie dog habitat probably supported prairie dog densities similar to that on LC. Prime habitat would have been below 2,200 m in elevation and would have had much cool season palatable forage. Most such habitat has been taken for farms or houses during the past 100 years. As a result, most Utah prairie dogs now inhabit either densely populated colonies which have alfalfa, or sparsely populated colonies on high plateaus.

Permanent Utah prairie dog colonies always are associated with areas that provide moist vegetation throughout the summer. Prairie dogs at HC daily traveled 300 m to moist areas during the summer (Crocker-Bedford and Spillett 1977). The nutritious, succulent plants found in such areas are crucial for Utah prairie dogs: colonies without moist vegetation are decimated by drought, and higher moisture content in the vegetation allows greater population density (Collier 1975:56, 50). Similarly, Koford (1958:10, 12, 13, 35, 37, 39, 66, 68) found that black-tailed prairie dogs concentrated near moist vegetation such as provided by swales, and that colonial expansion and new colonies were more likely to occur near areas where vegetation remained moist. Close proximity of moist vegetation to home burrows is beneficial due to less exposure to predation and less energy expenditure, and because lactating females may be behaviorly confined near their home burrows (Crocker-Bedford 1975).

M. Hatch (personal communication) recalled that gullies in areas inhabited by Utah prairie dogs were fewer and much shallower in the early 1900's than today. Also, his father found almost no gullies upon his arrival in the Panguitch area in 1873, 2 years after settlement by white man. Gullies lower surrounding water tables to the level of their channel beds. The many swales that have gullied since the 1870's consequently have dried, and their vegetation has shifted from succulent grasses and forbs to shrubs (Cottam and Stewart 1940). This loss of essential summer food has eliminated many Utah prairie dog colonies, as evidenced by many abandoned dog towns located next to gullies. Heavy grazing by livestock was the main cause of the gullying (Cottam and Stewart 1940), but the near elimination of beaver (*Castor canadensis*) dams possibly played a role.

Heavy livestock grazing has caused a marked increase in shrubs at the expense of palatable grasses, even on uplands in Utah (Cottam 1961, De Vos 1959:154). This shift contributed to the decline of the Utah prairie dog (Collier and Spillett 1975). Palatable cool season forage, which is essential for Utah prairie dogs, possibly decreased most and now is rare in areas that previously supported Utah prairie dogs. A lower incidence of fire likewise contributed to the increase in shrubs (Plate 11).



Plate 11. Overgrazing by livestock and fire control have caused a marked increase in shrubs in south-central Utah. Not only are shrubs mostly unpalatable to Utah prairie dogs, but shrubs often become so tall and dense that prairie dogs do not enter them.

The eventual destruction of Utah prairie dog habitat by heavy livestock grazing does not refute the fact that grazing can benefit Utah prairie dogs (see page 10), nor does it refute the observation that overgrazing results in increased numbers of black-tailed prairie dogs (Koford 1958, Norris 1950, Osborn 1942, Osborn and Allan 1949, and Smith 1958). Cattle benefit black-tailed prairie dog populations by causing short grasses such as blue grama (*Bouteloua gracilis*) and buffalograss (*Buchloe dactyloides*) to increase (Koford 1958:67). However, these are warm season species and so are unfavorable for the Utah prairie dog which occurs in a locale with a short growing season. Also, the overgrazing of grass-shrubs habitats in Utah generally results in an eventual increase in tall shrubs, which are not suitable Utah prairie dog habitat.

Density-Habitat Correlation for Colonies Without Alfalfa

Density indices (see Collier 1975) for 19 Utah prairie dog colonies that lacked alfalfa were correlated ($r^2 = 0.79$) with four of the habitat factors discussed above, namely elevation, percentage of cool season grass canopy coverage, forage condition in the swale or moist area, and average distance from the home burrows to the moist area:

Density index = 138.2

- 0.0472 x elevation in meters (0.0144 x elevation in feet)
+ 2.16 x percentage of cool season grass canopy cover up to 20%
+ 7.27 x forage condition on moist area in midsummer*
- 0.0713 x average distance in meters from home burrows to moist area

*** Forage condition on moist areas in midsummer**
0 = brown grasses and forbs
1 = green grasses and forbs that are fairly dry
2 = green grasses and forbs that are moist
3 = soggy ground

Collier's (1975) density indices were 59 for HC and 78 for LC. Collier's colonies without alfalfa that had 25 or more prairie dogs had density indices which ranged from 8 to 89 ($\bar{x} = 53$). The presence of alfalfa, such as at AC, overrides most other habitat components; thus, this equation to model the density index does not concern areas with alfalfa.

MANAGEMENT RECOMMENDATIONS CONCERNING HABITAT

The major recovery effort being made for the Utah prairie dog is the transplanting of prairie dogs onto public lands. Transplant sites must include the animal's essential habitat components. Habitat manipulations sometimes will be necessary before a site can sustain a Utah prairie dog colony.

A well-drained area must be available for winter-spring home burrows, so dormant and newborn prairie dogs do not drown. Furthermore, good drainage, along with deep soils, allows prairie dogs to better avoid temperature extremes and predators (Crocker-Bedford 1975).

If prairie dogs are to thrive in an area, the vegetation must not be so tall nor so dense that they cannot see over or through it. Manipulation by fire, mechanical, or chemical means is necessary in areas of tall, dense shrubs to create suitable habitat for prairie dogs. Furthermore, young leaves are much more palatable than old leaves. Because livestock grazing usually results in shorter vegetation and induces young leaves through regrowth, livestock grazing often is beneficial to Utah prairie dogs, especially in locations or during years with high primary forage production. In areas of high primary forage production and little grazing, tall vegetation sometimes reduces an established colony's chances of survival (Osborn and Allan 1949).

Palatable forage should be available to pregnant and lactating females. This growth must be in the vicinity of winter-spring home burrows, because adult females may be behaviorally confined to this area until lactation is complete (Crocker-Bedford and Spillett 1977). Above 2,200 m (7,200 feet), palatable early spring forage consists almost exclusively of short new blades of cool season grasses, but early spring forage at lower elevations may include alfalfa and mustard. Large amounts of young leaves of cool season grasses can compensate partially for short growing seasons at high elevations. In contrast, longer growing seasons at lower elevations may negate the need for cool season forage—Collier (1975) described two dog towns at about 1,650 m that had no palatable cool season forage. Seeding or other treatments sometimes may be necessary to provide adequate amounts of suitable cool season forage.

Moist vegetation must be available throughout the summer. Prairie dogs without moist vegetation grow poorly due to inadequate water and nutrient intake (Crocker-Bedford 1975). Utah prairie dog colonies without moist areas are decimated by drought (Collier 1975:56). A swale is usually necessary to provide moist vegetation; however, vegetation at very high elevations may stay moist throughout the summer because of late snowmelt or abundant summer rainfall. Moist vegetation may be provided in some areas presently dry during summer through treatments such as swaling or the construction of gully plugs or ponds.

A swale is more beneficial if it is close to the home burrow area. Prairie dogs then require less energy to travel to and from an area that provides moist vegetation, and they are less susceptible to predators. Also, females may remain near their parturition burrows until lactation is completed. Still, prairie dogs may travel 300 m daily between their home burrows and moist forage.

Four habitat components (elevation, cool season grass, forage condition on moist area, and proximity of moist area) are combined in an equation which models the prairie dog density index for sites that are suitable in other aspects, but which lack alfalfa (see page 23). A proposed transplant site should have a predicted density index of at least 37.

The reproductive parts of many forbs, as well as those of rabbitbrush, provide palatable and nutritious forage during the summer and fall. These foods help prairie dogs to gain sufficient weight to survive the winter. On the other hand, the vegetative parts of most forbs and shrubs are unpalatable to Utah prairie dogs, and the presence of forbs and shrubs reduces the availability of important cool season grasses. Thus, forb availability, as well as that of rabbitbrush, promotes prairie dog density, as long as the presence of forbs and rabbitbrush does not greatly reduce the availability of cool season grasses.

In summary, Utah prairie dog habitats or proposed transplant sites should be managed or selected so that they provide the following critical habitat components:

1. Well-drained and deep soils for home burrows.

2. Vegetation that prairie dogs can see over or through.

3. Young leaves of cool season grass, alfalfa, or mustard, particularly in the vicinity of parturition burrows.

4. Moist, palatable forage throughout the summer that is not more than 300 m from home burrows.

Finally, a proposed transplant site should have a predicted density index of at least 37.

SUMMARY AND CONCLUSIONS

The Utah prairie dog (*Cynomys parvidens* Allen) inhabits five south-central Utah counties and presently is considered as a species in danger of becoming extinct (U.S. Fish and Wildlife Service, 1977). Utah prairie dog colonies are of three basic types: (1) High elevation (above 2,200 m), (2) low elevation (below 2,200 m) (Collier 1975), and (3) low elevation associated with alfalfa.

Two representative Utah prairie dog colonies—a high elevation colony (HC) near the Bryce Canyon airport and a low elevation colony associated with alfalfa (AC) near the junction of Utah Highway 12 and the Sevier River—were intensively studied between February 1974 and September 1975. Comparative data also were collected at a low elevation colony lacking alfalfa (LC) near Hatch.

Aspects studied included the Utah prairie dog's life history, food preferences, and habitat relationships. The species' effects upon vegetation also were evaluated, and recommendations pertinent to the selection of prairie dog transplant sites and habitat management were developed.

Major factors affecting Utah prairie dog densities:

1. Deep, well-drained soils in the area of winter-spring home burrows promote prairie dog survival.

2. Vegetation that is low or sparse enough so that prairie dogs can see over or through it enhances prairie dog survival and densities. Management is sometimes necessary to keep vegetation in such a state.

3. Livestock grazing benefits prairie dogs by promoting new growth. Grazing is especially necessary where prairie dogs cannot keep vegetation from becoming rank.

4. Longer growing seasons at lower elevations promote higher prairie dog densities.

5. Cool season, palatable forage species, i.e., bluegrasses, cheat grass, squirreltail grass, wheatgrasses, and needle-and-thread grass, promote prairie dog densities by increasing the period of food availability.

6. Succulent grasses and forbs must be present throughout the summer in order for prairie dogs to gain sufficient weight to survive the winter. A swale usually is necessary to provide such herbage; however, irrigation water or a locale with abundant rainfall, such as on some high elevation areas, may maintain moist forage. A year of high precipitation allows some prairie dogs to live away from swales, but these animals usually die during a drought year.

7. The close proximity of succulent summer forage to home burrows promotes higher prairie dog densities. Still, prairie dogs may travel 300 m daily between their home burrows and moist food.

8. The availability of forbs, as well as that of rabbitbrush, enhances prairie dog densities by providing summer forage, if their presence does not substantially reduce the availability of cool season grasses.

9. Alfalfa can override all the preceding factors in promoting high prairie dog densities, because alfalfa is highly palatable and highly nutritious.

10. A scarcity of predators promotes higher prairie dog densities and colonial expansion.

11. Continued overgrazing by livestock can reduce Utah prairie dog populations by reducing the production of cool season grasses, by causing the loss of swales through gullying, and by encouraging tall shrubs.

12. Without fire or vegetational treatments, habitat usually becomes too brushy to support prairie dogs.

Effects of Utah prairie dogs upon vegetation:

1. The order of food preference for Utah prairie dogs was cicada insects, alfalfa, grasses, forbs other than alfalfa, shrubs, and then dead vegetation. Plant parts ranked as follows: flowers and seeds, young leaves, old leaves, and then stems.

2. Prairie dogs are detrimental to alfalfa fields. They consume and stunt up to 90 percent of the potential primary production. Alfalfa and other palatable plants soon die out. Colonial expansion is rapid when alfalfa is available.

3. In colonies below 2,200 m (7,200 feet) which lack alfalfa, prairie dogs typically take about 10 percent of the production of grasses and forbs.

4. In most colonies above 2,200 m, prairie dogs normally take less than 2 percent of the production of grasses and forbs. They apparently do not induce adverse range trends. Such colonies do not expand or expand slowly.

5. About 440 active Utah prairie dogs ingest as much food as a cow and calf; about 350 ingest as much food as a dry cow; and about 90 ingest as much food as a ewe and lamb. However, Utah prairie dogs are active only about 5 months during the year. Therefore, on a year-round basis, the number of prairie dogs equalling a livestock unit should be multiplied by 2.4 (12 months/5 months).

6. Prairie dogs improve soil depth and possibly soil quality.

7. Prairie dogs ingest most cicadas which emerge within a colony. This may benefit primary production of vegetation in such areas.

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Appendix Table 1. By study site, seasonal forage preference indices[a] of Utah prairie dogs and the averages over five seasons of percentage of chewing time and of percentage of availability[b].

	Seasonal Preference Indices					5-Season Percentage	
Study Area and Forage	Early Spring	Late Spring 1974	Late Spring 1975	Summer	Early Fall	Chewing	Availability
HC's UPLAND							
Cicadidae insects	N/A[c]	300.0	N/A	N/A	N/A	5.6	0.02
GRASS[d]	15.0	4.5	6.5	14.0[e]	9.7	60.8	7.6
FORBS (no alfalfa)							
Cryptantha abata	0.6	3.4[e]	0.0	1.6[e]	0.2	1.6	1.0
Eriogonum racemosum	0.0	4.2	0.0	10.0[e]	42.0[e]	1.3	0.1
E. umbellatum	0.0	0.3	0.0	0.3[e]	10.0[e]	0.3	0.2
Hymenoxys richardsonii	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Penstemon caespitosus	0.0	0.0	0.0	0.1[e]	0.0	0.0	1.2
Petradoria pumila	0.0	0.0	0.0	0.8[e]	0.6[e]	0.4	0.8
Phlox muscoides	0.3[e]	0.3	0.9[e]	0.5	0.1	16.5	38.0
All forbs	0.3	0.4	0.8	0.6	0.2	20.9	41.8
SHRUBS							
Artemisia arbuscula nova	0.0	0.0	0.0	0.0	0.1[e]	0.2	10.7
A. pygmaea	0.0	0.0	0.0	1.1[e]	1.3[e]	1.4	2.9
Chrysothamnus nauseosus	0.0	0.2	0.0	0.0	58.0[e]	7.0	0.6
C. parryi	0.0	0.3	0.0	0.0	2.2[e]	1.2	1.8
C. viscidiflorus stenophyllus	0.1	0.1	0.0	0.3	0.5[e]	0.8	5.1
Leptodactylon pungens	0.0	0.3	0.1	0.4[e]	1.5[e]	0.3	1.1
All shrubs	0.0	0.1	0.0	0.2	2.8	11.5	23.7
DEAD VEGETATION AND CATTLE FECES COMBINED	0.0	0.1	0.1	0.0	0.0	1.1	26.9
AC's NEWER AREA							
ALFALFA (*M. sativa*)	16.0	4.6	5.6	6.8	4.5	52.0	9.8
GRASS[d]	12.0	2.2	1.9	3.7	3.2	45.6	12.4
FORBS (without alfalfa)							
Aster frondosus	N/A	0.0	0.0	0.0	2.5[e]	0.1	0.8
Annual forbs[f]	N/A	0.0	0.0	0.0	0.0	0.0	2.4
All forbs except alfalfa	N/A	0.0	0.0	0.0	0.1	0.2	3.3
SHRUBS							
C. nauseosus only	0.0	0.0	0.0	0.0	0.9[e]	0.2	1.4
DEAD VEGETATION AND CATTLE FECES COMBINED	0.0	0.1	0.0	0.0	0.0	1.7	73.2
AC's OLDER AREA							
GRASS[d]	30.0	3.2	60.0	21.0	13.0	80.3	8.0
FORBS (no alfalfa)							
Aster frondosus	6.5	3.4	0.0	0.7	3.9[e]	3.0	1.1
Convolvulus arvensis	100.0	1.1	49.0	1.3[e]	1.4[e]	6.3	2.8
Annual forbs[f]	N/A	3.0	10.0	1.0[e]	1.8[e]	2.1	0.9
All forbs	40.0	1.8	6.9	1.2	2.0	11.4	4.8
SHRUBS							
Artemisia tridentata	0.0	0.0	0.0	0.0	0.0	0.0	3.6
C. nauseosus	0.0	0.0	0.1	0.0	1.1[e]	3.8	20.2
All shrubs	0.0	0.0	0.0	0.0	0.9	3.8	23.8
DEAD VEGETATION AND CATTLE FECES COMBINED	0.0	0.1	0.1	0.1	0.0	4.4	63.4

[a] Within a given location, the preference index for any forage category during a given season equaled the category's percentage of all chewing time during the season divided by its percentage of all aboveground nonwoody biomass during that season. The 2320 visual dietary observations averaged 2.8 minutes of chewing apiece. Forage availability was estimated from 1673 one-m^2 plots, of which 375 were clipped.

[b] Over the five seasons, the aboveground nonwoody phytomass averaged 695 kg/ha (dry weight) in HC's upland, 692 kg/ha in AC's newer area, and 219 kg/ha in AC's older area.

[c] N/A means that the category was not available.

[d] At HC's upland, 90 percent of the available grass was *Agropyron cristatum*, while 90 percent was *A. smithii* at both the newer and older areas of AC.

[e] This index was unusually high due to the availability and thus consumption of flowers and seeds.

[f] *Iva axillaris* and *Bassia hyssopifolia* were the most abundant annual forbs in the newer area. *Salsola kali* was the most abundant annual in the older area. These three annuals, plus *Atriplex truncata* and *Sphaeralcea coccinea*, were present in both parts of AC.

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