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Habitat selection patterns of feral horses in southcentral Wyoming

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Abstract

Feral horse habitat selection patterns and forage attributes on available habitats were studied on public rangelands of southcentral Wyoming. Environmental assessments preceding roundup of excess horses requires resource data to justify the number of horses removed. Randomly selected bands of horses were followed for 24-hour observation periods during the spring and summer to determine if they utilized habitats in proportion to their abundance. We also determined if forage abundance, succulence (an index to forage palatability), percent utilization, and dietary composition were related to habitats selected. Streamsides, bog/meadows, and mountain sagebrush habitats were preferentially selected ($p \leq 0.05$). Lowland sagebrush habitats were avoided and no apparent selection behavior was shown for grassland and coniferous forest habitats. Forage abundance, palatability, and percent utilization were higher ($p \leq 0.05$) in streamside and bog/meadow habitat classes. Diet composition indicated that sedges (*Carex* sp.), common in streamsides and bog/meadows, were an important forage of feral horses. Palatability and abundance of graminoid vegetation and proximity to preferred habitats seemed to be the primary influences on habitat selection by feral horses.

Key Words: forage abundance, succulence, utilization

Resúmen

Se estudiaron la selección del hábitat y los atributos asociados del forrajear en cada hábitat disponible a los caballos silvestres en las dehesas públicas de la zona sur central del estado de Wyoming. Las evaluaciones del medio ambiente que preceden el rodeo de los caballos determinados de ser en exceso requieren la acumulación de datos de los recursos para justificar el número de caballos que se van a reubicar. Se observaron unas bandas de caballos elegidas al azar por períodos de veinticuatro horas durante la primavera y el verano para determinar si utilizaban cada hábitat en proporción con su abundancia. También se investigó si la abundancia del forraje, la suculencia (un índice del aspecto de deseo del forraje), el porcentaje de la utilización, y la composición dietética se relacionaron con cada hábitat elegido. Las orillas de los arroyos, las ciénagas/los prados, y el hábitat donde crece la artemisa de la montaña se destacaron por ser preferibles ($p \leq .05$). La abundancia del forraje, el deseo del forraje, y el porcentaje de utilización eran los variables más altos ($p \leq .05$) en las dos clases de hábitat de las orillas de los arroyos y las ciénagas/los prados. La investigación de la composición de la dieta indicó que las juncias (*Carex* sp.), una planta común en las orillas, las ciénagas y los prados, eran un forraje importante de los caballos silvestres. El deseo del forraje, la abundancia de la vegetación herbácea, y la cercanía de cada hábitat preferido parecían ser las influencias más importantes en la elección de hábitat por parte de los caballos silvestres.

Management of rangeland is contingent upon understanding the influences of each species of herbivore on the system. The impact of feral horses (*Equus caballus*) on plant communities and physiographic areas must be determined to provide a basis for the planned herd size, to quantify numbers to remove, and potential impacts on other species.

A recently completed census estimated that over 46,000 feral horses inhabit federally owned rangelands in the western United States (USDI-BLM and USDA-FS 1993). The potential for rapid population growth (Eberhardt et al. 1982, Boyd 1980, Cook 1975) coupled with the management constraints of the Wild Free-Roaming Horse and Burro Act of 1971, has lead to excessive feral horse densities in important habitats on many public rangelands (Krysl et al. 1984, Cook 1975).

Krysl et al. (1984), Denniston et al. (1982), Rittenhouse et al. (1982), Salter and Hudson (1979) suggest similarities in habitat selection and diet composition, thus a potential for interspecific competition between feral horses and other domestic and wild herbivores. Most feral horse habitat selection studies in the western U. S. were conducted in sagebrush steppe or desert areas (Ganskopp and Vavra 1986, Denniston et al. 1982, Miller 1983) ecosystems with a relatively low diversity of habitats, where water is often the determining factor in habitat selection. The area of the study described here has diverse habitats and abundant water sources. In such an area, Salter and Hudson (1979) found that forage attributes including standing crop and quality were the most important factors influencing habitat selection by horses and other large herbivores (Smith et al. 1992, Pinchak et al. 1991, and Senft et al. 1985).

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Our research was initiated to address the lack of information regarding feral horse habitat selection and activity patterns in an area of southcentral Wyoming. We hypothesized that greater standing crop and quality of forage would be positively related to habitat selection by feral horses, and that this would result in their preference for riparian plant communities over uplands. Explicitly tested hypotheses were that proportions of horses using each of the various habitat classes in the study area would not be the same as the proportion of the study area occupied by each habitat class, and that vegetation abundance, palatability (quality), and utilization, would not be equal for all habitat classes. We also nonstatistically evaluated the diet composition of feral horses to ascertain if feral horse diet composition was consistent with observed habitat selection patterns.

Materials and Methods

Study Area

The study area is located in the Sweetwater River valley of southcentral Wyoming, and includes the Willow, Cooper, and Spring Creek drainages on the north slope of Green Mountain (Fig. 1). To meet the assumptions of our statistical analysis, the study area was defined by the smallest convex polygon enclosing all horse relocation points (Johnson 1980). The study area is within the 28,633-ha Whiskey Peak grazing allotment administered by the Bureau of Land Management. Elevations on the allotment range from 1,976 to 2,812 meters. Thirty-year average annual precipitation (1951–1980) was 25.4 cm at the Muddy Gap Junction of highways US287 and WY220, one-half occurring as snowfall. Average annual high and low temperatures at the same station were 13.4 and 0.33°C, respectively (Martner 1986). The frost free period varies elevationally from 114 to <60 days (BLM 1990).

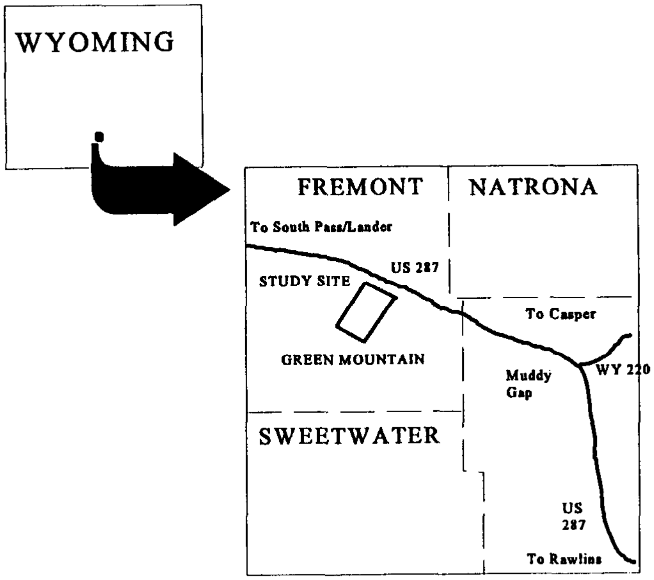

Fig. 1. Study area location in southcentral Wyoming.

Topographic features of the study area include outwash plains, gently rolling hills, forested and open ridges, canyons, and rock outcrops. Soils are generally well developed and of loamy texture, with the occurrence of some coarse sandy and skeletal, very gravelly, or very cobbly soils (BLM 1990).

Plant communities and associated physiographic habitats occurring on the Whiskey Peak allotment were designated for our purposes as streamside, bog/meadow, mountain sagebrush, lowland sagebrush, grassland, and coniferous forest. The delineation of these habitat classes was based on dominant vegetation, topographic position, and geographic location. Streamside habitats were areas within 5 m of a water course with a willow (*Salix* spp.)/graminoid plant community. Bog/meadow habitats were low-lying areas associated with surface and/or subsurface water (other than streamsides) which supported a more mesic graminoid plant community than surrounding areas. Lowland sagebrush habitats were generally alluvial plains dominated by Wyoming big sagebrush (*Artemisia tridentata* Nutt. var. *wyomingensis* (Beetle and Young) Welsh) and graminiods situated geographically north from and not interspersed with other habitats. Coniferous forest habitats had a 50–90% canopy coverage of limber pine (*Pinus flexilis* James), lodge pine pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm. ex Wats.) and other conifers and usually supported understory graminoid/forb communities different from adjacent non-forested habitats. The mountain sagebrush habitat class was largely non-forested slopes and ridges of Green Mountain and Owl Hills dominated by mountain big sagebrush (*Artemisia tridentata* Nutt. var. *vaseyana* Rydb.) and graminoids, and intermingled with coniferous forest habitat. Grasslands were dominated by graminoids and usually occurred on high elevation, wind-swept slopes. Area estimates from digitized orthophoto maps (1:24,000 scale) indicate approximately 0.05, 0.06, 28, 59, 0.07, and 12% of the study area were streamside, bog/meadow, mountain sagebrush, lowland sagebrush, grassland, and coniferous forest, respectively.

The Whiskey Peak allotment supported approximately 75% of the 500 feral horses within the Green Mountain Wild Horse Herd Management Area prior to 1993. A roundup during the summer and fall of 1993 reduced the population to planned management levels of between 170 and 300 horses (BLM 1993). In addition to horses, the area also supports populations of pronghorn antelope (*Antilocarpa americana americana* Ord), elk (*Cervus elaphus nelsoni* Bailey), and mule deer (*Odocoileus hemionus hemionus* Rafinesque). Seasonal cattle (*Bos taurus*) use (7,723 animal unit months) occurs annually but did not occur in 1993 until after the conclusion of this study.

Habitat Selection

Habitat selection patterns of feral horses were observed in 1992 and 1993. During the June-August 1992 field season, habitat selection was estimated from 320 repeated observations of 20 individually identified horses of different sex and age classes. Daily surveys during daylight hours were conducted to relocate these individuals and determine their activity and habitat selection from independent, instantaneous observations. After the season, we suspected a visibility sampling bias in the 1992 observations resulting from potentially lower probabilities of horse relocation in wooded streamside and coniferous forest habitats.(Oedekoven and Lindzey 1987, Neu et al. 1974).

To reduce potential bias in 1993, 23 randomly selected bands of undisturbed horses were followed and visually observed during daylight hours. Scan sampling (Altmann 1974) at 30-minute intervals was used to determine the proportion of horses in the band in each habitat class, activity class (feeding, idling, or traveling), and time of day class (1=0500-0900 hours, 2=0901-1300 hours, 3=1301-1700 hours, 4=1701-2200 hours). Feeding included harvesting forage, drinking, and travel <5 steps while feeding. Idling included resting and minor movements. Traveling was directed movement of more than 5 steps. Geographic locations were recorded to allow determining distance to water and minimum convex polygon enclosing the study area.

Observation periods began during daylight hours, terminated at dark, resumed at daylight, and continued until the same time as the initial observation the previous day. Band relocations at daylight were usually close to where they were last seen at dark the previous evening. Horses were observed from a distance (≈200m) that would not disrupt "normal" habitat selection and activity patterns with the aid of a 10 to 20 power spotting scope and binoculars. Horse bands were followed on horseback.

Habitat selection data from 1992 were summarized by determining the proportion of total observations occurring in each habitat. All 1993 observations were summarized by calculating the proportion of animals in each activity by habitat and time of day class.

Vegetation Utilization, Palatability, and Abundance

Percent utilization and percent moisture (succulence) were determined for the most abundant graminoid plant species on each habitat. Feral horses select primarily graminoid species (Krysl et al. 1984, Salter and Hudson 1979, Hansen 1976). Utilization will be indicative of the potential detriment of grazing on plant health. Utilization of plant species was determined through sequential biweekly late May through August 1993 estimates (n=7) of dry weight standing crop of 30 individually marked bunch grass plants or 0.01 m^2 quadrats containing one rhizomatous species along 3 transects (30m) in each habitat class (Smith et al. 1992). The difference between the average ending weight of grazed and ungrazed plants and ungrazed plants was used to calculate total percentage of herbage removal (utilization) for each habitat class. Bi-weekly utilization was not calculated because we observed relatively low levels of total utilization, and found no seasonal variation in feral horse habitat selection patterns with which to correlate seasonal utilization.

Forage succulence appears to be correlated with quality and palatability as herbivores usually graze plants with higher succulence, quality, and palatability (Smith et al. 1992, Pinchak et al. 1991, Senft 1985). Vegetation succulence was used as an index to forage palatability and quality. Randomly selected whole plant samples were collected from each habitat class (50 to 100 plants including major species with about 200-g total of plant material/habitat) at bi-weekly May–August intervals coinciding with utilization sampling. Green weights of these samples minus oven-dried (50°C, 36 hours) weights were divided by oven-dried weights to determine percent moisture (succulence).

Forage abundance as indicated by standing crop biomass of all herbage, above a minimum weight, was determined using visual obstruction measurements (following Robel et al. 1970). Biweekly May–August measurements were taken at 50 random points in each habitat class. The relationship between Robel readings and actual above-ground oven dry biomass was determined by taking the visual obstruction measurement in and harvesting 30 quadrats (0.25 m^2), followed by determining coefficients by simple linear regression in each habitat class.

Diet Composition

Fecal samples from feral horses were collected during the spring, summer, and winter of 1991 and 1992. A minimum of 5 samples were collected by searching the vicinity of 4–6 sites (depending on seasonal access) on the allotment. Only fecal material determined by freshness and color to have been deposited during the seasonal period was collected. Fecal piles were subsampled, material was mixed and 5 subsamples taken. Subsamples were sent to a commercial lab (AFAB Laboratories in Ft. Collins, Colo.) for identification of plant species in feces. The relative frequency of fragments of each plant species in each sample were quantified by microhistological procedures outlined by Sparks and Malechek (1968). Plant epidermal characteristics determined from reference slides are used to identify species in microscope slides of fecal materials. Twenty fields per slide and 5 slides per sample were examined. Data were summarized by sites within seasons.

Statistical Analyses

Chi-square analyses (Neu et al. 1974) of 1992 and 1993 data separately were employed to determine whether feral horses utilized all habitat classes in proportion to their availability. Calculated χ^2 statistics may be biased if expected values are very low (eg. streamside, bog/meadow, and grassland habitat classes),thus creating an artificially large χ^2 and making the probability of a type I error greater than apriori p (Zar 1984). However, we did not combine these habitat classes because the mean (over all classes) expected value exceeded the minimum suggested by Roscoe and Byars (1971).

If χ^2 analyses indicated a significant difference existed between habitat selection and availability, relative preference for individual habitat classes was determined using the Bonferroni Z simultaneous confidence interval (CI) approach described by Neu et al. (1974) and revised by Byers et al. (1984). If the availability of a habitat class was less or greater than the CI, the habitat was considered to be preferred or not preferred respectively.

A General Linear Model analysis of variance (AOV) (Hicks 1973) was used to test for significant differences in vegetation attributes between habitat classes. If a significant difference was observed, a Scheffe mean separation test was employed. A factorial AOV design was used to evaluate the influence of time of day class, month, habitat class, and horse activity on proportions of horses in habitats. The 1993 data summary experimental unit for analysis was a monthly mean (n=3) proportion of horses for each time of day (n=4), habitat (n=6) and activity (n=3) class. The data assumptions of independence, normality of residuals, and equal variances necessary for AOV were evaluated prior to hypothesis testing.

Analyses were performed using the Statistical Analysis System (SAS Institute 1988) and Statistix (Statistix 1988) statistical software packages. All statistical tests were evaluated at the $p \leq 0.05$ level of significance.

Results and Discussion

Habitat Selection

Overall expected usage and observed usage (Table 1) were significantly different ($p \leq 0.05$) in 1993. Comparison of simultaneous confidence intervals to proportion of the area in each habitat (Table 1) indicated that the proportional use of streamside,

Table 1. Total area, relative area, expected use, and observed use by feral horses for 6 habitat classes on a study area within the Whiskey Peak Allotment, southcentral Wyoming, 1993.

Habitat Class	Total Area	Relative Area (P_{io})	Relative Usage (U_{io})	Expected Use ($E_i = n^1 p_{io}$)	Observed Use (O_i)[2]	Bonferroni Intervals for U_{io}	Apparent[3] Selection Behavior
	(ha)						
Streamside	31	0.005	0.09	0.43	7.7	$0.008 \leq P_1 \leq 0.17$*	+
Bog/Meadow	39	0.006	0.12	0.53	11.7	$0.029 \leq P_2 \leq 0.22$*	+
Mtn. Sagebrush	1699	0.28	0.51	24.92	45.4	$0.37 \leq P_3 \leq 0.65$*	+
Low. Sagebrush	3620	0.59	0.17	52.51	15.1	$0.03 \leq P_4 \leq 0.30$*	-
Grassland	44	0.007	0.05	0.62	4.5	$0 \leq P_5 \leq 0.12$	=
Coniferous Forest	750	0.12	0.07	10.68	6.2	$0 \leq P_6 \leq 0.14$	=

[1]n=86 for streamside and 89 for other habitat classes
[2]$X^2 5 = 441$, p=0.00; $X^2_{(5, \alpha=0.05)} = 11.07$
[3]+ use greater than expected, p≤0.05
= use not different from expected, p≤0.05
- use less than expected, p≤0.05

bog/meadow, and mountain sagebrush habitats was significantly greater ($p \leq 0.05$) than the proportion of the study area occupied by these habitat classes. In contrast, lowland sagebrush habitats (Table 1) were used significantly less ($p \leq 0.05$) than the extent of these habitats within the study area. Feral horses used the coniferous forest and grassland habitat classes in similar ($p \leq 0.05$) proportion to their relative abundance on the study area.

Our suspicion of a visibility bias in the method of observing horses during 1992 appeared to be confirmed by the reduced proportion of horses observed in the streamside (1992=0.02, 1993=0.09) (Tables 1 and 2). Otherwise the 1992 results generally support the results of 1993 since (Byers et al. 1984) the observed proportions of habitat use in 1992 (Table 2) occur within the confidence intervals of proportional use in 1993 (Table 1). Many streamside habitats support dense stands of willow, cottonwood, and aspen which obscure horses. This problem was mitigated with the 1993 sampling method, likely increasing the proportion of streamside observations.

A feral horse monitoring program, independent of our study, was conducted in 1992 in the general vicinity of our study area, by the Lander Resource Area of the Bureau of Land Management (unpublished). These results lend support to our overall conclusions that feral horses show a preference for riparian habitats.

The degree of selection for riparian habitats by unmanaged feral horses on this study area seems noteworthy considering the widespread concern for the condition of riparian vegetation; the streamside and bog/meadow habitats combined account for slightly over 1% of the study area, but received 21% of the use by feral horses. The preference of large herbivores for riparian habitats is well documented (Smith et al. 1992, Pinchak et al. 1991, Roath and Krueger 1982), yet this selection behavior in feral horses has not been widely reported in the literature. Ganskopp and Vavra (1986) reported that feral horses in the northern sagebrush steppe exhibited no preference for a particular plant community, and instead made the greatest use of the most prevalent habitat. In contrast, the results of Salter and Hudson (1979) and Hubbard and Hansen (1976) indicate that *Carices* were the major dietary constituent of feral horses, suggesting that horses select more mesic communities in their foraging behavior if they are available. Our findings are consistent with Salter's (1979) observations that feral horses utilized certain meadow types more heavily on a year-long basis. Berger (1986) also reported that

Table. 2. Total area, relative area, expected use, and observed use by feral horses for 6 habitat classes on a study area within the Whiskey Peak Allotment, southcentral Wyoming, 1992.

Habitat Class	Total Area	Relative Area (P_{io})	Relative Usage (U_{io})	Expected Use ($E_i = n^1 p_{io}$)	Observed Use (O_i)[2]	Bonferroni Intervals for U_{io}	Apparent[3] Selection Behavior
	(ha)						
Streamside	31	0.005	0.02	1.6	6.4	$0 \leq P_1 \leq 0.041$	=
Bog/Meadow	39	0.006	0.12	1.92	38.4	$0.072 \leq P_2 \leq 0.17$*	+
Mtn. Sagebrush	1699	0.28	0.59	89.6	188.8	$0.52 \leq P_3 \leq 0.66$*	+
Low. Sagebrush	3620	0.59	0.17	189.0	54.4	$0.12 \leq P_4 \leq 0.23$*	-
Grassland	44	0.007	0.04	2.24	12.8	$0.01 \leq P_5 \leq 0.07$*	+
Coniferous Forest	750	0.12	0.06	38.0	19.2	$0.25 \leq P_6 \leq 0.10$*	-

[1]n=320
[2]$X^2 5 = 320.4$, p=0.00
[3]+ use greater than expected, p≤0.05
= use not different from expected, p≤0.05
- use less than expected, p≤0.05

Table 3. Herbaceous vegetation standing crop (g/0.25m² ± SE[1]) of 4 habitat classes on Whiskey Peak Allotment in southcentral Wyoming, 1993.

	Herbaceous Standing Crop Sampling Period					
Habitat Class	6/30	7/7	7/20	8/4	8/17	Average
	(g/0.25m² ± SE[1])					
Streamside	24 ± 1.84	22 ± 1.27	33 ± 1.97	43 ± 2.40	21 ± 1.27	29 ± 4.02a[3]
Bog/Meadow	30 ± 1.84	33 ± 1.97	41 ± 1.84	66 ± 5.94	52 ± 3.68	44 ± 5.81b
Grassland	8 ± 1.27	48 ± 13.29	15 ± 1.84	13 ± 1.56	21 ± 2.12	20 ± 6.26c
Coniferous Forest	<4[2]	5 ± .424	4 ±.424	5 ± .57	6 ± .57	5 ± 0.22d

[1]SE = Standard error N=5 dates, 50 observations within dates
[2]Standing crop below the minimum detectable amount
[3]Means followed by the same letter were not significantly different, $p \leq 0.05$

meadows received the greatest use in proportion to their availability, when compared to all other habitats.

Forages in the streamside and bog/meadow habitat classes had the greatest ($p < 0.05$) vegetation standing crop (Table 3) and were high ($p \leq 0.05$) in succulence (Table 4) compared to other habitats. Habitat selection by large herbivores is reported to be positively associated with forage biomass and succulence (Smith et al. 1992, Pinchak et al. 1991, Senft et al. 1985). Salter and Hudson (1979) found that seasonal variability in diet composition of feral horses was related to forage palatability and abundance. Utilization levels (Table 5) on these habitats, while not high because of the herd reduction, was significantly higher ($p \leq 0.05$) than on all other habitats. Higher horse numbers would undoubtedly result in these habitats having the greatest potential to receive overuse of the vegetation resource.

The later growth initiation by forage species at higher elevations may partially explain the preference of horses for the mountain sagebrush habitat class over the lowland sagebrush habitats during the months of this study. Forage abundance (Table 3) was low for both habitats, being below the minimum measurable with the Robel et al. (1970) technique (≈ 4 g/0.25m²) but succulence (Table 4) was higher ($p \leq 0.05$) in mountain sagebrush areas. Topographic diversity and proximity to other preferred habitat offer a better explanation of why feral horses may prefer mountain sagebrush habitats. Feral horses may select the open ridges and slopes of this habitat class for refuge from insects (Keiper and Berger 1982), or to enhance their visual assessment of threats (Ganskopp and Vavra 1986). Miller (1983) also found that the proximity to ridges was a significant factor in the habitat selection of feral horses in the Red Desert of Wyoming. The preference for these habitats may also be related to the close proximity of many mountain sagebrush habitats to streamside and bog/meadow habitats. Following feeding or watering in riparian habitat classes, horses moved into the adjacent mountain sagebrush habitats. However, the preference for the more abundant mountain sagebrush habitats was not reflected in significantly higher ($p \leq 0.05$) utilization (Table 5) because of the large area relative to animal numbers.

The lower use than availability of lowland sagebrush habitats may be related to low ($p \leq 0.05$) forage productivity (Table 3) and succulence (Table 4) compared to higher elevation habitats. The avoidance of lowland sagebrush habitats by feral horses in this study illustrates seasonal movements from lower to higher elevations in summer. Area ranchers and agency personnel have observed that feral horses on the Whiskey Peak Allotment winter on lowland sagebrush sites where access to feed is less hampered by snow accumulation. We did observe a larger proportion of horses using the lowland sagebrush habitats during the early spring prior to initiation of observations. This selection behavior may also be a result of earlier growth initiation by forage species on these lower elevation sites. Miller (1983) and Salter and Hudson (1979) also concluded that areas which remained snow-free or had reduced snow depth throughout the winter were exploited as feeding habitat by feral horses. Salter (1979) also suggested that habitat selection during early spring was related to stage of forage growth and that areas which "green-up" first were most heavily used for grazing. Although water is abundant on the study area as a whole, during the summer distance to water from the northern reaches of the lowland sagebrush area may exceed 1.5 km. This distance to water may be sufficient to discourage feral horse use of these sites.

Table 4. Forage succulence (% moisture, dry weight basis4) of 6 habitat classes on Whiskey peak Allotment in southcentral Wyoming, 1993.

	Sampling Period[2]							
	5/27 SD[1]	6/10	6/24	7/7	7/20	8/4	8/17	Mean ± SE[1]
Habitat Class		(% moisture)						
Streamside	70	72	70	65	68	64	62	67 ± 1.47a[3]
Bog/Meadow	75	71	65	65	64	63	54	65 ± 2.49ab
Mtn. Sagebrush	74	64	62	58	54	49	42	58 ± 3.93bc
Low. Sagebrush	65	62	56	54	48	41	33	51 ± 4.27c
Grassland	72	69	65	59	42	47	36	56 ± 5.32c
Coniferous Forest	84	75	66	70	67	58	52	67 ± 4.08a

[1]SE = Standard deviation
[2]Bi-weekly sampling from 5/27 to 8/18
[3]Means followed by the same letter were not significantly different, $p \leq 0.05$
[4]((wet weight-dry weight)/dry weight × 100=% moisture on a dry weight basis)
% moisture of fresh samples = ((%moisture dry basis/(% moisture dry basis + 100)) × 100

Table 5. Utilization (% ± SE[1]) of annual forage growth in 6 habitat classes on Whiskey Peak Allotment in southcentral Wyoming, as of 18 Aug. 1993.

Habitat Class	Utilization
	- - - (% + SE[1]) - - -
Streamside	7.5 ± 1.5 a[2]
Bog/Meadow	11.0 ± 2.9 a
Mtn. Sagebrush	2.3 ± .83 b
Lowland Sagebrush	2.0 ± 1.09 b
Grassland	2.2 ± 1.02 b
Coniferous Forest	2.9 ± 1.02 b

[1]SE = Standard Error N=5
[2]Means followed by the same letter were not significantly different, p ≤ 0.05

No apparent selection behavior was observed for grassland habitats even though the abundance of forage (Table 3) on these sites was relatively high. Forage succulence (Table 4) was lower ($p \leq 0.05$) than on preferred habitats. The steep topographic position of grassland habitats and the distance to preferred riparian habitats may also have made these sites less attractive for foraging.

Coniferous forest habitats, used in proportion to their availability, had higher ($p \leq 0.05$) forage succulence (Table 4) but lower ($p \leq 0.05$) biomass (Table 3) than other habitats. This indicates that the influence of forage succulence on habitat selection is initiated above some minimum level of forage productivity. This habitat, as with all other abundant but less preferred habitats had lower ($p \leq 0.05$) utilization (Table 5) than the less abundant preferred habitats.

Horse Activities

The proportion of horses feeding, idling, or traveling did not differ significantly ($p \leq 0.05$) between habitat class or monthly categories. This lack of seasonal variation in habitat selection was also observed by Ganskopp and Vavra (1986) and Denniston et al. (1982).

Feral horses spent 61, 32, and 7% of their diurnal hours feeding, idling, and traveling, respectively. We observed a significant difference in feeding and loafing activities between different time classes (Fig. 2). Generally, horses spent morning and evening hours feeding and loafed during mid-day. Traveling was not significantly different between time classes. These results are consistent with observations reported by Salter and Hudson (1979). We found no significant interaction between diurnal activity patterns and habitat selection which suggests that feral horse activity patterns are independent of habitats used.

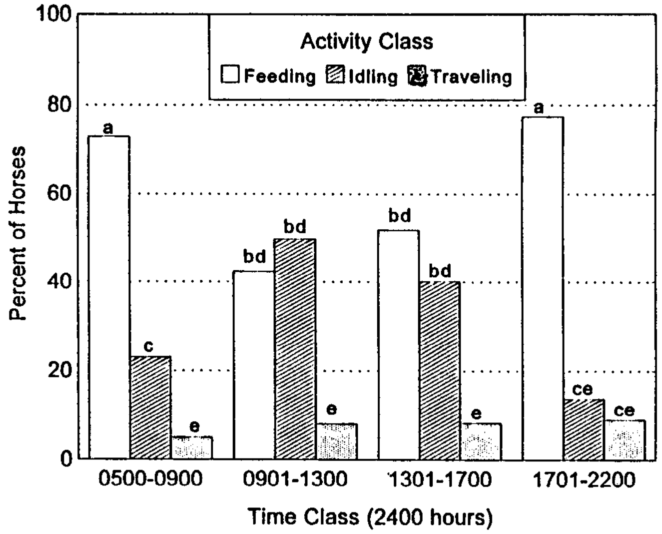

Fig. 2. Activity % in each time of day class in 1993.

Diet Composition

The annual diet of feral horses on this study area was comprised mostly of graminoid species with a relatively small and highly variable forb and shrub component (Table 6), similar to findings of Salter and Hudson (1979) and Hubbard and Hansen (1976). Forage species of the *Agropyron, Stipa,* and *Carex* genera were major dietary constituents during all seasons. The proportional intake of each forage species was relatively constant between seasons, except for *Carex* which increased in the spring and *Festuca* which increased in the summer consistent with the seasonal availability and use of habitats where these species occur. Microhistological analyses cannot distinguish between upland and mesic/aquatic *Carices*, however the increase in *Carices* consumption early in the growing season may reflect horses selection of upland species of this genus (threadleaf and needleleaf sedge, *C. filifolia* Nutt. and *C. stenophylla* Wahl., respectively) because of their early growth and high palatability in the spring. *Festuca* occurs on higher elevation sites of the study area that are only used in summer.

In general, *Carices* are the most important forage genus to feral

Table 6. Major dietary components (mean % ± SE[1]) of feral horses on the Whiskey Peak Allotment in southcentral Wyoming.

Plant Name	Winter 1991 (n=5)	Spring 1991 (n=5)	Summer 1991 (n=4)	Winter 1992 (n=6)	Spring 1992 (n=6)	Summer 1992 (n=4)
Graminoids		- - - - - - - - - - - - - - - - (% Relative Density ± SD[1])- - - - - - - - - - - - - - - -				
Agropyron	13 ± 2.68	12 ± 2.23	14 ± 2	10 ± 1.22	8 ± 1.63	8 ± 2
Carex	24 ± 5.8	62 ± 7.15	31 ± 2.5	26 ± 4.49	41 ± 5.71	23 ± 5
Festuca	4 ± 1.34	< 1	18 ± 1.5	6 ± 2.44	8 ± 1.63	24 ± 12
Juncus	2 ± .89	1 ± .89	2 ± 1	1 ± .408	3 ± .816	< 1
Poa	< 1	1 ± .357	< 1	4 ± .816	9 ± 1.63	3 ± .5
Stipa comata	22 ± 7.15	18 ± 2.68	19 ± 1.5	28 ± 4.89	27 ± 4.49	32 ± 9
Oryzopsis	1 ± .89	2 ± .447	7 ± 3.5	1 ± .244	3 ± 1.22	1 ± .3
Forbs and Shrubs						
Total	23 ± 14.31	< 1	<1	19 ± 6.53	< 1	< 1

[1]SE=Standard error of n sites. Data were averages of pooled samples within sites.

horses in this study area. Although a portion of the total *Carex* intake is from upland species, selective preference of horses for streamside and bog/meadow habitats indicate that mesic and aquatic species of this genus represent a significant proportion of feral horse diets compared to other forage species. Dietary composition generally follows patterns of habitats selected by horses.

Conclusions

Selectivity, diets, and utilization observed in this study indicate any detrimental impacts from excessive numbers of feral horses would first be apparent in the streamside, bog/meadow, and secondarily in mountain sagebrush habitats of this study area. These habitats were preferentially selected by feral horses during the growing season on the study area, the most probable season of negative grazing impact. The streamside and bog/meadow habitats represent a small portion of the study area and the allotment as a whole, yet these are also the habitats preferred by wildlife (Dealy et al. 1981, Leckenby et al. 1982, Collins 1980, Hubbard 1977) and livestock (Smith et al. 1992, Pinchak et al. 1991, Hart et al. 1991, Roath and Krueger 1982). Further evidence of potential for spatial overlap between feral horses and elk occurs with their common preference for the open ridges of the mountain sagebrush habitats (Hart et al. 1991, Oedekoven and Lindzey 1987, Thomas and Toweill 1982, Julander and Jeffery 1964).

Feral horse numbers must be kept at appropriate levels to mitigate the potential for detrimental impacts to habitats. Feral horses should also be managed with the knowledge that there appears to be a potential for interspecific competition between horses and other large herbivores.

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