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Impacts of Cattle Grazing on Mesic Grizzly Bear Habitat Along the East Front of the Rocky Mountains, Montana

Abstract

During the summers of 1985 and 1986, we measured vegetation characteristics to determine impacts of cattle grazing on cover and forage preferred by grizzlies within aspen and willow plant communities along the East Front of the Rocky Mountains in north-central Montana Information collected on the phenology of bear foods growing in aspen and willow stands revealed that the more nutritious bear foods produced seeds late in the growing season. The utilization of bear foods by cattle in five study pastures showed that in 6 weeks all herbaceous bear foods were >40 percent utilized. Although sites protected from cattle grazing for 2 to 10 years had more aspen and willow suckers than did grazed sites, grazed sites appeared to be recruiting enough shoots for stand survival. Hiding cover for bears tended to be higher in ungrazed than grazed sites and in sites grazed in months other than June than in sites grazed in June. Deferring grazing in pastures with willow and aspen stands until 1 July and removing cattle from pastures when 50 percent of herbaceous forage in mesic communities was eaten would minimize short term impacts of cattle on plant species preferred by grizzlies. Long term management systems could be designed to encourage or discourage grizzly use of pastures by implementing livestock rotation systems that influenced seed production and standing crop of phenologically desirable growth stages of food plants and cover value of other plants.

Key words: Grizzly bear, *Ursus arctos*, habitat, grazing.

Introduction

Studies on the East Front of the Rocky Mountains of Montana have produced a large data set on grizzly bear (*Ursus arctos horribilis*) habitat use, movements, and distribution (Schallenberger and Jonkel 1978, 1979, 1980; Aune and Stivers 1981, 1982, 1983; Aune *et al*. 1984; Aune 1985; Aune *et al*. 1986; and Aune and Brannon 1987). Approximately 65 percent of spring and early summer grizzly range in this area is managed primarily for the production of livestock forage. Cattle account for 89 percent of livestock grazing. During spring and early summer, cattle and grizzly bears show considerable overlap in diet and habitat use because they use common riparian plant communities (Aune 1985).

Although many researchers believe that livestock grazing can have negative impacts on grizzly bear habitat (Mealey *et al*. 1977, Schallenberger and Jonkel 1980, Sizemore 1980, Knight *et al*. 1981, Aune and Stivers 1982), no data were available to assess the impacts of grazing on vegetation composition, phenology, and/or the structure of riparian communities favored by bears along the East Front. This study was initiated to gather these data.

Study Area

The study area encompassed 600

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km² in Teton and Pondera counties in the foothills of the Rocky Mountains and adjacent prairie (Fig. 1.). Land ownership was divided among the U.S. Forest Service (USFS), Bureau of Land Management (BLM), Montana Fish, Wildlife, and Parks (MFWP), The Nature Conservancy, the Boone and Crockett Club's Theodore Roosevelt Memorial Ranch, and private individuals. Federal agencies controlled access to approximately 5 percent of the study area, MFWP approximately 6 percent, private conservation groups approximately 8 percent, and private landowners approximately 80 percent. The dominant land uses were cattle ranching and recreation. The area had been subjected to extensive oil and gas exploration since the 1950's, but few wells were in production at the time of the study.

Elevations in the study area ranged from 1340 to 2070 m. Annual precipitation averaged 30 cm at low elevations and approximately 50 cm at high elevations (Stivers 1988). Temperatures ranged from -40 to 32° C annually. The average growing season was 90 days. Strong westerly to southwesterly winds were common.

Vegetation varied with landscape position. Along streams, the dominant plant communities consisted of aspen (*Populus tremuloides*), cottonwood (*P. trichocarpa*) and willow (*Salix* spp.). The prairie and higher elevation grasslands were dominated by bluebunch wheatgrass / Idaho fescue (*Agropyron spicatum / Festuca idahoensis*) and shrubby cinquefoil / rough fescue (*Potentilla fruticosa /F. scabrella*) habitat types. Stands of subalpine fir (*Abies lasiocarpa*), Douglas fir (*Psuedotsuga menziesii*), lodgepole pine (*Pinus contorta*), limber pine (*P. flexilis*), and Engelmann spruce (*Picea engelmannii*) were common at higher elevations and/or on wetter slopes of foothills. Detailed descriptions of the vegetation and habitat types are given by Harvey (1980), Kasworm (1981), and Lesica (1982). Vegetation communities occupying study sites were classified into cover-types based on the plant species dominating the primary and secondary canopy strata. Plant identification followed Hitchcock and Cronquist (1973).

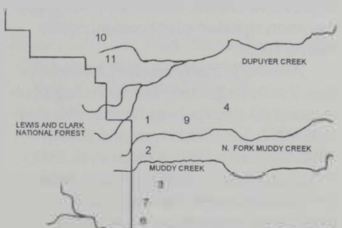

Figure 1. *Map of the East Front study area showing major features and locations of sites used in paired vegetation comparisons.*

METHODS

During 1979-85, the senior author worked with Charles Jonkel and Keith Aune on grizzly bear studies conducted along the East Front. Sites selected for paired comparisons, cattle utilization comparisons, and plant phenology descriptions were identified based on this experience.

Paired sites

We selected sites used in paired comparisons on the bases of similarity in vegetation communities, seral stages, slope, topography, aspect and elevation; and marked differences in grazing regimes. We categorized grazing regimes into 5 types: Grazed (G = pastures grazed in several months between May and October); Ungrazed (U = pastures that had been rested for at least 1 year prior to May 1985); Late Grazed (LG = pastures in which grazing was deferred until after 1 July); Early

Grazed (EG = pastures in which cattle were grazed in late spring and/or early summer but were moved by 1 July); and Winter Grazed (WG = pastures in which cattle were held for supplemental winter feeding during several months between November and May). Both current and historic grazing regimes were considered when selecting stands, and sites comprising pairs were in the same or adjacent drainages with grazing regimes separated only by fences. All paired sites in aspen stands were in the same clones

Three randomly located points were identified in each site in each pair (Stivers 1988) and marked with a 100-cm steel pin to aid in relocation. A 20-m transect was established at each pin. On a randomly chosen side of each transect, a 20 x 3-m rectangular plot was delineated. Deviations from random placement were made only to insure that plots did not overlap or fall on vegetation ecotones.

Estimates of bare soil were made in 40 50-cm^2 microplots at 0.5 m intervals along each transect. We also recorded all vegetation, alive or dead, that intercepted a tape stretched along each transect in a plane 0.5 to 1.0 m above the ground as an index to the lateral coverage a stand would provide for a walking or sleeping bear. The index was calculated by dividing the total millimeters intercepted by plant material by 60,000 millimeters available on the 3 transects at each site.

Overhead canopy coverage, an index to the shade provided by a stand, was estimated using a vertical viewing tube (Emlen 1967). The tube had a field of vision of approximately 1 m^2 at a distance of 3 m above the tube. Canopy coverage was measured as the percent of the viewed field covered by vegetation. Nine readings were taken at 1 m above the ground at each sampling site.

The 60 m^2 plot marked at each sampling site was used to obtain information on abundance, species composition, and size distribution of vegetation. The taller shrubs (species capable of growing to heights > 2.0 m) and all trees in each 60-m^2 plot were counted and placed in height (0-1, 1-2, and >2m) categories by species. Percent canopy coverage by height category (0 - 0.5, 0.5-1, and 1-2 m) was estimated for small shrubs (species incapable of growing to heights >2 m).

For herbaceous species considered desirable bear foods (Aune and Stivers 1981, 1982, 1983), canopy coverages of small species were estimated as a percentage of each 60-m^2 plot; stems of the larger forb species were counted; and the average heights of species in both groups were recorded. An examination of data collected in the first half of the 1985 field season indicated that variation in herbaceous vegetation within plots was as great as variation among plots in the same stand so the 60-m^2 plots were subdivided into 15 m^2 units for measurement of herbaceous vegetation during the second half of the 1985 field season and throughout the 1986 field season.

Although riparian sites within pairs were similar except for grazing treatment, different pairs varied extensively in vegetative character and placement in the landscape. They also differed greatly in current and past land use. We were unable to locate appropriate, independent replicates necessary for conventional statistical analyses. Logistical constraints (limited personnel, the need for sampling all sites within a narrow time window, difficulty in relocating sample points in dense vegetation, and problems with obtaining permission to sample some private lands) and our desire to minimize the number of unexpected confrontations with bears also limited the number of sites included in the study.

Because sampling problems precluded most conventional parametric, multi-treatment, and multivariable approaches to analysis of differences between individual paired sites, we used the Wilcoxon signed-rank test (Zar 1984) to compare median values between groups of sites. Stivers (1988) used Student's t-tests and 2x2 contingency tests (Zar 1984) to explore differences between sites within pairs based on values obtained from the three 60-m² plots, 12 15-m² subplots, and three 20-m transects per site. This approach had low power to detect differences between paired sites and introduced the possibility of pseudo-replication in some tests, but it did eliminate extraneous variation in tests due to a heterogeneous landscape. This approach also allowed us to identify threshold values for differences in vegetative characteristics that we use in this paper. Most t-tests that were significant in Stiver's (1988) exploratory analyses involved differences between sites of ≥100 percent (high value minus low value divided by low value x 100) in variables measured by counting stems or estimating canopy coverage. "Differences" noted in data related to paired sites that we present in this paper are based on this threshold.

The grazing regimes in effect in 1985 and 1986 at many of the sites did not represent historic regimes, and measurements based on our system of pairing may not have reflected historic impacts of grazing on individual stands. We did not have the resources to identify and measure an independent set of sites to investigate long term changes in vegetation associated with grazing, but we did have access to information on pasture fencing patterns (which determine the landscape arrangements that constrain cattle use patterns), stocking rates, and grazing timing on paired sites dating from the 1950's. We used this information to assess the relationship between variables we thought might reflect changes in vegetation that could influence use of stands by grizzly bears that would occur over several decades of grazing (numbers of perennial forbs in the family Umbelliferae, numbers of trees and tall shrubs <2 m in height, percent ground coverage of common herbaceous plants used by bears, and canopy coverage of shrubs 0-1 m in height). We used measurements of vegetation at paired sites in 1986, a year when all transects were measured after canopy coverage had reached near maximum closure, to compare these variables with the number of years pastures had been released from grazing, historic stocking density, and the proportion of pasture in aspen and/or willow stands using Spearman rank correlations (Zar 1984). Preliminary assessments of some stands indicated that bear foods might be most vulnerable to cattle grazing during late spring and early summer so we also contrasted pastures in which summer grazing had been historically deferred until after 1 July with those pastures in which grazing did occur in June using Mann-Whitney rank-sum tests (Zar 1984).

Pasture utilization by cattle

Pastures included in tests of cattle utilization patterns were selected based on the proportion of the pasture covered by riparian vegetation, the cattle grazing system in effect during 1985-86, and the willingness of land managers to allow us access to land they controlled. In order to determine short term impacts of cattle grazing on bear foods in mesic plant communities, five pastures were chosen that differed in size, shape, relief, proportions of mesic communities, timing of livestock use, stocking density, and age classes of livestock. We used these pastures to determine the association between cattle utilization of mesic tree communities (and associated bear foods) and two variables related to grazing patterns: 1) the amount of time cattle were in the pasture: and 2) the distance of mesic tree stands from the gates where cattle entered the pasture.

In each pasture, sample points were chosen in mesic vegetation at 200-m intervals from the gate cattle entered the pasture. At each point, 20 x 3-m plots were established following the procedures described for paired sites. The measurements taken at each plot were also the same, except that microplots and line intercepts were not employed. Vegetation measurements were made 1 week before cattle were put in the pasture and at 2 to 3-week intervals while cattle were present.

To determine the extent to which cattle utilized bear foods, two indices of bear food biomass were calculated for each plot. The first biomass index was calculated by multiplying the number of stems of species of bear foods in the family Umbelliferae [sharptooth angelica (*Angelica arguta*), cow-parsnip (*Heraculem lanatum*), mountain sweet-cicely (*Osmorhiza chilensis*), and western sweet-cicely (*O. occidentalis*)] by the average height per plant. The second index was calculated by multiplying the canopy coverages of three other categories of herbaceous plants used extensively by bears [grasses/sedges, common dandelion (*Taraxacum officinale*), and clovers (primarily *Trifolium longipes*)] by the average height of plants in each category in the plot. Utilization was estimated by comparing the change in biomass-index values between measurements. Values were expressed as the percentage of the maximum estimated biomass for each plot. Differences between sampling periods were assumed to represent a combination of increases of plant biomass due to growth minus biomass removed by grazing and/or trampling. Mean utilization values for each grazing interval were calculated based on values for individual pastures in both years. The association between the length of time cattle grazing occurred and the residual biomass was tested using Spearman's rank correlations.

To determine if mesic sites close to the entrance gate were utilized more than distant sites, utilization plots were grouped into 0.2-km categories based on plot distances from the gate cattle entered the pasture. The percentage of maximum estimated biomass left at the end of the grazing period was then averaged for all pastures and compared by distance categories. The association between the distance from the gate cattle entered and the residual biomass at the end of the grazing period was tested using Spearman's rank correlations.

Bear food phenology

Plant phenology descriptions were based on information collected at paired stands, pastures measured for cattle utilization patterns, and sites with concentrations of specific species of plants heavily utilized by bears. Information on plant phenology was used to construct a time sequence for phenological stages of important bear food plants. The phenological categories we used were: 1) new leaves; 2) flower bud; 3) flowering; 4) fruit/seed set; 5) fruit/seed ripe (fully swollen); 6) fruit/seed dry and shedding; 7) fruit/seed shed; and 8) plant dry and brown. The ranges of dates at which bear foods were in the "seed ripe" phenological stage were recorded for 1985 and 1986. Survival to this stage was deemed necessary for long term survival of the plant species.

Results

Paired contrast sites

Site characteristics. — Fifteen sites were established and measured in 1985 (Table 1). During 1986, the original 15 sites were remeasured and an additional six were established and measured. From these 21 sites, 15 paired site comparisons and two 3-site comparisons were made to examine differences attributable to cattle grazing.

Table 1. *Site characteristics and characteristics of the pastures in which sites were located for paired sites measured in the East Front study area, 1985-86.*

	Site characteristics				Pasture characteristics			
Site code[a]	Cover Type[b]	Elevation (m)	Aspect	Slope (%)	Prior years rest	Stocking density[c] (AU/ha)	Aspen and willow coverage in pasture (%)	Historic grazing period[d]
1U	Aspen-snowberry	1576	90	7	5	0.3	10	Jun 1-Sep 30
1G	Aspen-snowberry	1580	90	7	0	0.4	25	Jul 15-Sep 15
2U	Aspen-snowberry	1567	70	3	5	0.3	10	Jun 1-Sep 30
2G	Aspen-snowberry	1614	70	3	0	0.1	17	Jul 1-Sep 1
3U	Aspen-willow	1494	35	2	5	1.5	6	Sep 15-Oct 31
3G	Aspen-willow	1497	35	2	0	0.5 or 1.1	1	Jun or Aug 1-Oct 15
4U	Willow-cowparsnip	1402	120	1	2	2.2	10	Sep 5-Mar 1
4EG	Willow-cowparsnip	1408	120	1	0	1.3	19	Nov and Feb 15-May 15
4WG	Willow-cowparsnip	1381	120	1	0	3.2	26	Jan 1-Mar 31
6U	Aspen-forb	1858	135	4	2	0.6	7	Jul, Aug or Sep 1-20[e]
6G	Aspen-forb	1858	135	4	1	0.6	5	Jul, Aug or Sep 1-20[e]
7U	Aspen-forb	1896	145	4	7	0.6	1	Jul, Aug or Sep 1-20[e]
7G	Aspen-forb	1892	145	3	0	0.6	0.5	Jul, Aug or Sep 1-20[e]
8U	Aspen-forb	1593	40	9	9	0.3	7	Jun 7-Sep 1
8G	Aspen-forb	1598	40	9	0	0.4	4	Jun 15-Aug 15
9LG	Willow-forb	1512	85	3	0	0.4	25	Jul 15-Sep 15
9EG	Willow-forb	1518	85	4	0	0.6	12	Jun 1-Jul 15
10LG	Aspen-forb	1451	57	9	0	0.4	23	Aug 15-Oct 15
10EG	Aspen-forb	1451	57	7	0	0.3	18	Jun 1-Jul 31
11LG	Aspen-willow	1498	33	6	0	0.5	26	Jul, Aug or Sep[f]
11EG	Aspen-willow	1495	33	6	0	0.3	18	Jun 1-Jul 31

[a] Ungrazed (U = pastures rested for one or more years prior to measurements), grazed (G = grazed during most or all of summer 1985-86), early grazed (EG = grazed during late winter - early summer in 1985-86), late grazed (LG = grazed during late summer and/or autumn during 1985-86), and winter grazed (WG = grazed during the winter prior to measurement in 1985-86).

[b] Overstory dominated by Aspen (*Populus tremuloides*) or willow (*Salix* spp.) - understory dominated by snowberry (*Symphoricarpus albus*), willow, cow parsnip (*Heracleum lanata*), or mixed forb species.

[c] Based on the area of the pasture minus steep slopes and stands of closed coniferous forest with animal units (AU = 1 cow and 1 unweaned calf for the length of the grazing season) averaged since 1950.

[d] Dominant grazing system in effect from 1950 - 1985 or up to date of rest.

[e] A 4 pasture rest-rotation system since 1974; prior grazing season was approximately Jul 1 - Sep 15.

[f] A 3 pasture rotation system.

In 1985, most measurements were made in May and June. In 1986, most sites were measured in June and July. Remeasurements of sites sampled in both years were timed to sample stands at different phenological phases. All measurements in grazed pastures were made prior to use of new growth at sites by cattle.

Aspen dominated the upper canopy stratum at 16 sites and willow in five (Table 1). Sites ranged in elevation from 1381 to 1896 meters. Slopes were between 1 percent and 9 percent, and most aspects were easterly (33 - 145°). Seven of the sites had not been grazed for 2 to 9 years prior to 1985. Of these, one site (8U) was on the MFWP Ear Mountain Wildlife Management Area, three (1U, 2U, and 3U) were on the MFWP Blackleaf Wildlife Management Area, two (6U and 7U) were within BLM cattle exclosures, and one (4U) had been rested by a private landowner.

Cattle stocking densities ranged from 0.1 to 1.1 animal units per hectare (A.U./ha) on grazed pastures and had historically been 0.3 to 2.2 A.U./ha on pastures protected from cattle grazing. Those sites in pastures with the highest stocking densities were in winter pastures where cattle were fed hay (4U, 4EG, and 4LG) or in pastures with a fall grazing period of short duration (3U and 3G) (Table 1).

The current, or historic, grazing periods of pastures containing study sites were: eight pastures grazed during the month of June (1U, 2U, 3G, 8U, 8G, 9EG, 10EG, and 11EG), eight pastures with summer grazing (1G, 2G, 6U, 6G, 7U, 7G, 9LG, and 11LG), four pastures with fall / winter grazing (3U, 3G, 10LG, and 4U), one winter pasture (4WG), and one late winter / early spring pasture (4EG). The proportion of each pasture covered by aspen and willow communities ranged from 0.5 to 26 percent (Table 1).

Measurements for short term effects. — The 1985 and 1986 microplot measurements (Table 2) indicated that ungrazed and late grazed (grazing deferred until after 1 July) sites had less bare ground (median = 2 percent) than sites grazed in June (grazed and early grazed median = 7 percent) (signed-rank test, $P < 0.01$). Eight grazed and early grazed sites of the 15 paired comparisons had ≥100 percent more bare ground than the ungrazed or late grazed site with which they were paired. The winter grazed site had less bare ground than the early grazed and ungrazed sites with which it was contrasted.

Ungrazed sites and late grazed sites had a higher median (6 percent) for the lateral coverage index than the grazed and early grazed sites with which they were paired (4 percent) (signed-rank test, $n = 15$, $P = 0.03$). Five of the 12 ungrazed sites had lateral cover index values ≥100 percent higher than the sites with which they were paired, and two of the three late grazed sites had lateral cover index values ≥100 percent higher than the early grazed sites with which they were paired. Lateral coverage in the comparison of winter grazed, ungrazed, and early grazed sites did not exhibit any clear pattern (Table 2).

No consistent differences in overhead canopy coverage were apparent in the sites we sampled (Table 2). A Wilcoxon signed-rank test comparing ungrazed and late grazed with grazed and early grazed failed to reject the null hypothesis ($n = 15$, $P = 0.25$), and all differences between paired sites were <100 percent of the lower value.

Aspen and willow were the dominant overstory species at all sites. Douglas fir, lodgepole pine, Engelmann spruce, and limber pine were present at six sites but made up < 2 percent of the total stem count. Water birch (*Betula occidentalis*), red-osier dogwood (*Cornus stolonifera*), and common chokecherry (*Prunus virginiana*) were present in small amounts and varying combinations at

Table 2. *The 1985-1986 plot cover measurements.*

Site	Cover type	Sample date	Bare ground (%)	Lateral cover index (%)	Tree canopy coverage (%)	Trees and tall shrubs (stems per height class) 0-1m	1-2m	>2 m	Low shrubs (% cover by height class) 0-1m	1-2m
1U[a]	Aspen - snowberry	04/28/85	<1	<1	7	6	33	64	18	0
1G		04/28/85	0	1	7	<1*	7*	38	4*	0
1U		07/26/86	1	17	56	7	26	61	59	1
1G		07/22/86	1	13	49	4	7*	36	25*	<1
2U	Aspen - snowberry	05/08/85	0*	1	4	77	101	59	7	<1
2G		05/07/85	2	1	4	24*	24*	31	5	<1
2U		06/26/86	<1	13	53	43	59	56	37	0
2G		06/19/86	<1	5*	62	26	19*	33	40	0
3U	Aspen - willow	05/14/85	0*	6	20	59	17	28	1	<1
3G		05/15/85	7	2*	14	16*	5*	31	1	<1
3U		06/24/86	7	21	56	13*	17	25	16	2
3G		06/22/86	9	6*	56	31	22	28	9	<1*
4U[a]	Willow-cowparsnip	05/17/85	12	5*	17	68	22	37	1	<1
4EG		05/21/85	13	7	27	12*	5*	45	1	0
4WG		05/25/85	6*	10	29	2*	4*	20*	1	0
4U		07/10/86	14	47	54	19	24	35	11	1
4EG		07/09/86	17	37	61	18	22	41	1*	<1
4WG		07/11/86	1*	65	64	<1*	1*	13*	3*	1
6U	Aspen - forb	06/15/85	0	2	31	77	19	23	1*	0
6G		06/12/85	0	1*	23	34*	4*	12	2	0
6U		07/30/86	0	6	58	105	17	18	1*	0
6G		07/28/86	0	2*	45	101	3*	14	2	0
7U	Aspen-forb	06/19/85	4*	2	25	95	1*	20	1	0
7G		06/19/85	13	3	28	20*	2	33	1	0
7U		08/01/86	5*	5	50	116	1*	18	11	0
7G		07/31/86	14	6	55	92	2	31	2*	0
8U[a]	Aspen - forb	08/21/85	6*	8	42	25	16	13	7*	0
8G		08/19/85	26	7	46	17	9	11	18	0
8U		06/16/86	2*	10	45	19	17	13	12	0
8G		06/17/86	14	6	43	24	9	11	23	<1
9LG	Willow - forb	05/25/86	10*	4	15	3*	31	34	16	0
9EG		05.26.86	23	6	20	7	31	52	7*	0
10LG	Aspen - forb	06/11/86	2*	28	25	4*	2	12	10*	0
10EG		06/02/86	14	<1*	17	11	1*	10	31	0

Table 2. *(Continued)*

Site	Cover type	Sample date	Bare ground (%)	Lateral cover index (%)	Tree canopy coverage (%)	Trees and tall shrubs (stems per height class) 0-1m	1-2m	>2 m	Lowshrubs (% cover by height class) 0-1m	1-2m
11LG	Aspen - willow	06/10/86	4	4	48	38	11	36	22	<1
11EG		06/09/86	3	2*	36	54	3*	30	25	0

[a] U = pastures rested for one or more years prior to measurements; G = pastures grazing during most or all of summer in 1985-86; EG = pastures grazed during late winter - early summer in 1985-86); LG = pastures grazed during late summer and/or autumn during 1985-86. WG = pastures grazed during winter in 1985-86).
[b] Mean percent bare ground (calculated from 120 50-cm² microplots per site).
[c] Percent lateral coverage (sum of millimeters intercepted by vegetation in a plane ≤50 cm above the ground along 3 20-m transects per site divided by 60,000 mm sampled multiplied by 100).
[d] Percent overhead canopy coverage (calculated from 27 viewing tube readings per site), and mean number of stems (calculated from 3 60-m² plots per site) by height categories for trees (>98 percent *Populus tremuloides* and *Salix* spp.) and tall shrubs (predominantly *Betula occidentalis*, *Cornus stolonifera*, and *Prunus virginiana*) and for low shrubs (predominantly *Ribes* spp., *Rosa* spp., *Rubus idaeus*, and *Symphoricarpus albus*) recorded at paired contrast sites in the East Front study area in 1985-86.
* Difference in paired comparison ≥100 percent (high value minus low value divided by low value multiplied by 100).

sites 3U, 3G, 4U, 4EG, and 4WG.

Sites protected from cattle grazing usually had more aspen and/or willow stems in the 0-1 m (ungrazed median = 51, grazed median = 24; signed-rank test: n = 12, P = 0.03) and 1-2 m (ungrazed median = 17, grazed median = 7; signed-rank test: n = 12, P = 0.01) height classes but not in the >2 m height class (ungrazed median = 21, grazed median = 31; signed-rank test: n = 12, P = 0.20). In 2 of 3 comparisons of the 0-1 m height class in late grazed sites versus early grazed sites, the early grazed sites had >100 percent more stems per 60-m² than did late grazed sites. In comparisons of the 1-2 m and >2 m height classes, late grazed sites followed the same pattern as ungrazed sites (Table 3). The winter grazed site had fewer stems in plots in all height categories than either the early grazed or ungrazed sites with which it was contrasted.

Fifteen species of shrubs with low (< 2 m) growth forms were identified in plots during the study. The 4 shrubs most often encountered were currant (*Ribes* spp.), rose (*Rosa woodsii*), red raspberry (*Rubus idaeus*), and common snowberry (*Symphoricarpos albus*) (Table3). Snowberry had the highest average canopy cover over all sampled sites (7.1 percent canopy coverage and present in 76 percent of site samples). Rose had a mean canopy coverage of 2.1 percent and was present in 86 percent of site samples. Currant had a mean canopy coverage of 1.6 percent and was present in 94 percent of site samples. Raspberry had a mean canopy coverage of 1.5 percent and was present in 28 percent of site samples. All other low shrub species had overall mean canopy coverages of <1 percent and were present in <25 percent of site samples.

Comparisons of canopy coverage in ungrazed and late grazed sites versus paired grazed and early grazed sites indicated no differences in canopy coverage of low shrubs in the 0-1 m height class (signed rank test, n = 15, P = 0.89). Differences in canopy coverage of >100 percent between ungrazed and late grazed sites and the grazed or late

Table 3. *Mean numbers of stems (N) or percent canopy coverage (percent) for herbaceous bear foods[a] in three 60-m² plots at paired contrast sites in the East Front study area, 1985-86.*

Site	Date	Sharp-tooth angelica N	Cow-parsnip N	*Osmorhiza* spp. N	Mountain sweet-cicely N	Western sweet-cicely N	Glacier lily N	Strawberry percent	Grass percent	Dandelion percent	Clover percent
1U[b]	04/28/85		0*	71				<1	<1*	<1*	0
1G	04/28/85		16	132				<1	5	5	<1
1U	07/26/86	0*	0*		9	195*		<1	4*	<1*	0
1G	07/22/86	9	69		7	443		1	23	8	<1
2U	05/08/85			8*			0*	<1	<1	<1	
2G	05/07/85			34			98	<1	<1	<1	
2U	06/26/86				75	20*	0*	1*	<1*	<1	
2G	06/19/86				82	253	14	4	3	1	
3U	05/14/85	188	13	50			65	<1	5	3	<1
3G	05/15/85	2*	0*	26			0*	<1	1*	3	<1
3U	06/24/86	306	30		201*			<1	10	2	<1*
3G	06/22/86	6*	0*		405			<1	7	3	2
4U[b]	05/17/85	0	328*	15*				<1	11	<1	<1
4EG	05/21/85	<1	731	14*				<1	3*	1	0
4WG	05/25/85	0	487	155				<1	1*	<1	0
4U	07/10/86		490		10*			0	18	<1*	<1
4EG	07/09/86		594		30*			1	11	2	<1
4WG	07/11/86		726		160			<1	3*	<1*	0
6U	06/15/85				558	6*	97	1*	11	11	8*
6G	06/12/85				58*	12	34*	6	10	16	24
6U	07/30/86				179	22		5	24	12	3*
6G	07/28/86				65*	5*		2*	17	20	11
7U	06/19/85		0		1247		293	7	6	10	
7G	06/19/85		1*		1025		317	1*	7	13	
7U	08/01/86		0		483			4	18	9	
7G	07/31/86		<1		401			<1*	20	8	
8U[b]	08/21/85				77		<1	<1	24	2*	
8G	08/19/85				124		<1	<1	13	5	
8U	06/16/86				151*			1	24	6	
8G	06/17/86				339			<1	16	7	
9LG	05/25/86	143	0		94			<1	17	9	<1
9EG	05.26.86	0*	58*		86			<1	8*	8	<1

Table 3. *(continued)*

Site	Date	Sharp-tooth angelica N	Cow-parsnip N	*Osmorhiza* spp. N	Mountain sweet-cicely N	Western sweet-cicely N	Glacier lily N	Strawberry percent	Grass percent	Dande-lion percent	Clover percent
10LG	06/11/86		243		25*	1198		<1	23	1*	
10EG	06/02/86		11*		70	549*		<1	7*	15	
11LG	06/10/86	95	38		186	126		<1*	20	16	1
11EG	06/09/86	0*	1*		353	34*		3	12	11	1

[a] Plant species routinely utilized by bears (Aune and Stivers 1981, 1982, 1983): sharptooth angelica (*Angelica arguta*), cow-parsnip (*Heracleum lanatum*), *Osmorhiza* spp. (immature plants that could not be identified at the species level), mountain sweet-cicely (*O. chilensis*), western sweet-cicely (*O occidentalis*), glacier lily (*Erythronium grandiflorum*), strawberry (*Frageria virginiana*), grass (all grass and sedge species with *Poa pratense* the most common), dandelion (*Taraxacum officinale*), and clover (predominantly *Trifolium longipes*).

[b] U = pastures rested for one or more years prior to measurements; G = pastures grazing during most or all of summer in 1985-86; EG = pastures grazed during late winter - early summer in 1985-86); LG = pastures grazed during late summer and/or autumn during 1985-86: WG = pastures grazed during winter in 1985-86).

* Difference in paired comparison ≥100 percent (high value minus low value divided by low value multiplied by 100).

grazed sites with which they were paired occurred in eight of 15 comparisons, but in four comparisons the ungrazed/late grazed site had higher canopy coverage and in four it had lower values. No obvious pattern was observed in the contrast between the winter grazed site and associated ungrazed and early grazed sites. Too few sites had shrubs in the 1-2 m height class to support a signed-rank test.

For summed stem counts of five forb species used as food by bears, no consistent pattern was evident in paired comparisons of ungrazed/late grazed and grazed/early grazed sites (signed-rank test, n = 15, $P = 0.42$) or for contrasts involving the winter grazed site. Three, sharptooth angelica, cow-parsnip, and western sweet-cicely, were considered highly desirable food for bears. Two, glacier lily (*Erythronium grandiflorum*) and mountain sweet-cicely, were eaten but were not regarded as highly as food species. Only cow-parsnip and mountain sweet-cicely occurred in enough plots for Wilcoxon tests, and neither test indicated significant differences (n=15, $P = >0.10$) among medians for ungrazed/late grazed sites versus the grazed/early grazed sites with which they were paired.

For paired comparisons with ≥100 percent differences, stem counts for angelica were higher at ungrazed sites than at grazed sites in two of three comparisons, and counts were higher at late grazed than early grazed sites in both pairs where angelica occurred. Cow-parsnip stem counts were higher at grazed sites than ungrazed sites in four paired comparisons and higher at ungrazed sites than grazed sites in three paired comparisons. Stem counts in late grazed sites were higher than in early grazed sites in two of the three pairs where it occurred. Western sweet-cicely stem counts were >100 percent higher in plots at grazed sites than at ungrazed sites in three of four pairs and higher in late grazed than early grazed sites in both pairs where it occurred. Mountain sweet-cicely was more abundant in two of three ungrazed sites and two of two late grazed sites than in the sites with which they were paired. Glacier lily was more abundant in two of four grazed sites than in paired ungrazed sites and did not occur in any of the sites where we contrasted late versus early grazing.

Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*) and smooth brome (*Bromus inermis*) were the dominant species in the "grass" category. This category had the highest coverage of the 4 groups of herbaceous bear foods we measured using canopy coverage (Table 3). Grazed and ungrazed sites were not significantly different for the strawberry and grass categories (signed-rank test, n = 12, $P >$ 0.67). Grazed sides had higher median coverage of dandelions (6 percent) than did ungrazed sites (2.5 percent) with which they were paired (signed-rank test, n = 12, $P = 0.01$). Clover coverage did not occur at enough sites to support a Wilcoxon test. Late grazed sites generally had higher grass coverage than early grazed sites. The winter grazed site had lower grass coverage than the ungrazed and early grazed sites with which it was contrasted.

Measurements for long term effects — Years without cattle grazing for 21 sites measured in 1986 varied from 0 - 10 (Table 1). Spearman rank correlations indicated a significant, but weak, negative relationship between number of years of rest and the number of preferred umbel stems (angelica, cow-parsnip, and western sweet-cicely) counted in plots ($R_s = -0.38$, $P = 0.09$). Associations with percent coverage of grasses, dandelions, and clover, numbers of overstory species < 2 m in height and percent canopy coverage of low shrubs were not significant (R_s = 0.05 to 0.32, $P > 0.10$).

Historic stocking rates in pastures associated with sites varied from 0.1 - 3.2 AU per ha. The only significant rank correlation with this variable was a negative association ($R_s = -0.75$, $P <$ 0.01) with percent low shrub canopy coverage. Associations between stocking rates and other variables ranged from - 0.07 to 0.17 ($P > 0.10$).

Numbers of preferred umbels were positively associated ($R_s = 0.77$, $P < 0.01$) and numbers of stems of trees and tall growth-form shrubs in the 0-1 m height class were negatively associated with ($R_s = -0.63$, $P < 0.01$) the proportion of deciduous tree coverage in the pasture. Associations between mesic deciduous tree community coverage and other variables ranged from - 0.08 to 0.21 ($P >$ 0.10).

Twelve sites measured in paired comparisons were in pastures historically deferred from grazing in June (1G, 2G, 3U, 4U, 4WG, 6U, 6G, 7U, 7G, 9LG, 10LG, and 11LG). Eight sites were located in pastures that had been historically grazed in June (1U, 2U, 3G, 8U, 8G, 9EG, 10EG, 11EG). One site (4EG), not grazed in June but frequently grazed in February through mid May, did not fit well in either category and was not included in tests.

The median number of preferred umbel stems (angelica, cow-parsnip, and western sweet-cicely) in 60-m^2 plots in pastures with little or no June grazing was 256. The median for pastures historically grazed in June was 28. A Mann-Whitney rank test did not indicate the medians were different (P = 0.18). This test was heavily influenced by two outliers. Sites 7U and 7G were the only deferred stands with <5 umbel stems per plot. When these stands were deleted from the test, medians were significantly different ($P = 0.046$).

The median percent canopy coverage of staple herbaceous bear foods (grasses, strawberry plants, dandelions, and clover) in 60-m^2 plots in deferred pastures was 28 percent. The median in pastures historically grazed in June was 20 percent. This difference was not significant (Mann-Whitney rank-test $P = 0.18$), but the test was influenced by at least 1 outlier. Exclusion of site 4WG raised the median for deferred pastures slightly, but produced a significant summed rank score (sum of ranks = 144, $P = 0.048$).

Median values for the number of stems of canopy species in plots (0-1 m height class: deferred = 22, non-deferred = 22 stems, rank-test $P = 0.94$; 1-2 m height class: deferred = 9, non-deferred = 19, rank-test $P = 0.23$) were not significantly different. The median percent canopy coverage of low growth-form shrubs also did not differ between historically deferred and non-deferred sites (deferred = 11, non-deferred = 24, rank-test $P = 0.11$). Outliers did not influence these tests.

Pasture utilization by cattle

Five pastures were measured to determine short term impacts of cattle grazing on herbaceous bear foods in mesic communities (Table 4). The Kurt Heinrich (KH) and North Cow Creek (NC) pastures were measured in 1985, the Tom Salansky (TS) and Hightower (HT) pastures in 1986, and the South Dupuyer Creek (SD) pasture in both years. These pastures varied in shape, physiography (from relatively flat grassland with shallow coulees to steep foothills), abundance of aspen and willow communities (from 4 - 15 percent

Table 4. *Characteristics of five pastures in which cattle utilization patterns in deciduous tree communities were monitored in the East Front study area, 1985-86.*

	Pasture				
	KH	NC	SD	TS	HT
Year	1985	1985	1985-86	1986	1986
Plots/pasture (#)	10	10	10	3	5
Range of plot distances from gate (km)	0.8-1.6	0.2-1.2	0.2-2.0	1.4-1.8	0.4-1.6
Pasture physiography	prairie and gentle foothills	prairie and shallow coulees	gentle to steep foothills	gently rolling prairie	gentle to steep foothills
Proportion of pasture in aspen and willow (percent)	13	12	15	4	4
Pasture area (ha)	259	259	324	66	222
Class of livestock	yearling heifer	cow/calf	cow/calf	yearling heifer	cow/calf
Stocking density (A.U./ha)	0.6	1.0	0.5	0.6	0.4
Period grazed	Jun 10 - Jul10	Jun 6 - Jul 5	Jun 25 - Aug 21 ul 1 - Aug 17	Jun 1 - Sep 30	May18 - Aug 1

of surface area), and size (from 66 to 324 ha). The number of plots in each pasture ranged from three to 10 and was roughly proportionate to the amount of aspen and willow present. The distances of plots from the gate through which cattle entered the pasture varied from 0.2 to 2.0 km. Black angus or crossbreed black angus yearlings or cow/calf pairs grazed the study pastures. Stocking densities were 0.4 to 1.0 A.U./ha. All pastures were grazed for at least a 30-day period between 1 June and 30 September. The earliest entry date was 18 May, and the latest was 1 July (Table 4).

Cattle utilization of two categories of bear foods, (1) grasses/sedges, common dandelion, and clover and 2) Umbelliferae (including sharptooth angelica, cow-parsnip, and mountain and western sweet-cicely) varied widely among pastures, but the median decline in biomass was >40 percent for both categories after 6 weeks of grazing, and 80 percent or more of preferred Umbelliferae biomass had disappeared after 9 weeks of grazing (Fig. 2). In pastures where cattle were kept for 3 months or more, approximately 80 percent of the biomass of grasses, sedges, dandelions, and clovers was removed after 12 weeks of grazing. Spearman rank correlations indicated a significant negative relationship between days of grazing and residual

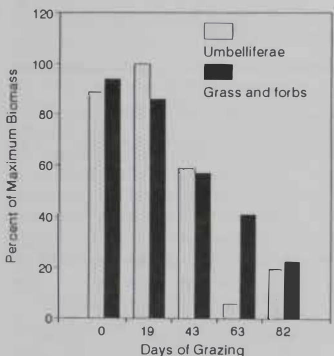

Figure 2. *Estimated median residual biomass (percent of maximum) of Umbelliferae species (angelica, cow—parsnip, and sweet-cicely) and grasses and forbs (predominantly Kentucky bluegrasses, timothy, smooth brome, clovers, and dandelion) in 5 pastures at 5 intervals during the summer grazing seasons of 1985 and 1986 in the East Front study area. The biomass index was calculated by multiplying the average height of plants by numbers of stems (umbels) or canopy coverage (grasses and small forbs) in 60-m² plots.*

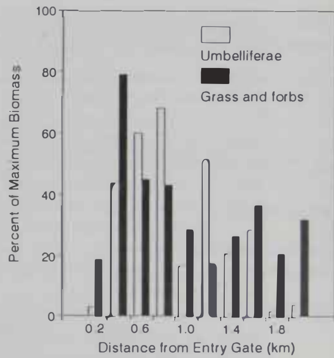

Figure 3. *Estimated median residual biomass (percent of maximum) of Umbelliferae species (angelica, cow—parsnip, and sweet-cicely) and grasses and forbs (predominantly Kentucky bluegrasses, timothy, smooth brome, clovers, and dandelion) by distance from the gate at which cattle entered at the end of the grazing season in 5 pastures during the summer grazing seasons of 1985 and 1986 in the East Front study area. The biomass index was calculated by multiplying the average height of plants by numbers of stems (umbels) or canopy coverage (grasses and small forbs) in 60-m² plots.*

biomass of umbels (R_s = -0.63, n = 23, P < 0.01) and the grass-forb category (R_s = -0.46, n = 23, P = 0.03).

We did not identify a significant relationship between distance of a deciduous tree stand from the gate at which cattle entered and utilization of preferred umbels (R_s = -0.23, n = 48, P = 0.12) or the grass-forb category (R_s = -0.08, n = 48, P = 0.60). Cattle tended to spread quickly throughout the pasture in which they were released. The median residual biomass at the end of the grazing period at sites 200 m from the entry gate was similar to or lower than medians for sites 1.8 - 2.0 km from entry gates (Fig. 3).

Bear food phenology

Seven bear foods were analyzed for earliest and latest dates at the "seed ripe" stage (Fig.4). The earliest plant species to produce seeds was common dandelion (19 May). Next were clover, the grasses (primarily Kentucky bluegrass, smooth brome, and timothy), and mountain sweet-cicely, which produced seeds in early June. Later were western sweet-cicely (15 June), cow-parsnip (25 June), and sharptooth angelica (14 July). Survival to this stage was deemed necessary for long term survival of the plant species.

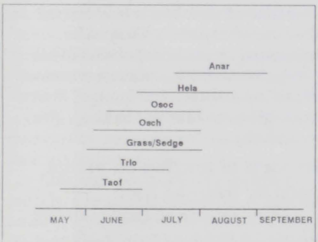

Figure 4. *Earliest and latest observed dates at which bear foods reached the "seed ripe" phenological stage in the East Front study area, 1985-86.*

Discussion

Impacts of grazing on willow and aspen communities

Grizzly bears within the study area use aspen and willow stands in significantly higher proportions than their availability would suggest (Aune 1985). These stands provide dense lateral cover that creates a secure place for bears to rest and forage. The overhead canopy provides shade on warm summer days. Willow and aspen stands growing along stream courses often form contiguous riparian corridors. These corridors provide hiding cover and resting sites for bears as they exploit foods available in prairie habitat types and during spring searches for winter-killed wild ungulates and the dead cattle annually available in boneyards of ranches (Aune and Brannon 1987). Cattle grazing has the potential to alter cover value.

The aspen literature from the Central Rocky Mountains suggests that once a mature stand is established, regeneration is minor until the stand is cut or destroyed by fire or other natural agents (Smith *et al.* 1972, DeByle and Winokur 1985). After disturbance, even-aged shoots from roots grow quickly and enough can usually survive cattle grazing to regenerate the stand if the total area of the stand is large enough (Smith *et al.* 1972, Mueggler and Bartos 1977).

In uneven-aged aspen stands, regeneration is usually sparse and the shoots grow slowly. Cattle grazing can inhibit stand regeneration under these conditions (Krebill 1972, Beetle 1974). Shoot production and stand regeneration are also influenced by carbohydrate reserves, hormonal growth promotors in the roots, genotype, and nongenetic factors such as clone history, stem age, and environmental factors at the site (Tew 1970, Schier and Johnston 1971, Jones 1975, Schier 1975 and 1981, Schier and

Campbell 1980).

In the East Front study area, aspen appears to be a climax species. The aspen parklands of Canada extend southward into northern Montana along the east slope of the Rocky Mountains (Lynch 1955). Unlike aspen of the Central Rocky Mountains, the climax aspen parklands of Canada are expanding in the absence of fire (Moss 1932, Bailey and Wroe 1974).

The data collected in this study suggested that ungrazed sites produced more aspen and willow shoots that survived the growing season, had less bare ground, more hiding cover at 0 - 0.5 m above the ground, and fewer dandelions than grazed sites. We did not find consistent short term differences in grazed and ungrazed sites in overhead canopy, canopy of low growth-form shrubs, numbers of tree stems >2 m in height, or abundance of herbaceous species. Sites grazed after June tended to resemble ungrazed sites, and sites grazed only during May and June shared many characteristics of sites grazed for the whole growing season.

Long term impacts of grazing could not be measured directly, but we were able to determine the association between historic management of pastures and some stand characteristics. Resting pastures up to 10 years evidently had little impact on stand structure, but heavy historic stocking rates may have lead to declines in canopy coverage of low shrubs. Fencing patterns that resulted in high percentages of deciduous tree stands in pastures were associated with low numbers of 0-1 m height deciduous tree species and greater abundance of some large Umbelliferae species. Deferring grazing until July on summer grazed pastures apparently impacted the species composition of the herbaceous ground stratum in deciduous communities but had no consistent impact on the structure of tree and shrub strata.

Vulnerability to damage by cattle varied among and within stands. Understory conditions in stands open to grazing varied from almost no living vegetation, to dense carpets of aspen shoots, to dense herbaceous vegetation which may have adversely affected tree shoots, but most grazed sites had aspen or willow shoots in the 1-2 m height class that had survived previous years of grazing. Impacts of cattle on stands to which they had access were not uniform. Cattle generally had preferred places for loafing and tended to feed and trample shoots most heavily in these localized areas. No sites were observed where remnant aspen or willow stands had been displaced by coniferous, shrub, or grassland plant communities. The majority of aspen and willow stands within the study area appeared to be stable in size or expanding, and bears were observed in or near all of the pastures included in the study (Aune and Stivers 1981, 1982, 1983, Aune 1985) suggesting that the range of stand conditions we observed in grazed pastures did not preclude use by bears.

Factors not measured in this study may have affected habitat security more than the vegetation characteristics we measured. Aune (1985) showed that grizzly bears avoided aspen and willow sites located close to roads (0-500 m). Bear use of any site is likely to be influenced by the juxtaposition of other plant communities, tradition, memory of past disturbance and food availability, and current food availability.

Impacts of grazing on plants used by bears as food

During spring and early summer, deciduous tree communities are important sources of succulent vegetation used by grizzly bears for food (Aune and Brannon 1987). Counts of stems of five large forb species regularly utilized by bears during spring and cattle during any part of the growing season did not vary consistently between grazed and ungrazed or late grazed and early grazed sites. Comparisons for individual species of highly preferred Umbelliferae in individual paired sites did suggest that resting pastures or deferring summer grazing until at least 1 July might favor angelica.

Sites that had been rested for several years or had historically low stocking rates and sites in pastures with abundant deciduous tree cover had a greater number of preferred umbels than heavily stocked sites in pastures with low deciduous tree cover. Sites that had been grazed during June, since the 1950's, tended to have lower numbers of stems of one or more of the three species of preferred umbels than sites that had not been grazed in June. Pastures traditionally grazed in early spring (4U, 4EG, and 4WG) had high stem counts for cow-parsnip.

Deferring grazing until July or later (through management or because of the time required for cattle to reach interior areas in large aspen or willow stands) would presumably allow some individuals of species which produce mature seeds in July and August, such as angelica, cow-parsnip, and western sweet-cicely, to complete seed production before cattle reached them. Plants consumed by cattle in June would not likely have time to produce a new seed crop before the first killing frosts in September, but plants subjected to early - mid spring cattle grazing followed by summer rest would have time to produce seeds.

Although bears actively seek large umbels, a large part of the diet of grizzly bears in spring and early summer along the East Front consists of "staples" such as grass, strawberry plants, dandelions, and clover (Aune and Brannon 1987). We did not measure many consistent differences in coverage of these plant groups among ungrazed, summer grazed, early grazed, or late grazed sites. Only median dandelion coverage differed between grazed and ungrazed sites. Sites that had been grazed during June since the 1950's tended to have lower canopy coverage of staple herbaceous foods than those in which summer grazing was deferred until after 1 July.

The three most common grasses on plots we measured (timothy, Kentucky bluegrass, and smooth brome) were abundant in most sites. All three species are tolerant of grazing and trampling. The median date for seed production in grasses and sedges on the study area was the first week of July.

Common dandelion and clovers are also low growing plants that tolerate grazing well and were widely distributed in ungrazed, early grazed, and late grazed pastures in the study area. Median dates for production of ripe seeds fell in June. Plants grazed by cattle in June would have time to produce new seed crops. Plants that were in pastures deferred in June would produce seeds and could restore root reserves prior to exposure to cattle.

Grazing patterns vs. herbaceous bear food availability

The five pastures that were monitored for utilization showed that cattle ate or trampled herbaceous bear foods. Almost 50 percent of the biomass of these foods was removed after 6 weeks of grazing by cattle, and by the end of the grazing period, cattle had utilized bear foods in all aspen and willow stands in all pastures.

In 1985 and 1986, cattle were turned into the five pastures in late June or early July when the grassland vegetation was still succulent and the days were cool. Within 2 days, the cattle were evenly distributed over the grasslands. Their rate of movement and consumption when foraging seemed to be dependent on the volume of succulent grasses and how easily they could be procured. When there were no topographical or physical obstructions and forage volume was great, they moved slowly. When the succulent grasses were consumed, became dry, or became unpalatable, cattle either moved faster or shifted to aspen and willow stands to forage.

The cattle first chose open areas within aspen and willow stands where there were ample amounts of succulent vegetation (including herbaceous bear foods) to enable them to fill their rumens with the least amount of effort. Such areas were often used for "shading up" and loafing during the heat of mid-day. Loafing areas were often dominated by grasses, dandelions, and clovers. When these plant species were consumed or trampled, cattle shifted to adjacent areas and fed on the more nutritious bear foods (sharptooth angelica, cow-parsnip, and western sweet-cicely).

Cattle generally consumed the smaller, more tender, lateral stems of these plants before the apical, seed-bearing stems. If the apical stems were mature, they either escaped herbivory altogether or were not eaten until the tender stems were gone, a process which often took 2 to 3 weeks.

Grazing management systems and bear food availability on the East Front

The pattern traditionally followed by ranchers along the East Front when rotating cattle through their pastures affects bear food availability. Many ranchers hold their cattle in willow / hay meadow pastures during winter and early spring. These pastures generally have an abundance of the more desirable bear foods because of favorable moisture regimes due to their locations in drainage bottoms and probably because cattle are moved early enough in spring to allow regrowth of herbaceous plants during the summer.

During May and June, most ranchers release their bulls into pastures occupied by cows for breeding. Many ranchers use small pastures during these 2 months in order to maximize fertilization of cows. This results in a high stocking density in pastures where plants are susceptible to damage from trampling because of relatively high soil moisture and are very attractive to cattle as forage because they are succulent and rapidly growing.

The most palatable umbels evidently cannot tolerate this pressure in June, and pastures used for breeding had low densities of these species. Herbaceous bear foods such as dandelions, clover, and grasses, which have low growth forms that protect them from grazing and either reproduce asexually or produce seed in a short time, can regrow and reproduce if cattle are removed after June. Pastures grazed in June generally had ample amounts of these plants.

After breeding, ranchers move their cows and calves to summer pastures. Summer pastures are usually large and are grazed from July into September. Some ranchers rotate cattle among several pastures during this period. Most summer pastures in the study area contained enough acreage of aspen and willow that the majority of western sweet-cicely and cow-parsnip plants on favorable sites produced seeds before being damaged or consumed by cattle. Sharptooth angelica, the umbel that produced seeds latest in the growing season, seemed to require wetter sites than the other Umbelliferae species. It was locally common at microsites within summer pastures where wet "swampy" areas or dense tangles of willow limbs denied cattle access.

During October, ranchers typically herd their cattle onto hay meadow pastures to fatten cows and calves prior to weaning and selling of the calves. The herbaceous bear foods in these pastures have already shed their seeds and have had time to replenish root reserves for the next year's growth by this time. Of the pastures examined in this study, fall-winter holding pastures generally produced the largest biomasses of nutritious bear foods.

Aune and Brannon (1987) reported the results of food habits analyses of 1,020 grizzly bear scats collected from the East Front during 1979-86. Their results showed that mammals (primarily domestic cattle) were the most frequently found food items in March scats. Mammals and graminoids were the most important bear foods found in April scats. During May, graminoids were most important, followed by forbs, insects, and mammals. Graminoids and forbs were most important during June and July, followed by insects and mammals, respectively.

The changes in diet identified through fecal analysis are closely tied to the manner in which bears use willow and aspen communities along the East Front. In spring, bears routinely visit ranch boneyards in search of dead cattle, and deciduous tree communities along streamcourses provide secure travelways. Dead domestic calves are most abundant in early spring (March and April). This food source is usually consumed by May.

During May and June, some herbaceous bear foods are available virtually everywhere bears travel and in quantities greater than the grizzly bear population within the study area could possibly consume. Aspen and willow stands are rich foraging areas at this time of the year despite elimination or declines in Umbelliferae species due to cattle grazing because of the abundance of grasses, clovers, and dandelions. If one considers that most ranch operations within the study area have annual calving mortality of approximately 5 percent and an annual mortality rate on adult cattle of approximately 1 percent, the biomass of domestic cattle carrion may energetically offset, or surpass, the negative effects of cattle on herbaceous bear foods.

Conclusions

The dominant cattle grazing systems in the East Front study area in 1985-86 were compatible with maintenance of aspen and willow communities. Cattle grazing, particularly in June, does have the potential to decrease abundance of several important herbaceous bear foods in deciduous tree stands along the East Front. These foods include: cow-parsnip, angelica, western sweet-cicely, grasses, clovers, and dandelions. The three umbels (cow-parsnip, angelica, and sweet-cicely) are more likely to be eliminated from stands than the other plant groups. Grasses, clovers, and dandelions are of minor concern since they are tolerant of grazing, widely distributed, and available to bears in excess of their needs. Cattle grazing, as practiced in the study area in 1985-86, provided benefits in the form of carrion that offset much of the damage incurred from loss of palatable plants.

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