GRIZZLY BEAR FOOD HABITS, MOVEMENTS, AND HABITAT SELECTION IN THE MISSION MOUNTAINS, MONTANA

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Abstract: The food habits, movements, and habitat selection of grizzly bears (*Ursus arctos horribilis*) were studied in the Mission Mountains, Montana from 1976 through 1979. Important foods by season were: spring—graminoids and carrion; summer—forbs, ferns, and graminoids; and autumn—tree and shrub fruits, insects, and graminoids. Home range was measured for 6 radio-collared grizzly bears. Adult males had larger home range sizes ($\bar{x} = 1{,}402$ km^2) than females ($\bar{x} = 285$ km^2). Home ranges of all age- and sex classes overlapped and there was no evidence of territorial behavior. Home range overlap of 3 female grizzly bears was least in spring and greatest in autumn, and was related to seasonal changes in resource distribution. Density averaged 1 bear/49 km^2 within the 780-km^2 study area. Grizzly bears were seasonal altitudinal migrants in the Mission Mountains. Areas used more ($P < 0.05$) than expected were riparian zones and wet seeps in spring, wet seeps and alpine slabrock in summer, and riparian zones, wet seeps, wet meadows, and alpine slabrock in autumn.

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Interest in the status and biology of grizzly bears in the lower 48 states has increased since 1975 when they were declared a threatened species under the Endangered Species Act (U.S. Dep. Inter. 1975). The lack of critical data on grizzly bear biology outside of national parks was 1 of the justifications cited for listing the bear as threatened.

Optimum grizzly bear habitat is composed of a structurally diverse combination of forested land and open habitats (Mundy and Flook 1973, Mealey 1975, Craighead 1976, Martinka 1976, Herrero 1978), but quantification of this structural diversity has only recently been attempted (Zager 1980; Servheen 1981; Craighead et al. 1982; J. D. W. Hamer, pers. commun.; S. Herrero, pers. commun.).

The objectives of this study were to describe grizzly bear habitat selection within the Mission Mountains, Montana by comparing habitat use to habitat availability and to describe seasonal grizzly bear movement patterns and food habits.

This work was part of a comprehensive study of grizzly bear biology and habitat use on the Flathead Indian Reservation, Montana. The assistance of R. Klaver and J. Claar of the U.S. Bureau of Indian Affairs, and D. Carney, H. Carriles, G. Day, M. Haroldson, L. Lee, R. Mace, M. Madel, J. Perry, T. Their, and P. Zager of the University of Montana was greatly appreciated. Funding was provided by the U.S. Bureau of Indian Affairs, the Confederated Salish and Kootenai Tribes, the U.S. Fish and Wildlife Service, the Montana Department of Fish, Wildlife and Parks, and the Montana Forest and Conservation Experiment Station through the School of Forestry, University of Montana. I especially thank C. Jonkel, L. Pengelly, B. O'Gara, L. Marcum, and J. Ball for discussion and manuscript review.

STUDY AREA

The Mission Mountains form the southwest edge of occupied grizzly bear habitat within the Northern Continental Divide

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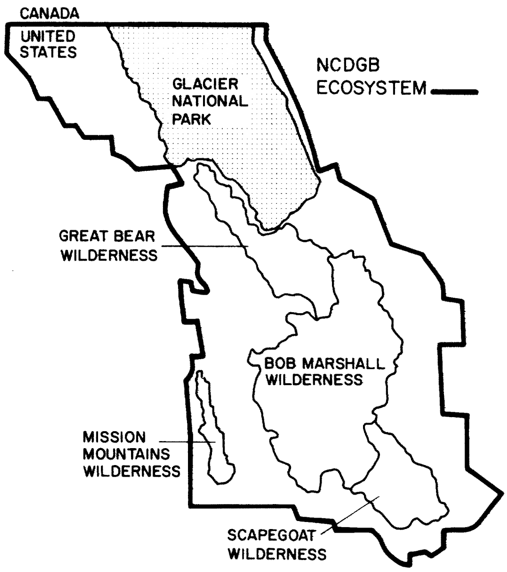

Fig. 1. Northern Continental Divide Grizzly Bear Ecosystem in northwest Montana.

Grizzly Bear Ecosystem (NCDGBE) (U.S. Dep. Inter. 1981) in northwest Montana (Fig. 1). The study area was approximately 780 km² and included the east and west slopes of the Mission range. Elevations range from 850 m on the west side and 1,100 m on the east to 3,000 m along the Mission divide. The Missions extend 80 km north–south and are a maximum of 16 km wide at their widest point. The Mission range divide is the eastern boundary of the Flathead Indian Reservation and most lands on the west slope above 1,300 m are tribal lands administered as wilderness. The east slope is administered by the U.S. Forest Service; the 300-km² Mission Mountain Wilderness comprises most lands above 1,500 m.

Areas below 850 m typically receive an average of 70 cm of precipitation each year, whereas areas above 2,000 m may receive in excess of 150 cm/year, mostly as snow. The climate is maritime, influenced by air masses from the Pacific Ocean.

The vegetation of northwest Montana has been described by Pfister et al. (1977). Dominant trees include supalpine fir (*Abies lasiocarpa*), spruce (*Picea* spp.), Douglas-fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), and lodgepole pine (*Pinus contorta*). Moist sites support western red cedar (*Thuja plicata*), along with spruce and quaking aspen (*Populus tremuloides*).

Human-related activity has constituted the principal influence on vegetation structure during the past 60 years. Organized fire suppression virtually eliminated the effects of wildfire in the area. On the lower west slope, agricultural activities and livestock grazing were the main factors influencing vegetative composition and distribution. Timber harvesting and associated road building were the major influences on the east slope.

METHODS

Bears were captured in leg-hold snares from 1976 through 1979. Captured grizzlies were collared with radio transmitters, tagged with numbered ear tags, and serial numbers were tattooed on the upper lip. A premolar tooth was removed from each captured bear and sectioned to estimate age (Mundy and Fuller 1964, Craighead et al. 1970).

Movements of collared bears were monitored from aircraft and from the ground. Locations were plotted on 5.7-cm : 1-km U.S. Geological Survey topographic maps and on aerial photos of 12.5-cm : 1-km scale.

Habitats were partitioned into 19 different components representing structural and/or geological differences (Table 1). Each of the 19 habitat components represented at least 1% of the study area. Habitat components were identified from aerial photos and checked on the ground for accuracy. A composite, minimum

Table 1. Habitat component descriptions for the Mission Mountains, Montana after Lee (1979) and Zager (1980).

Component Number	Component Name	Description
1	Snowchute/sidehill park	Naturally open site on a steep slope at high elevations with convex shape at upper end of snowchute. *Xerophyllum* dominant.
2	Snowchute/shrubfield	Same as #1 except occurs at lower end of snowchute at mid-elevations. Shrubs dominant because of mesic characteristics.
3	Sidehill park	Naturally open site on moderate to steep slopes at mid- to high elevations. Straight, convex, or undulating configurations. Graminoids and forbs predominate.
4	Shrubfield	Open, dominated by shrubs. May be created and maintained by wildfire, timber harvest, or topo-edaphic influences.
5	Timbered sidehill park	Same as #3 except with sparse, open timber. Up to 30% forested.
6	Wet meadow	Concave, naturally open sites with generally flat topography. Dominated by graminoids and forbs. Mesic.
7	Slabrock alpine	Exposed blocks of glaciated rock with shallow soils between them. Mesic to xeric depending on parent rock. Above treeline.
8	Slabrock—mid- to low elevation	Same as #7, below treeline.
9	Talus/scree/rock	Slopes of loose rock fragments of variable size or extensive solid rock areas. Little or no soil development. Some forbs may occur sparsely.
10	Snowfield	Permanent snowfields or glaciers in high elevation areas.
11	Riparian zone	Hydrologically active with moving water that may be ephemeral. Mesic vegetation and usually timbered with dense understory.
12	Riparian zone/cut	Same as #11 except disturbed by timber harvest.
13	Road	Open, disturbed areas, cleared or graded.
14	Cut	Open or timbered site where timber harvest has disturbed natural vegetation.
15	Timbered shrubfield	Open timber site dominated by shrubs in the understory. Timber cover 30–60%.
16	Timber	Closed-canopy timber with tree cover >60%.
17	Marsh	Open, wet area with standing water dominated by open canopy marsh vegetation.
18	Agricultural lands	Lands managed for crops or livestock, usually plowed, mowed, grazed, or fenced.
19	Seeps	Perennially moist with shallow standing water and generally dense overstory and understory. Major species include *Picea*, *Lysichitum americanum*, and *Athrium felix-femina*.

home-range polygon (Mohr 1947) was formed by overlapping movement data of 4 grizzly bears radio instrumented during 1977–79 (Table 2). The relative availability of each habitat component within the composite, minimum home-range polygon was determined by a random point sampling method (Marcum and Lofts-

Table 2. Age, weight, and home ranges of 6 grizzly bears in the Mission Mountains, Montana, 1977–79.

Bear	Age (yr)	Weight (kg)	Period monitored	Locations		Minimum home range (km^2)
				N	Days	
Adult females						
230[a]	14	136	6 Oct 1977–21 Nov 1979	123	776	458
305[a]	8	218	29 Sep 1978–21 Nov 1979	86	419	112
Adult males						
206[a]	9	181	4 May–19 Nov 1977	35	199	293
225	9	200	28 Apr–15 Aug 1977	10	109	886
229	8	218	30 Sep 1977–2 Dec 1978	29	428	3,029
Subadult female						
224[a]	2	39	14 Oct 1977–21 Nov 1979	184	766	85

[a] Home range used to form composite home range.

gaarden 1980). Seasonal availability of habitat components was determined by selecting only those components available within the elevational range used by the 4 radio-instrumented bears during each season. Seasonal divisions based on changes in food habits and elevation were: spring—den emergence–15 June, summer—16 June–30 August, autumn—1 September–den entry. Total availability included all components within each bear's home range for the year.

Habitat use was ascertained from 381 radiolocations over 6 bear-years (Table 2) from 1977 through 1979. Habitat component, elevation, and aspect were recorded for each radiolocation. Only 1 location was used/bear/24-hour period. Locations were recorded during daylight. Only specific locations that could be verified by triangulation or low-level airtracking were recorded.

A chi-square test was used to determine if differences ($P < 0.05$) occurred between the use and availability of habitat components. A modification of the Bonferonni z statistic (Neu et al. 1974) was used to test if individual components were used more ($P < 0.05$) or less ($P < 0.05$) than expected. Food habits were quantified by scat analysis using procedures described by Tisch (1961), Russell (1971), and Mealey (1980). Scats were distinguished as those of grizzly bears on the basis of 2 criteria: size (diameter $\geq$50 mm, or amorphous volume of at least 1 liter) and indirect on-site evidence of grizzly bear activity at the collection site. Only scats less than 2 weeks of age on the basis of desiccation and decay were collected. Diameter of scats has recently been shown to be an unreliable indicator of bear species (Hamer et al. 1981). Most scats, however, were associated with instrumented animals or grizzly bear activity and I believe they were representative of grizzly bear food habits. Collected scats were frozen within 4 days of collection.

RESULTS AND DISCUSSION

Food Habits

In the Mission Mountains, food habits varied with season (Fig. 2). Seasonal food use was determined by habitat availability and plant phenology. Perennial graminoids and forbs, such as *Taraxacum* spp. and *Trifolium* spp., comprised the bulk of spring foods. Mammal carrion and birds were also important as spring foods. Most

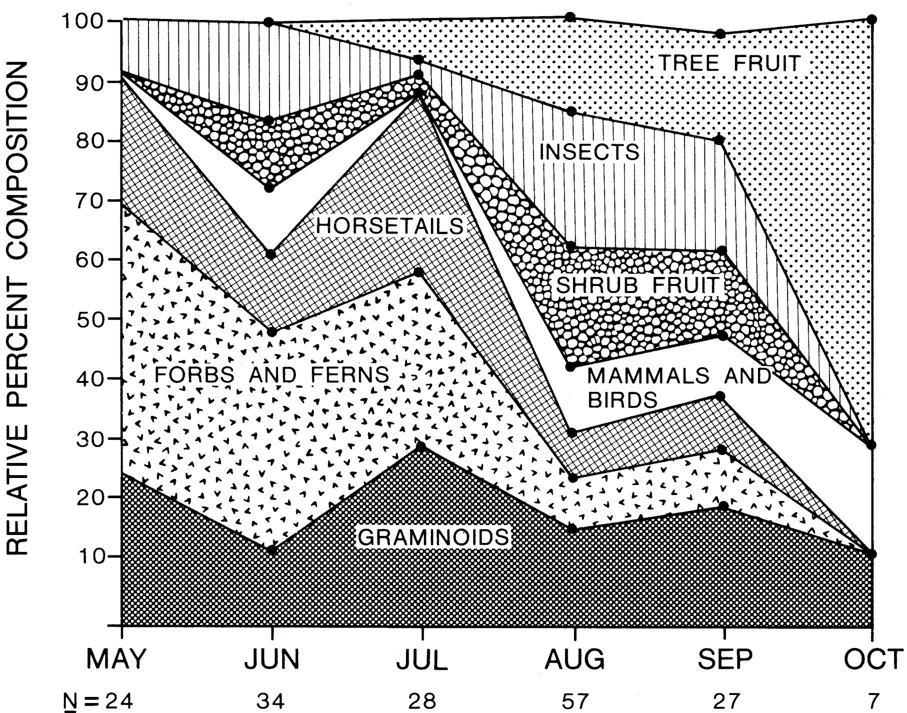

Fig. 2. Food habits of grizzly bears in the Mission Mountains, Montana, 1979. *N* = 177 scats.

carrion occurred at sites of domestic livestock carcass disposal. Grizzly bears visited traditional livestock carrion dumps regularly throughout the spring whether carrion was available or not. Livestock carrion was unavailable in the spring on the east slope of the Missions, but beaver (*Castor canadensis*) and grouse (Tetraoninae) remains were occasionally identified in scats from the east slope. Grizzly bears obtained spring insects by excavating rotting wood from tree stumps and logs.

During late spring–early summer, succulent forbs such as *Heracleum lanatum* and other Apiaceae attained sufficient growth to become food sources. These forbs were associated with wet sites in low elevation areas. As snowmelt progressed, avalanche chutes and sidehill parks became exposed and abundant water provided excellent growing conditions for these forbs. Later in the summer, many of these sites became dry and forbs died or became less palatable. Forbs with starchy, tuberous roots, such as *Erythronium grandiflorum*, *Lomatium* spp., and *Hedysarum* spp., were excavated during June and July. Dependence on perennial graminoids remained relatively constant through the summer but at higher elevations, summer use of sedges (*Carex* spp.) increased.

Horsetails (*Equisetum* spp.) were eaten until shrub fruits, such as *Vaccinium* spp., *Shepherdia canadensis*, *Amelanchier alnifolia*, and *Crataegus* spp., began to rip-

Table 3. Home range size and overlap for 2 adult and 1 subadult female grizzly bears in the Mission Mountains, Montana, 1979.

Season, bear number, and status	Home range (km^2)	Percent of 1979 minimum home range	Total overlap km^2 (%)	Overlap with adult female(s) km^2 (%)	Overlap with subadult female km^2 (%)
Spring					
#230 +3 cubs	108	25	0 (0)	0 (0)	0 (0)
#305 +1 yearling	34	30	6 (18)	0 (0)	6 (18)
#224	16	30	6 (38)	6 (38)	
Summer					
#230 +3 cubs	122	28	12 (10)	13 (11)	4 (3)
#305 +1 yearling	72	64	49 (68)	12 (17)	43 (60)
#224	51	96	43 (84)	43 (84)	
Autumn					
#230 +3 cubs	136	31	39 (29)	36 (26)	28 (21)
#305 +1 yearling	69	62	42 (61)	35 (51)	24 (35)
#224	33	62	33 (100)	33 (100)	

en. Most summer insect use occurred at concentrations of estivating army cutworm moths (*Chorizagrotis auxiliaris*) that were excavated out of talus slopes above 2,700 m. Use of army cutworm moths by grizzly bears in the Missions was previously reported (Chapman et al. 1953). Underground nests of Vespidae were excavated at low elevations and the larvae were consumed.

Domestic tree fruits (apples, plums, and pears) were the major autumn food resource used on the west slope of the Missions. Occasionally, dead domestic livestock were consumed in boneyards in autumn, but carrion occurrence was sporadic during this season. Small rodents such as Columbian ground squirrels (*Spermophilus columbianus*) (Taylor 1964) and deer mice (*Peromyscus maniculatus*) were occasionally consumed in autumn.

Movements and Density

Eleven grizzly bears were captured in the study area from 1976 to 1979. Nine were radiotracked for varying lengths of time. Three of the 9 were relocated as management actions and their movements were not considered representative of natural habitat use. The remaining 6 were radiotracked to estimate home range size and 4 of these were tracked to ascertain habitat selection.

Spacing in grizzly bears is related to distribution of food resources (Craighead and Craighead 1972, Stonorov and Stokes 1972, Atwell et al. 1980, Glenn and Miller 1980, Judd and Knight 1980). Food resource concentration in the Mission Mountains varied with season. Seasonal resource distribution was: spring—dispersed graminoid use with occasional resources available at livestock boneyards; summer—dispersed use of wet-site forbs and starch-rooted forbs and sedges, and occasional use of insect concentrations by some bears; autumn—concentrated use of domestic tree fruits, insects, and some shrub fruits. Seasonal grizzly bear concentrations were highest in autumn when foods were concentrated (Table 3, Fig. 3). Early spring concentrations were mainly influenced by habitat availability rather than food concentration. As snowmelt proceeded, bears dispersed into high elevation habitats.

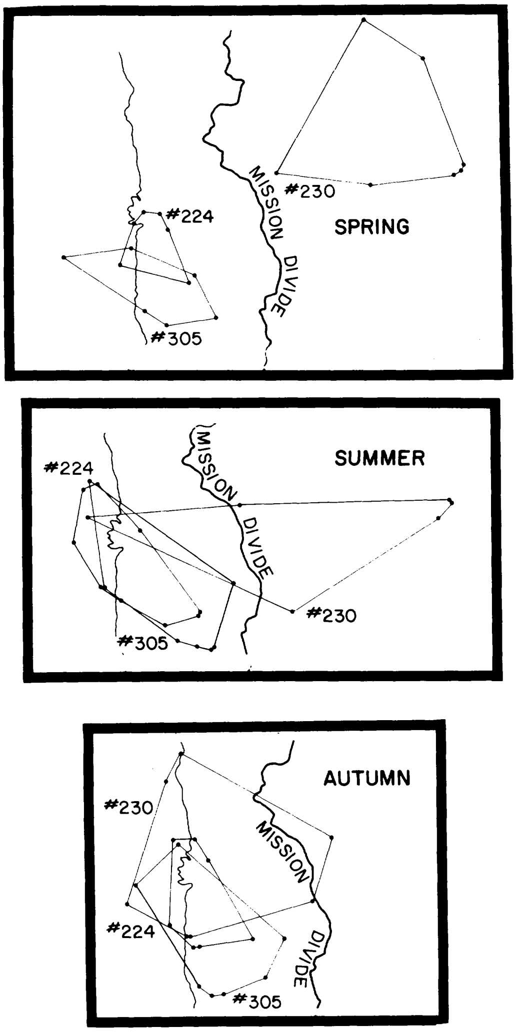

Fig. 3. Seasonal range changes and overlap for 3 female grizzly bears in the Mission Mountains, Montana, 1979.

Home range overlap occurred between all sex and age-classes monitored. Telemetry and observational data indicated no evidence of territoriality as described by Rogers (1977:51) for black bears (*Ursus americanus*) ("an area defended so as to be occupied more or less exclusively by an individual or its family"). Kinship of the 6 grizzlies monitored was unknown. No evidence of defense of territory was noted and during autumn 1979, a minimum of 3 adult females, their 6 cubs and yearlings, and 1 subadult female were bedding and feeding in a 13-ha seep component area, indicating some conspecific tolerance.

Home range overlap was examined for 3 female grizzly bears (1 subadult, 2 adults) in spring, summer, and autumn 1979 to ascertain if bear distribution was related to resource distribution (Table 3, Fig. 3). The adult female with 3 cubs showed the least overlap with both the other adult female and the subadult female in spring (0%) and summer (12%), even though she had the largest home-range size for both seasons. This adult female with cubs expanded her home range from 205 km^2 in 1978 when she was solitary to 436 km^2 in 1979 when she was with cubs.

Distribution varied with seasonal resource concentration. In spring and summer 1979, radio-collared grizzly bears used most of the 780-km^2 study area. The estimated total resident grizzly bear population on the study area in 1979 was 16 or 1/49 km^2. This estimate included 2 adult males, 2 subadult females, 3 adult females with 7 cubs, and 1 adult female with 1 yearling.

Habitat Use

Comparison of habitat use with habitat availability demonstrated that certain habitat components were used seasonally more than expected and others less than expected. Low elevation riparian zones and seep areas were used more ($P < 0.05$) than expected during spring (Fig. 4). Only agricultural lands were used less ($P < 0.05$) than expected in spring. Lack of use during spring did not necessarily imply avoidance of agricultural lands. Limited night-tracking indicated that grizzly bears

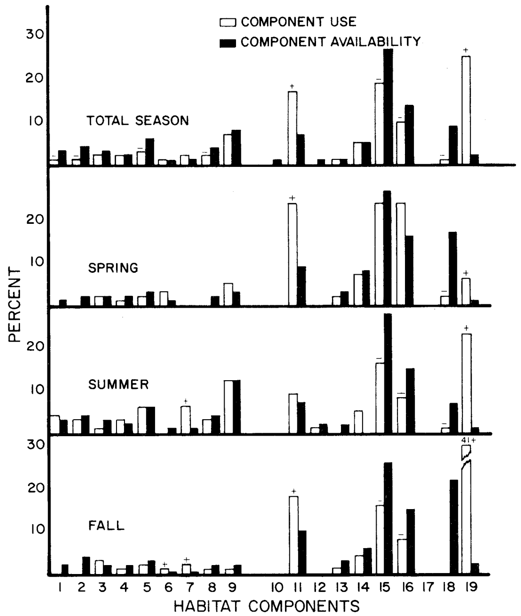

Fig. 4. Seasonal habitat component use and availability within the composite home range of 4 grizzly bears in the Mission Mountains, Montana. A "+" indicates more ($P < 0.05$) use than expected; a "−" indicates less ($P < 0.05$) use than expected. Component codes are in Table 1.

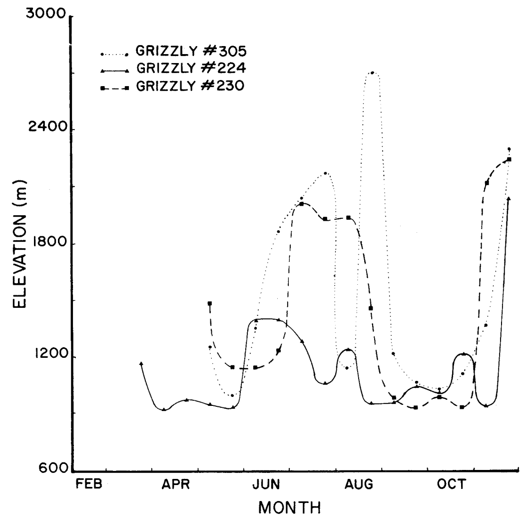

Fig. 5. Elevational movements of 3 radio-instrumented female grizzly bears in the Mission Mountains, Montana, 1979.

traversed agricultural lands far from hiding cover, as defined by Thomas (1979), during darkness. During spring, these movements were usually between riparian zones and seeps that provided most spring foods.

During summer, seeps and alpine slabrock were used more ($P < 0.05$) than expected. Seeps were used for hiding cover and as feeding sites when grizzly bears moved to low elevation west slope areas. Of 129 summer locations, 24% were in seeps. The use of seeps as hiding cover was indicated by beds connected by numerous trails in the dense understory vegetation. Summer foods such as forbs, ferns, horsetails, and graminoids were common within seeps, and scats containing these foods were found around beds in seeps.

Alpine slabrock areas were also used as bedding and feeding sites. Excavations of cutworm moths occurred in alpine talus areas adjacent to slabrock. Bedding sites were found on the slabrock and scats containing cutworm moths were found in association with each bed.

Timber, timbered shrubfield, and agricultural lands were used less ($P < 0.05$) than expected during summer. Movements from low (<1,200 m) to high elevation areas (>1,800 m) and vice versa were abrupt, with little use of habitats between 1,200 and 1,800 m (Fig. 5). Forty-nine percent of the timber and 44% of the timbered-shrubfield habitat components occurred between 1,200 and 1,800 m. This distribution accounts for the lack of use of this elevational zone in summer and autumn.

Habitat components used more ($P < 0.05$) than expected in autumn included riparian zones, wet meadows, and seeps in low elevations, and alpine slabrock at high elevations. Low elevation wet sites provided succulent vegetation as food and visual cover in autumn. Seeps provided food and hiding cover during daylight hours. Thirty-nine percent of daylight autumn locations occurred in a seep ($N = 144$). Agricultural lands were important foraging areas in autumn. Domestic tree fruits comprised 29% of September and October scats. No daylight use of agricultural lands was recorded in autumn, indicating that agricultural lands where visual cover was limited were used mainly during darkness.

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