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GRIZZLY BEAR HABITAT SELECTION IN THE SWAN MOUNTAINS, MONTANA

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Abstract: In the contiguous United States grizzly bears (Ursus arctos horribilis) are classified as a threatened species, thus resource managers have a continuing interest in how grizzly bears use available habitats. We examined the use of satellite derived cover types by 19 individual radiomarked grizzly bears over 8 years and developed a hierarchial preference classification. We found that avalanche chutes were used in higher proportions than available during all seasons, along with slab rock. Shrub fields and timber harvest units were selected relative to availability during the summer and fall. Forested areas were among the least selected cover types during all seasons. Clear patterns of elevational movement were identified and were similar among most bears.

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Key words: avalanche chute, geographic information system, GIS, grizzly bear, habitat selection, home range, Montana, movements, radiotelemetry, satellite, selection ratio, Swan Mountains, *Ursus arctos*, vegetation.

Wildlife managers have sought to understand the seasonal patterns of grizzly bear habitat selection. Past grizzly bear habitat research efforts can be grouped into 2 categories. The first includes those that described the vegetative characteristics of grizzly bear habitat (Craighead et al. 1982, Blanchard 1983, Butterfield and Key 1985, Leach 1985, Mace and Bissell 1985, Aune and Kasworm 1989). The second group described habitat components and used telemetry data to examine selection patterns among the components (Servheen 1981, Kasworm 1985, Hamer and Herrero 1987, Hamilton and Bunnell 1987, Wielgus and Bunnell 1994).

This study belongs to the second group, but was of longer duration and obtained larger sample sizes. We describe 7 broad cover types, derived from satellite imagery, and test for selection by grizzly bears among the cover types using telemetry data. We also describe patterns of seasonal elevational movement.

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STUDY AREA

The 1,457 km² study area was located in the Swan Mountains of northwestern Montana. The study area was bordered by the Flathead River and the town of Hungry Horse to the north, Hungry Horse Reservoir to the east, the Bob Marshall Wilderness to the south, and the Swan and Flathead valleys to the west. Pacific maritime weather patterns prevailed. Average annual precipitation exceeded 250 cm, the majority being snow accumulation at higher elevations. The study area was characterized by rugged mountain topography with elevations varying from 915 m in the Flathead valley to 2,316 m along the crest of the Swan Mountains. Variations in slope, aspect, elevation, fire history, moisture, and land use has resulted in a complex mosaic of vegetation communities. Fiftyone community types were described and mapped within the study area (Hadden et al. 1987). These community types ranged from dry grasslands on steep southerly aspects to moist Sitka alder/devil's club (Alnus sinuata/Oplopanax horridum) shrub fields in riparian areas.

The primary land-uses were timber harvest and recreation. About 14% of the study area had been modified by timber harvest (Waller

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			Home range size (km ²) and percent within study area						
Bear ID	Year	Age	Spring	%	Summer	%	Fall	%	
F3	1987	1	667.5	67.2	287.0	90.1	324.4	76.9	
F5	1987	7	206.6	92.2	107.9	100.0	62.6	100.0	
F18	1989	2	61.9	100.0	109.8	100.0	74.6	99.8	
F45	1990	19	143.4	97.6	156.0	100.0	124.3	100.0	
F48	1990	10	107.5	100.0	154.0	100.0	82.7	100.0	
F69	1992	3	301.5	77.0	192.8	95.7	80.6	90.9	
F94	1988	8	80.1	93.0	87.2	99.2	117.3	100.0	
F96	1988	15	149.0	100.0	151.8	100.0	119.8	99.6	
F137	1988	1	136.0	90.4	182.3	98.9	92.7	100.0	
F143	1988	5	136.4	100.0	75.8	100.0	86.7	100.0	
F147	1987	1	387.5	68.0	270.9	72.9	314.4	74.3	
M15	1993	7	448.9	65.2	582.8	87.0	379.5	94.3	
M22	1989	3	1,092.3	84.1	731.6	78.2	774.5	56.6	
M25	1990	4	480.6	61.0	168.0	99.7	373.2	91.8	
M71	1990	2	886.1	87.6	625.0	94.4	329.1	98.6	
M144	1988	11	470.7	95.6	347.8	88.3	406.3	98.4	
M146	1988	4	719.0	90.5	550.0	90.1	269.5	94.3	
M149	1988	8	1,178.5	60.0	993.0	62.5	918.2	64.2	
M150	1988	6	480.1	88.5	517.7	90.8	438.2	99.9	

Table 1. Year and age at first capture, seasonal home range size, and percent of home range within the study area for each radiocollared grizzly bear, Swan Mountains, Montana.

1992). A network of roads existed in most drainages and was described in detail by Mace et al. (1996). Road construction began during the construction of Hungry Horse dam in the late 1940s. The dam permanently flooded 9,712 ha of riparian and upland habitats (Casey et al. 1984).

METHODS

Capture and Telemetry

Adult (≥ 5 yr old) and subadult grizzly bears were captured and radiocollared (Table 1) as described by Mace et al. (1994). Radiocollared bears were located from fixed-wing aircraft once per week in 1988 and 1989 and twice per week from 1990 through 1994. Optimal flying conditions, and thus our relocation flights, usually occurred between 0700 and 1100 hours. Each location site was photographed with self-developing film. Using these photographs and 1: 24,000 orthophotographic quadrangles, we assigned each location a Universal Transverse Mercator (UTM) coordinate. Coordinates were then converted to map layers with EPPL7 (Minn. Land Manage. Info. Cent., 330 Centennial Building, 658 Cedar Street, St. Paul, MN 55155), a computerized geographic information system (GIS). Aerial telemetry locations were accurate to within 150 m, established by "blind" placement of radiocollars (Mace and Manley 1988).

Seasonal Home Range Estimates

We used the computer program CALHOME (Kie et al. 1996) to calculate seasonal multi-annual 95% adaptive kernel home ranges (Worton 1989) for 11 female and 8 male grizzly bears. We chose the 95% isopleth to measure potential grizzly bear occupancy but exclude short-term forays. The home range polygons were then converted to GIS map layers.

Three seasonal foraging categories, (spring, summer, and fall), were defined based on observed changes in food habits, behavior, and prior literature (Craighead et al. 1982, Mace and Jonkel 1983). Spring was defined as the period from den exit to 15 July, summer as 16 July to 15 September, and fall as 16 September to den entrance.

GIS Mapping

A LANDSAT Thematic Mapper satellite image (Manley et al. 1992) was classified into 7 cover types based on spectral value, aspect, and aerial photo interpretation (Mace et al. 1996). These 7 classes were as follows: sites dominated by either rock or grass/forb communities (grass land/non-vegetated), natural shrub lands, sites with >40% conifer overstory (forest), avalanche chutes (chutes), slabrock, timber harvest units (cuts), and those areas that could not be classified to a cover type due to shadow (unclassified). Unclassified areas consisted primarily of closed conifer forest and avalanche chutes on steep north and northwesterly aspects.

We used 1,416 rapid reconnaissance plots (Hadden et al. 1985,1987) to describe the vegetation in each cover type by 3 elevation zones; low temperate (870–1,494 m), temperate (1,495–1,981 m), and subalpine (>1,981 m). Each plot was assigned a GIS cover type based upon its UTM coordinates. Plant taxonomy followed Hitchcock and Cronquist (1973). Appendix 1 presents species lists for cover type and elevation zones, summarized by life form. Graminoids were ubiquitous in all cover types and zones, and were omitted. Each species' dominance (frequency of occurrence x mean canopy coverage) was standardized within cover type/ elevation zones by: relative dominance = (dominance/ Σ dominance) \times 100.

To test the accuracy of the final cover type map we used 121 field plots (Manley et al. 1992). These plots, conducted to ground truth a previous satellite image classification, were selected to represent the geographic area, and the range of elevation and aspect of each spectral class. Ninety-one percent of the 121 plots were assigned a cover type consistent with the cover type map. Shrub land was misclassified as forest in 7 of the 11 classification errors. To address telemetry error, each 30-m pixel of the cover type map was assigned the dominant habitat within the surrounding 24 pixels (the telemetry error polygon) with a moving window routine.

Habitat Selection

We calculated selection indices for each bear during each season as the observed difference between the percent of each habitat used and the percent available. We ranked the indices from largest to smallest and used the Friedman nonparametric ANOVA on ranks to detect departures from random (Alldredge and Ratti 1986, 1992; White and Garrott 1990). If the test statistic exceeded the critical value $(1-\alpha)$ of the *F*-distribution, selection was presumed to be occurring. If selection was detected, multiple comparisons were made to identify those habitats, or groups of habitats, that were significantly different (Conover 1980).

The elevation of each aerial telemetry location was recorded and entered into our database. We combined each bears average weekly elevation over all years to examine patterns of elevational movement. Box-whisker plots were used to display the median and range of average elevations for each sex by week. We used the computer program Statistica (Statsoft Inc., 2325 East 13th St., Tulsa, OK 74104) for all statistical tests.

RESULTS

We found that cover type selection occurred within each sex during all 3 seasons (P < 0.015), despite variation among individual grizzly bears (Tables 2–4). Using multiple comparisons, we were able to group the 7 cover types into 3 to 4 distinct rankings, depending on sex and season (Tables 2–4). Although telemetry locations usually were during the morning, grizzly bears within our study area were crepuscular and moved little during the night (Mont. Fish, Wildl. and Parks, unpubl. data).

Males and females selected avalanche chutes over other cover types, relative to availability, during each season (Tables 2–4). During spring, avalanche chutes were selected significantly more than all other cover types by both sexes (Table 2). During summer, avalanche chutes again were selected by both sexes, but equally with slabrock and cuts, and for females, with shrub lands (Table 3). During fall, avalanche chutes and shrub lands were selected equally as the most used cover types, in addition to slabrock by females (Table 4).

Grizzly bears exhibited moderate selection for the grassland/non-vegetated cover type during each season. Forest was the least selected cover type among females during spring, and among males and females during summer and fall (Tables 2–4). During spring, the least selected cover types among males were cuts and unclassified areas, and among females, cuts and forest (Table 2). Unclassified and forested areas were among the least selected by both sexes during summer and fall (Tables 3–4).

During any particular day, grizzly bears could be found at any elevation (bounded by the availability of elevations within the individuals home range). However, after smoothing, clear patterns of elevational movement became apparent for both male and female grizzly bears (Fig. 1). The pattern of weekly movements were the same for males and females, but females were, on average, 95 m higher during spring and summer and 147 m higher during the fall.

DISCUSSION

In the Northern Continental Divide Ecosystem (NCDE), avalanche chutes long have been

				Cover type				
Bear ID	Unclassified	Grass/nonveg	Shrub land	Forest	Av. chute	Slabrock	Cutting unit	n
F3	-4.50(3)	-2.68(4)	13.78 (6)	-14.45(1)	16.90 (7)	-2.21(5)	-6.79(2)	26
F5	2.62(6)	-1.13(3)	-1.01(5)	-1.11(4)	16.14(7)	-2.12(2)	-13.39(1)	76
F18	-3.15(3)	-0.58(5)	-0.62(4)	-14.50(1)	29.56 (7)	0.97(6)	-11.69(2)	83
F45	1.19(5)	-2.50(4)	-4.17(2)	-3.48(3)	10.50(7)	4.85(6)	-6.14(1)	72
F48	2.89(6)	0.003(5)	-2.16(3)	-19.02(1)	27.30(7)	-0.91(4)	-8.10(2)	75
F69	-5.22(1)	-3.95 (2)	10.10(7)	0.65(5)	-0.79(4)	-3.79(3)	3.01(6)	14
F94	11.03(7)	-2.17(3)	-1.32(4)	-7.02(2)	9.68 (6)	0.00(5)	-10.19(1)	64
F96	-1.86(5)	-2.42(3)	-1.29(6)	-16.37(1)	26.74(7)	-2.23(4)	-2.53(2)	88
F137	-4.66(3)	-1.98(5)	-1.75(6)	-22.26(1)	44.48(7)	-2.17(4)	-11.65(2)	36
F143	4.08 (3)	4.19(5)	-8.12(2)	-39.65(1)	36.12(7)	10.82(6)	0.72(4)	30
F147	0.24(5)	1.56(6)	-5.49(1)	-2.70(2)	9.11(7)	-1.09(4)	-1.64(3)	65
All females*	В	В	В	С	A	В	С	
M15	-4.39(2)	16.07 (7)	0.43 (4)	-13.01 (1)	2.53 (6)	-2.80 (3)	1.18 (5)	10
M22	-3.49(2)	-0.32 (4)	3.76 (6)	-15.70(1)	14.12(7)	-1.30(3)	3.50(5)	82
M25	-8.23(2)	-0.71(3)	1.25(5)	11.32(6)	11.98(7)	-0.22(4)	-14.40(1)	18
M71	-4.25(2)	-1.69(5)	-3.40(3)	-21.19(1)	8.18(7)	0.89(6)	-1.82 (4)	78
M144	-5.43(3)	-2.15(4)	-7.68(2)	13.96 (7)	13.60 (6)	-1.84(5)	-9.43(1)	16
M146	-4.58(2)	-2.22(3)	6.62(6)	10.47(7)	-0.61 (4)	3.01(5)	-12.12(1)	20
M149	-4.43(3)	9.74 (6)	0.15(4)	-6.91(2)	10.18(7)	2.37(5)	-11.09(1)	25
M150	0.92(4)	-2.10(2)	-3.67(1)	3.95 (7)	3.78(5)	-1.81(3)	3.94(6)	20
All males*	С	В	В	В	Α	В	С	

Table 2. Spring season differences between percent used and percent available cover types, rankings (in parentheses), selection groupings*, and telemetry sample sizes for female and male grizzly bears, Swan Mountains, Montana 1988–95.

 \ast Selection groupings: cover type groups that are used equally have the same alphabetic code, and are significantly different from those groups with a different code, for example: A is different from B and B is different from C, BC is different from A, but is not different from B or C.

				Cover type				
Bear ID	Unclassified	Grass/nonveg	Shrub land	Forest	Av. chute	Slabrock	Cutting unit	n
F3	-5.87 (2)	-2.85 (3)	14.39 (7)	-28.00(1)	11.39 (6)	8.23 (5)	2.73 (4)	26
F5	-2.49(2)	-2.29 (3)	1.43(5)	-6.48(1)	1.12(4)	2.39(6)	6.32(7)	72
F18	1.72(4)	-0.94 (3)	9.49 (6)	-18.19(1)	10.51(7)	2.34(5)	-4.93(2)	69
F45	-5.55(1)	-0.006(5)	1.13(6)	-3.64(3)	-0.94(4)	13.84(7)	-4.86(2)	58
F48	-2.67(2)	-0.44 (5)	0.46(6)	-7.08(1)	-1.40(3)	-0.71(4)	11.86(7)	60
F69	2.91(5)	-2.62 (3)	-1.20(4)	-10.63(1)	-4.69(2)	11.48(7)	4.75(6)	24
F94	0.17(5)	-3.43 (1)	4.32(7)	-1.86(2)	-1.68(3)	0.00(4)	2.46(6)	52
F96	-3.66(3)	-0.53 (4)	5.42(5)	-18.46(1)	5.61(6)	16.41(7)	-4.78(2)	68
F137	-4.05(2)	-2.06 (3)	-0.55(5)	-6.69(1)	15.34(7)	-0.24(6)	-1.75(4)	41
F143	1.09(4)	0.63 (3)	11.38(7)	-14.85(1)	3.40(6)	-3.62(2)	1.98(5)	30
F147	-2.54(2)	-0.35 (4)	5.24 (6)	-28.26(1)	4.52(5)	-2.16(3)	23.55(7)	44
All females*	С	BC	A	D	А	А	AB	
M15	10.45 (6)	5.21 (4)	6.24 (5)	-22.91(1)	-6.85(3)	21.12 (7)	-13.27(2)	13
M22	-3.79(2)	-0.08 (3)	6.45(6)	-29.03(1)	4.16(4)	4.47(5)	18.30(7)	50
M25	-8.99(2)	-0.28 (4)	6.08 (6)	-11.49(1)	9.88 (7)	-0.28(3)	5.09 (5)	32
M71	-4.25(2)	-2.05 (3)	2.61(5)	-28.21(1)	4.09(7)	-0.28(4)	4.06 (6)	78
M144	-4.14(2)	-1.66 (3)	-6.90(1)	-1.24(4)	13.62(7)	-1.07(5)	1.39(6)	10
M146	-4.62(2)	-2.00 (3)	-6.02(1)	10.18(7)	3.78(6)	-1.42(4)	1.12(5)	13
M149	-2.31(3)	2.26(5)	3.57(6)	-5.10(2)	-1.21(4)	5.54(7)	-5.19(1)	42
M150	-4.74(3)	6.94 (6)	-8.88(1)	2.71(5)	-7.00(2)	-1.68(4)	12.66(7)	11
All males*	С	В	В	С	Α	А	Α	

Table 3. Summer season differences between percent used and percent available cover types, rankings (in parentheses), selection groupings*, and telemetry sample sizes for female and male grizzly bears, Swan Mountains, Montana 1988–95.

* Selection groupings: cover type groups that are used equally have the same alphabetic code, and are significantly different from those groups with a different code, for example: A is different from B and B is different from C, BC is different from A, but is not different from B or C.

	Cover type							
Bear ID	Unclassified	Grass/nonveg	Shrub land	Forest	Av. chute	Slabrock	Cutting unit	n
F3	-4.49(2)	-3.39 (3)	11.66 (7)	0.74(5)	-0.06(4)	4.05 (6)	-8.51(1)	13
F5	-2.42(2)	-0.67(5)	-1.16(3)	4.84(6)	5.95(7)	-0.75(4)	-5.78(1)	44
F18	5.79(5)	-0.57(3)	9.62 (6)	-21.73(1)	10.42(7)	-0.10(4)	-3.44(2)	40
F45	-6.05(1)	-2.04(3)	3.35(6)	4.69(7)	3.29(5)	2.29(4)	-5.53(2)	45
F48	-2.34(2)	-0.42(6)	-1.62(3)	-7.28(1)	-1.13(4)	-0.43(5)	13.22(7)	37
F69	-0.19(3)	-3.18(2)	2.86(5)	-14.85(1)	5.05(6)	10.16(7)	0.15(4)	19
F94	-2.45 (4)	-2.58(3)	12.60(7)	-4.61(2)	-4.76(1)	0.00(5)	1.81(6)	27
F96	2.38(4)	-1.37(3)	8.85(6)	-19.61(1)	14.40(7)	4.81(5)	-5.25(2)	42
F137	0.04(3)	-1.66(2)	13.86(6)	-31.89(1)	17.24(7)	1.92(5)	0.51(4)	23
F143	-1.10(5)	-2.62(4)	28.38(7)	-24.33(1)	13.29(6)	-3.08(3)	-10.55(2)	19
F147	-2.59(2)	-0.88 (4)	7.61(7)	1.32(5)	5.32(6)	-2.51 (3)	-10.03(1)	25
All females*	С	BC	А	С	Α	AB	С	
M15	-4.21 (3)	-2.75(4)	-9.89(1)	-0.53(6)	-7.82(2)	-2.24(5)	27.43 (7)	5
M22	-4.80(2)	-2.18(3)	10.06(7)	-9.23(1)	2.02(5)	-1.77(4)	6.92(6)	31
M25	-1.05(3)	-0.88(4)	22.75(7)	-21.07(1)	5.52(6)	-0.51(5)	-3.57(2)	19
M71	1.84(6)	-2.22(4)	1.65(5)	-6.63(1)	10.47(7)	-2.33(3)	-2.78(2)	42
M144	-6.32(3)	-1.83(4)	22.50(6)	-27.40(1)	25.70(7)	-1.80(5)	-10.85(2)	6
M146	-4.93(1)	-2.57(3)	2.30(6)	10.24(7)	-2.96(2)	-2.54(4)	2.02(5)	11
M149	-4.56(2)	-2.55 (4)	13.81(6)	-29.03(1)	27.21(7)	-1.71(5)	-3.16(3)	9
M150	-4.98(2)	-3.04 (3)	4.54(5)	-5.10(1)	48.94 (7)	-2.59(4)	5.09 (6)	7
All males*	D	С	Α	D	Α	В	BC	

Table 4. Fall season differences between percent used and percent available cover types, rankings (in parentheses), selection groupings*, and telemetry sample sizes for female and male grizzly bears, Swan Mountains, Montana 1988–95.

* Selection groupings: cover type groups that are used equally have the same alphabetic code, and are significantly different from those groups with a different code, for example: A is different from B and B is different from C, BC is different from A, but is not different from B or C.



Fig. 1. Median average elevation (m) by week for 12 female (top) and 8 male (bottom) grizzly bears 1988–94, Swan Mountains, Montana.

recognized as preferred spring bear habitat, however they continued to be selected relative to availability through summer and fall. Continued use most likely is due to the presence of herbaceous forage associated with riparian areas in the chutes (Mace and Bissell 1985), and with the visual security and temperature moderation provided by dense stands of alder.

The slabrock cover type also remained important during each season. Slabrock is characterized by uplifted, exposed, and often terraced bedrock. Soil development has occurred between these terraces through erosion, and thus a unique vegetation community has been established. Vegetation composition in these terraces was variable, but often contained patches of preferred bear foods such as spring beauty (*Claytonia lanceolata*), glacier lily (*Erythronium grandiflorum*), and biscuitroot (*Lomatium sandbergii*; Mace 1985).

The increased use of shrub lands and cuts during the summer and fall could be explained by the availability of fruit-bearing shrubs that occurred in these cover types. Cuts and natural shrub fields created by fire often produced abundant crops of globe huckleberry (*Vaccinium globulare*), mountain ash (*Sorbus scopuli*- na), and serviceberry (Amelanchier alnifolia) (Martin 1979, Zager 1980, Waller 1992).

Selection for the grassland/non-vegetated cover type was low because 50% occurred in the subalpine zone where food was generally less abundant (Craighead et al. 1982). Most bears selected the low temperate and temperate elevation zones during all seasons (Mace et al. 1996).

Low selection was observed for forest during all seasons. Other studies have shown an avoidance of timbered cover types (Servheen 1981, Almack 1985), while others suggest selection for this type (Blanchard 1983, Aune 1994). The forest cover type covered 62% of our study area. While we found that, statistically, forest was among the least selected cover types during all seasons, it is important to remember that about 50% of all radiolocations occurred in this type during all seasons. The forest cover type probably contains resources important to grizzly bears.

Our interpretation of the observed movement patterns is that during spring bears moved to lower elevations, after emerging from their dens, to seek green vegetation and carrion. Use of lower elevations entailed greater risk of encountering humans (Mace et al. 1996). During mid-spring, median elevation then increased as bears tracked optimum plant phenologies (Mealey 1980, Sizemore 1980, Hamer and Herrero 1987). During early summer, median elevations dropped slightly as bears exploited early ripening huckleberries at lower elevations, then followed the pattern of ripening to higher elevations (Martin 1979). Median elevation then declined as food resources at higher elevations became unavailable due to frost and snow. Similar patterns of seasonal movement have been documented in Yellowstone National Park (Mealey 1980), Glacier National Park (Martinka 1972), Jasper National Park, Canada (Mundy and Flook 1973), Mission Mountains, Montana (Servheen 1981), and Denali National Park (Darling 1987). The observed pattern was hidden by daily and yearly variation among bears and substantial smoothing of our data was required to observe this pattern (Schooley 1994). However, this general pattern is appropriate to areas where topographic relief causes site specific variation in food plant phenology. Grizzly bears are a widely distributed holarctic species capable of exploiting a wide variety of habitats within large home ranges. Thus, departures from this general pattern are certain to be found, as documented by Hamer and Herrero (1987). Furthermore, grizzly bears are not always feeding, and do not forage necessarily where the probability of food occurrence or optimum phenology is highest. Furthermore, grizzly bears have physiological and behavioral requirements other than feeding—such as thermal regulation, security, and breeding.

MANAGEMENT IMPLICATIONS

Bear foods occur in relatively small microsites within broad cover types. This patchy distribution of foods, combined with the grizzly bear's capacity for learning and tradition, make modeling difficult. However the selection of avalanche chutes over other cover types in this study area transcends analysis technique. Avalanche chutes clearly are an important habitat component, even in proximity to roads (Mace et al. 1996). Management should be structured to protect avalanche chutes that produce preferred bear foods from human disturbance.

We have ranked cover types in order of use, but we do not imply that this ranking is in order of importance. Cover types that rank low in use may be critical environmental components for grizzly bears. The juxtaposition of human activity and environmental condition related to demography is the ultimate test of how effective the study area is, and how effectively we are ensuring the continued survival of the grizzly bear.

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APPENDIX. Relative dominance of taxa in low temperate, temperate, and subalpine elevation zones and 7 cover types within the Swan Mountains, Montana study area. Only the 5 most dominant species in at least 1 cover type/zone combination are listed.

	Cover type						
Species by life form	Unclassified	Grass land/ non-vegetated	Shrub land	Forest	Chute	Slabrock	Cut
 Trees							
Abies lasiocarpa	69 55 59	** 21 92	24 76 92	$15 \ 71 \ 86$	25 73 82	* 88 89	26 67 *
Larix occidentalis	0 t 0	** 0 0	13 t t	4 t t	5 t 0	*00	33 3 *
Picea engelmannii	17 22 8	** t t	$13 \ 14 \ 2$	11 14 1	20 12 t	* 2.2	25 28 *
Pinus albicaulis	0326	** 6 7	036	t 3 13	$0\ 1\ 17$	* 10 11	tt*
Pinus contorta	0 t 0	** 1 t	6 t t	2.1 t	tt0	* 0 t	2 t *
Populus trichocarpa	000	** 0 0	000	t t 0	t t 0	*00	41*
Pseudotsuga menziesii	$14 \ 17 \ 0$	** 72 t	436 t	67 10 t	48 13 t	* t 0	9 t *
Shrubs							
Acer glabrum	720	11 t 0	40 2 t	23 2 t	30 10 t	* t 0	21 2 *
Alnus sinuata	t 4 t	0 t t	1 10 t	13t	$3 \ 14 \ 1$	*tt	77*
Amelanchier alnifolia	11t	$43 \ 31 \ 2$	3 1 t	7 1 t	13 5 t	*tt	4 t *
Berberis repens	0 t 0	11 t 0	ttt	ttt	t t 0	*00	t 0 *
Ceanothus velutinus	0 t 0	11 t 0	2 t 0	t t 0	t t 0	* 0 0	tt*
Menziesia ferruginea	$0\ 28\ 16$	009	t 23 7	1 29 13	t 3 2	* 20 6	2 35 *
Pachistima myrsinites	$23\ 6\ 1$	0 26 2	1554	16 4 t	4818	*tt	19 3 *
†Prunus virginiana	t t 0	11 t 0	tt0	tt0	2 t 0	* 0 0	t 0 *
Rubus parviflorus	240	010	85t	11 3 t	15 14 5	* 0 0	15 15 *
Sambucus racemosa	Ott	0 t t	ttt	ttt	t 2 t	*tt	t4*
f Sorbus scopulina	14t	052	6 12 5	271	6 20 6	*3t *20	2 t *
Spiraea betulafolia	tlt	25t	5tt	3tt	1 t t	* 30	1 t *
Spiraea densifiora	ttt	024	032	$t_1 t_7$	t 4 t	* 2 2	1 t * E • *
Symphoricarpos albus	15 t U	0 1 0	11 22 20	10 41 42	1310	* 50 0	0 t * 11 05 *
tvaccinium globulare	32 45 30	0 24 20	11 32 39	19 41 43	51730	* 18 44	11 20 .
Vaccinium scoparium	0144	0 2 00	1041	1440	1125	10 44	
A chillea millefolium	+ 1 +	4.6 t	1++	+++	* * *	* + +	+ + *
t Angelica arguta	0.0 t	000	0 ± 0	t 0 0	0 ± 0	* 0 t	00*
Anocunum androsaemifolium	2 ± 0	71 ± 0	5 t 5 t t t	t 1 0	ttÖ	* 0 0	00*
Arnica latifolia	2 15 9	0 + 9	345	8 9 16	4 t 2	* 7 17	4 10 *
Athurium filix-femina	210	0 t 0	t 2 0	020	460	* 0 0	44*
Balsamorhiza sagittata	0 t 0	06 t	0 t t	tt0	000	* 0 0	00*
†Clautonia lanceolata	000	0 t t	0 t t	0 0 t	000	* t 0	00*
Clintonia uniflora	35 t 0	000	3 1 t	$12\ 2\ 0$	420	* 0 0	85*
Disporum hookeri	t t 0	0 t 0	4 t 0	$1 \ 1 \ 0$	1 t 0	* 0 0	t 0 *
Epilobium angustifolium	t 4 t	491	$23 \ 12 \ 6$	$6\ 4\ 2$	19 14 5	* t 1	47 46 *
†Equisetum arvense	000	0 0 t	0 t 0	0 t 0	000	* 0 t	tt*
Eriogonum flavum	0 t 1	$0\ 20\ 5$	0 t t	0 t t	ttt	* 1 t	00*
†Erythronium grandiflorum	024	0723	0t9	t t 9	tt4	* 8 13	tt*
†Heracleum lanatum	0 t 0	0 t t	3 t t	ttt	$1 \ 1 \ 0$	* 0 t	tt*
Heuchera cylindrica	tlt	$18 \ 3 \ 1$	ttt	ttt	ttt	* 1 t	00*
<i>Ligusticum</i> sp.	0 t 0	000	0 t 0	0 t 0	000	* 0 0	t 0 *
†Lomatium cous	0 t t	Ott	ttt	t 0 t	0 t t	*tt	00*
Mitella breweri	033	0 t t	021	t 2 t	tit	* t t	01*
f <i>Osmorhiza</i> sp.	010	001	000	001	£00	* 0 0	00*
Penstemon sp.	010		011	tut	7.0	* 4 1	00*
Pteriaium aquiinium	000	000	1117	207	+01	* 0 0	21 · + 5 *
Senecio triangularis	042	009	1 11 i	297	131	* 0 0	112*
Tararacum sp	000	00+	000	0.0.0	000	*00	+0*
Thalictrum occidentale	53+	0 + 2	181	95+	4 13 3	* 0 t	26*
Urtica dioica	0+0	000	300	t 0 0	510	* 0 0	 t t *
Veratrum viride	013	0 ± 2	t 4 2	t 2 1	151	* t 4	tt*
Viola glabella	tlt	0 t 0	33t	1 2 t	29t	* 0 t	34*
Xerophyllum tenax	26 53 67	4 31 27	45 46 60	33 56 55	37 29 78	* 72 47	116*

+ Bear food species included for comparison.
* Cover type not present in elevation zone.
** Only one plot in this cover type, zone combination. No trees were present.
t = Relative dominance <1.