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Black bear habitat use at Priest Lake Idaho

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BLACK BEAR HABITAT USE AT PRIEST LAKE, IDAHO

By

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ABSTRACT

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Black bear (Ursus americanus) habitat use patterns were studied in northern Idaho between June 1980 and November 1981 as part of a long-term ecological study. Habitat use patterns were established from radio locations of 9 adult black bears (4 males and 5 females). In general, both male and female black bears used a variety of habitat components and habitat types, but both males and females exhibited selection for and against certain vegetative units. Black bears selected for selection cuts during spring, summer and fall. Clearcuts were selected against during all seasons. Female black bears used the timbered habitat component significantly more than did males. Roads were selected against by female black bears but were used in proportion to their availability by males. Black bears selected selection cuts and riparian zones for feeding and timber and selection cuts for bedding. Bears selected for the Hemlock/Pachistima h.t. during spring, summer, and fall. A strong correlation (R^2=0.92) was found to exist between the mean elevation of bear locations and the phenological development of key bear food plants. Management recommendations are presented.

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Special thanks go to my family for their unyielding support during my tenure at the University of Montana; the 'Dunnings' of Priest Lake for treating not only me, but the entire "bear crew", as family; and all my friends at the University of Montana for making the last 3 years most memorable.

PREFACE

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INTRODUCTION

Black bear (Ursus americanus) distribution in Idaho coincides roughly with that of the coniferous forests (Beecham 1980). Little is known, however, of the specific habitat requirements of geographically discrete black bear populations that inhabit Idaho's diverse coniferous forests. Habitat use information for black bear populations in Wyoming (Bray 1967), Montana (Jonkel and Cowan 1971), Washington (Lindzey and Meslow 1977), and California (Kelleyhouse 1980 and Novick and Stewart 1982) have limited application in Idaho because of differences in habitats.

Timber harvesting in the Pacific Northwest alters the vegetative structure and composition on thousands of hectares each year (Lindzey and Meslow 1977). In Idaho, silvicultural activities are currently being conducted with little knowledge of their potential impacts on black bear populations. In 1980, the Idaho Department of Fish and Game (IDFG) initiated a black bear habitat study at Priest Lake as part of a broad, black bear ecological research program begun in 1973.

The goal of this study was to document black bear habitat use at Priest Lake and to provide information for use in formulating a long-term black bear management plan for northern Idaho. Specific objectives were to: 1) quantify seasonal habitat use by black bears; 2) determine whether patterns of habitat use differed by sex; 3) identify relationships that existed between black bear habitat use and black bear activities (e.g. feeding, bedding, etc) on disturbed and undisturbed sites; 4) identify relationships that existed between black bear habitat use and the kinds, abundance, and phenologic development of key bear food plants; and 5) determine whether certain physical and environmental factors (e.g. elevation, aspect, weather conditions, etc.) affect habitat use patterns of north Idaho black bears.

Field work was conducted between June 1980 and November 1981.

STUDY AREA

The 228 km^2 study area is located within Bonner and Boundary counties, Idaho (Fig. 1). Elevations range from 700 m to 2316 m. The topography is steep and rugged with exposed bedrock common above 1675m. The climate is influenced by Pacific Maritime air currents which usually result in long, snowy winters and short, damp summers. Annual precipitation averages 82.5 cm and the mean annual temperature is 5.1 C.

Forests are dominated by the western hemlock (*Tsuga heterophylla*) potential climax series (Daubenmire and Daubenmire 1968) at the lower (<1200 m) and middle elevations (1200 - 1600 m). Pockets of the Douglas fir (*Pseudotsuga menziesii*) series occur on xeric sites at lower elevations. The western red-cedar (*Thuja plicata*) series is found on mesic sites at lower to mid-elevations. The higher elevations (>1600 m) are dominated by the subalpine fir (*Abies lasiocarpa*) series, with the subalpine fir/whitebark pine (*Pinus albicaulus*) series occurring above 1800 m. An interspersion of logging units, burns, and sidehill parks throughout these forests creates a diverse mosaic of plant communities.

Timber production is the major land-use practice affecting the Priest Lake study area. Commercial logging began in the southern portions of the Selkirk mountains during the mid-1940's. Harvesting proceeded northward until, by the 1960's, most timber in the northern areas had been logged. Parts of the Priest Lake Study Area have been commercially logged several times since the 1940's. Initial harvests were usually selection cuts for whitepine (*Pinus monticola*) saw logs. Subsequent

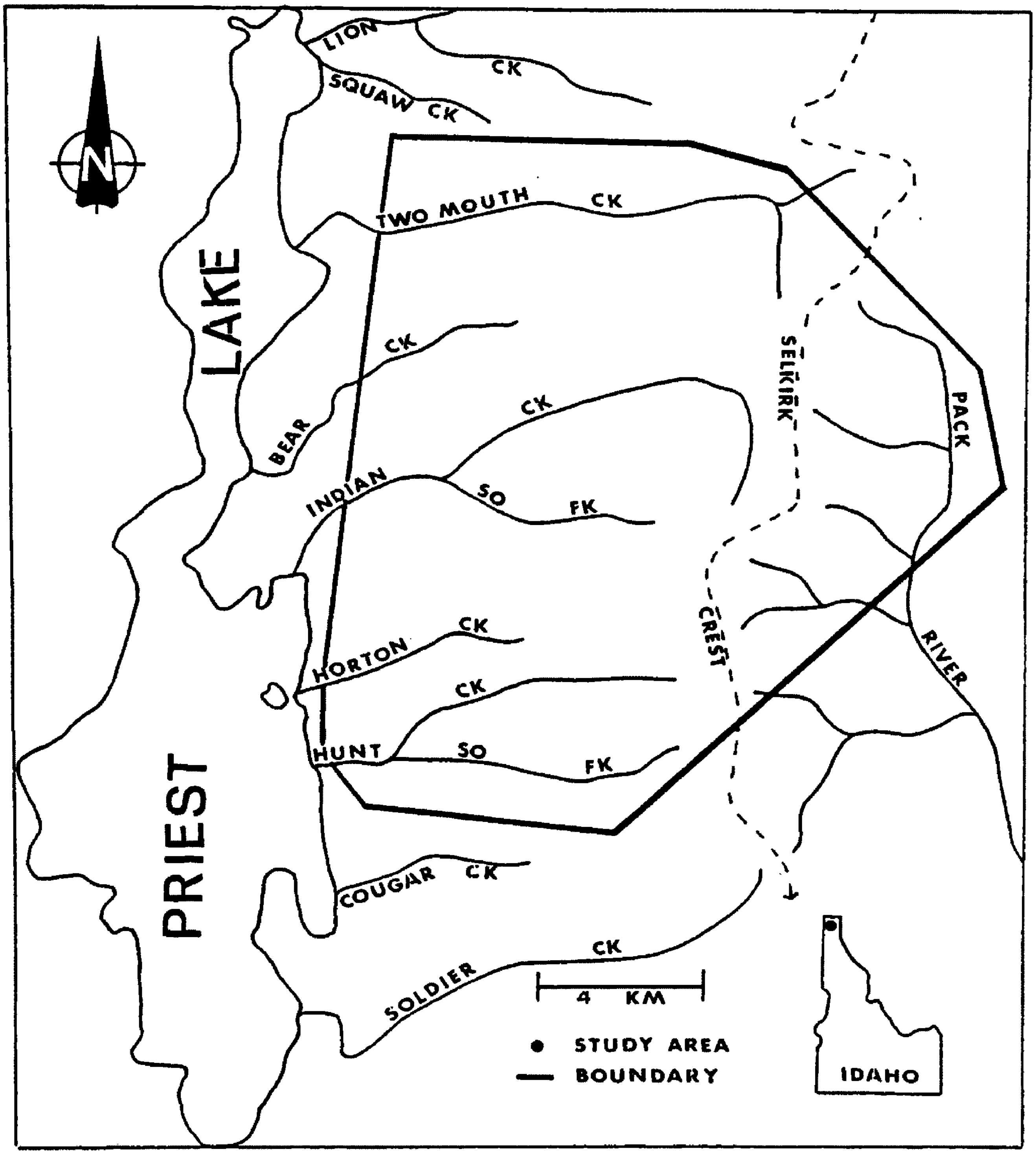

Figure 1. Geographic location and details of the Priest Lake study area.

harvests were primarily of poles or pulpwood in which a variety of tree species were removed. Other land use practices at Priest Lake include recreational activities such as backpacking, berry picking, camping, hunting, fishing and snowmobiling. Firewood cutting is also popular in the area.

Historically, wildfire was a significant factor affecting the Selkirk landscape, although effective fire suppression during the past 50 years has reduced this influence (Zager 1981). In 1967, however, 2 large wildfires occurred in the Priest Lake area: The 20,000 hectare Sundance burn bordering the study area to the south and the 5,000 hectare Trapper Peak burn 18 km north of the study area.

METHODS

Nine adult black bears (4 males and 5 females) were captured and immobilized according to methods described by Beecham (1980) and fitted with radio transmitters. Ages of bears were estimated using the cementum annuli technique (Stoneburg and Jonkel 1966). Radio locations were classified as follows: 1) close - bears were seen, heard or their locations estimated from signal strength to be 150 m, or less, from the observer; 2) close triangulation - both triangulation and signal strength indicated that the bear was within about 400 m of the observer; 3) triangulation; and 4) aerial. Close triangulations and triangulations were used for habitat use analysis only if the following criteria were satisfied: 1) three or more compass bearings intersected, roughly, at a single point (location);and 2) the specific point was located well within a homogeneous habitat component. All radio locations were plotted on U.S.G.S. topographic maps (scale 1:24,000).

Radio locations were stratified by season as dictated by seasonal movements of instrumented bears and seasonal food habits. Spring (approx. 15 April - 7 July) included the period after den emergence when their diet consisted primarily of herbaceous plants. Summer (approx. 8 July - 15 September) commenced when bears moved to the lower elevations to feed extensively on huckleberries (*Vaccinium globulare*). Fall (approx. 16 September - 1 November) began when bears switched from a diet of primarily huckleberry to mountain ash (*Sorbus* spp.) and bearberry (*Arctostaphylos uva-ursi*) and continued until they entered their dens.

Activities exhibited by instrumented black bears were classified as feeding, bedding, traveling, denning, or unknown. Radio locations classified as "unknown" were not considered in the analysis. Radio transmitters were equipped with mortality-sensing devices which aided in discerning between types of activity. Transmitters emitted a 70 beats-per-minute (BPM) signal whenever motion was detected and changed to a 58 BPM mode when the transmitter was motionless for a minimum of 5 minutes. Signal integrity was also used to discern between types of activity (Siedensticker et al. 1970; Amstrup and Beecham 1976), but to a lesser extent. Night tracking was conducted twice weekly to determine black bear nocturnal activity patterns.

A habitat component hierarchy developed by the University of Montana Border Grizzly Project (Zager et al. 1980, Servheen 1981) and Zager (1981) was modified to classify black bear habitat at Priest Lake (Table 1). Habitat components were used in addition to habitat types (e.g. Daubenmire and Daubenmire 1968) because they provided a precise description of the vegetation currently on the site. In addition, the habitat component classification system provides a systematic and repeatable means of classifying and monitoring non-forested (e.g. burns, meadows) as well as forested, and seral plant communities used by black bears. Habitat components were roughly delineated from aerial photographs and then "ground truthed". Vegetation in habitat components was sampled randomly using 0.04 hectare (0.1 acre) circular plots. The major plant species comprising the overstory and understory strata were recorded and assigned cover class values (Pfister et al. 1977). Vertical cover in respective habitat components was determined from ocular estimates of percent cover in each of 4 strata (i.e. 0-2', 2-7', 7-25', and $>$25') in sample plots. Differences in vertical cover between habitat components were detected using a grouped t-test ($P \leq 0.10$).

Table 1. Habitat Component Classification System

1.	Timber (T)	Closed canopy timber with tree cover greater than 60%.
2.	Open timber (OT)	Open timber with tree canopy cover between 30 and 60%. Understory dominated by shrubs.
3.	Selection cut (SC)	Sparsely timbered to open timbered sites created by selective logging. Small openings and patches of timber are commonly interspersed throughout the cuts. Dominated by shrubs. Tree canopy cover less than 30%.
4.	Clearcut (CC)	Open sites disturbed through timber harvesting. Dominated by shrubs.
5.	Slabrock (SR)	Naturally open to sparsely timbered sites with exposed blocks of glaciated bedrock. Sites mesic to xeric with shallow soils. Shrubs predominate.
6.	Open shrubfield (OS)	Naturally open sites that may be created and maintained by wildfire. Shrubs predominate. Generally at high elevations.
7.	Timbered shrubfield (TS)	Same as No. 6, except with sparse timber. Tree canopy cover up to 30%.
8.	Sidehill park (P)	Naturally open sites on moderate to steep slopes at low to mid elevations. Shallow soils with exposed bedrock common. Generally xeric sites dominated by graminoids and forbs.
9.	Timbered park (TP)	Mosaic created by an interspersion of sidehill parks (No. 8) and timber (No. 1).
10.	Riparian zone (RZ)	Hydrologically active sites with moving water which may be ephemeral. Mesic vegetation predominates.
11.	Scree/talus/rock (STR)	Slopes of loose rock fragments of various size or extensive areas of exposed bedrock.

(Continued)

Table 1. Continued

11.	(continued)	Timber, shrubs, and herbaceous vegetation may occur sparsely.
12.	Road (RD)	Open disturbed areas, cleared or graded.
13.	Wet meadow (WM)	Naturally open sites with relatively flat topography. Dominated by graminoids and forbs. Mesic.
14.	Snowchute shrubfield (SS)	Naturally open sites on steep slopes at high elevations created by periodic movements of snow. Dominated by shrubs.

Adopted from Border Grizzly Project studies in Montana (Zager et al. 1980, Zager 1980, Servheen 1981).

Plant nomenclature followed Hitchock and Cronquist (1973). Overstory density was measured with a spherical densiometer (Paul E. Lemmon, Forest Densiometers, 2413 Kenmore Street, Arlington, VA). The number of trees (≥10 cm in diameter at breast height) per hectare was estimated from the number of trees counted in the sample plot. A non-mapping, random dot grid technique (Marcum and Loftsgaarden 1980) was used to determine the availability of all habitat components within a composite home range of instrumented bears. Habitat component availability was also determined for respective male and female composite home ranges.

Habitat component selection patterns were developed entirely from the radio locations of instrumented bears. Incidental signs (e.g. scats, tracks, etc.) were not used in the analysis of habitat component selection patterns because of inherent biases. The chi-square "goodness of fit" test was used to detect significant differences between the availability and use of habitat components. Preference and/or avoidance of individual habitat components by instrumented bears were determined by applying a modified z statistic (Marcum and Loftsgaarden 1980). A habitat component "selected for" was one used significantly more than expected ($P \leq 0.10$) based on availability data; a habitat component "selected against" was one used significantly less than expected ($P \leq 0.10$).

Habitat type (h.t.) use patterns were determined following the same procedures as those described for habitat components. The habitat type classification system followed Daubenmire and Daubenmire (1968).

The phenological development of key bear food plants was recorded using the method of West and Wein (1971) (Table 2). Key bear food plants were identified from the food habits analysis conducted by

Beecham (1980b) at Priest Lake in 1979. Simple linear regression analysis was used to measure the degree of correlation between the mean elevations of bear locations and the phenological development of key bear food plants.

The frequency of occurrence and abundance of key bear food plants within respective habitat components is presented in Appendix B. Average percent canopy cover was used as an indicator of food abundance. Forage productivity was assumed to be directly related to abundance (Martin 1979), because it was not feasible to actually measure the food production of fruit-producing shrubs and other foods during this study.

Table 2. The respective phenological stages for shrubs and grasses.

Phenology code	Phenologic stage Shrubs/Gramonoids
1	Flower/Vegetative growth
2	Fruit set/Flower buds
3	Fruit swelling/Flower
4	Fruit turning color/Fruit set
5	Fruit ripe/Fruit swelling
6	Fruit dry or dropping/Plant curing

Table 3. The sex, age, reproductive condition, and related radio location data for 9 instrumented black bears at Priest Lake, Idaho.

Bear	Sex	Age[a]	No. cubs 1980	No. cubs 1981	No. of locations	Date of first location	Date of last location
269	M	10	-	-	31	12 June 1980	5 Sept. 1980
528	M	5	-	-	77	8 June 1980	16 Sept. 1981[b]
568	M	6	-	-	131	15 Oct. 1980	22 Oct. 1981
570	M	9	-	-	73	5 June 1981	11 Oct. 1981
650	F	6	0	1	177	11 June 1980	22 Oct. 1981
680	F	4	0	1	137	11 June 1980	22 Oct. 1981
688	F	6	0	-	12	10 June 1980	1 July 1980[c]
694	F	13	0	1	61	23 July 1980	21 Oct. 1981
810	F	3	-	0	92	6 June 1981	22 Oct. 1981

a. In 1980
b. Collar slipped off about 15 April 1981 and was replaced 9 July 1981.
c. Killed illegally on about 1 July 1980.

Table 4. The temporal distribution of black bear radio locations at Priest Lake, 1980-81.

Time	Radio locations No.	Radio locations Percent
Daylight - 0900	127	16.4
0901 - 1200	178	23.0
1201 - 1500	139	18.0
1501 - 1800	193	25.0
1801 - dark	101	13.1
Night	35	4.5
Total	773	100.0

RESULTS

Nine radio-collared black bears provided 791 radio locations during the 1980 and 1981 field seasons (Table 3). Radio locations were classified as follows: 481 close (60%), 126 close triangulations (16%), 182 triangulations (23%), and 2 aerials (<1%). Instrumented bears were seen on 106 occasions (13%). The temporal distribution of radio locations is presented in Table 4. Night monitoring of instrumented bears on 35 occasions indicated that bears were not nocturnal. During the study, an instrumented female black bear was killed illegally, and a radio-collared male black bear lost his collar but was re-instrumented within 3 months.

Significant differences in black bear use of habitat components (X^2=191.6, df=6, $\underline{P} \leq 0.001$) and habitat types (X^2=88.8, df=6, $\underline{P} \leq 0.001$) from their respective availability on the study area, implies active selection rather than passive use. Habitat type use by black bears did not differ significantly between sexes (X^2=8.7, df=4, $\underline{P} > 0.10$) or by activity (X^2=8.9, df=5, $\underline{P} > 0.10$) and, thus, are not presented in the text.

<u>Seasonal selection of habitat components by black bears</u> - Overall habitat component use by black bears differed significantly (X^2=46.7, df=10, $\underline{P} \leq 0.001$) between seasons (Table 5). Selection cuts were the only habitat component selected for by bears during all seasons (Fig. 2). Clearcuts were the only habitat component selected against during all seasons. Open timber and scree/talus/rock were selected against during spring and summer, but were selected in proportion to availability during fall when they provided sites for denning. Roads were selected against during summer and fall, but were selected in proportion to their availability during spring. All other habitat components were used in proportion to their availability during spring, summer, and fall. Although the timbered habitat component

was used in proportion to availability, it was second to the selection cut habitat component, in terms of use by black bears. Timber accounted for 72 or 249 (28.9%) radio locations during spring, 67 of 310 (21.6%) during summer, and 43 of 117 (36.8%) during fall.

Habitat component selection classified according to sex of bears - Overall habitat component use differed significantly (X^2=21.9, df=11, $P \leq 0.005$) between sexes (Table 5); female black bears selected against roads, and males used them in proportion to their availability (Fig. 3). Both sexes selected for selection cuts and selected against open timber, clearcuts, and scree/talus/rock. There was no significant difference (X^2=5.65, df=13, $P \leq 0.05$) in habitat component availability within respective male and female composite home ranges (Appendix C).

Habitat component selection classified according to black bear activity - There was a significant difference (X^2=44.9, df=6, $P \leq 0.001$) in the overall habitat component use of feeding and bedding black bears (Fig. 4) (Table 5). Differences in the use of habitat components for traveling and denning by black bears was not tested because of insufficient sample sizes.

Black bears selected for selection cuts and riparian zones for feeding. Known habitat components that were selected against by bears for feeding included open timber, clearcuts, scree/talus/rock, and timber. All other components mapped were used in proportion to their availability.

In terms of bedding, selection cuts and timber were selected for by bears. Open timber, clearcuts, scree/talus/rock, and roads were selected against by bears for bedding.

Table 5. Use of habitat components by radio-collared black bears broken down by season, sex, and activity.

Habitat component code [1]	Seasonal use [2]			Use by sex		Use by activity			
	spring	summer	fall	male	female	feeding	bedding	traveling	denning
T	28.9	21.6	36.8	21.8	30.2	15.9	38.2	27.9	14.3
OT	0.4	3.9	6.8	3.8	2.7	3.2	2.2	0.0	23.8
SC	54.6	66.1	47.9	59.4	58.3	67.0	53.1	55.8	42.9
CC	1.6	1.6	0.0	2.3	0.7	1.9	0.0	4.7	0.0
SR	0.8	0.0	1.7	0.8	0.5	0.3	0.4	0.0	9.5
OS	0.0	0.3	0.0	0.0	0.2	0.0	0.4	0.0	0.0
TS	2.4	3.2	3.4	2.3	3.4	4.1	1.8	0.0	0.0
P	0.8	0.3	0.0	0.8	0.2	0.3	0.7	0.0	0.0
TP	2.8	0.0	0.0	1.1	1.0	1.3	1.1	0.0	0.0
RZ	3.2	1.9	0.9	3.0	1.7	3.5	1.5	0.0	0.0
STR	0.0	0.0	1.7	0.4	0.2	0.0	0.0	0.0	9.5
RD	4.4	1.0	0.9	4.5	0.7	2.5	0.7	11.6	0.0
WM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
No. telemetry locations:	249	310	117	266	410	315	275	43	21

1. For component codes see Table 1.
2. Percent of telemetry locations in each habitat component.

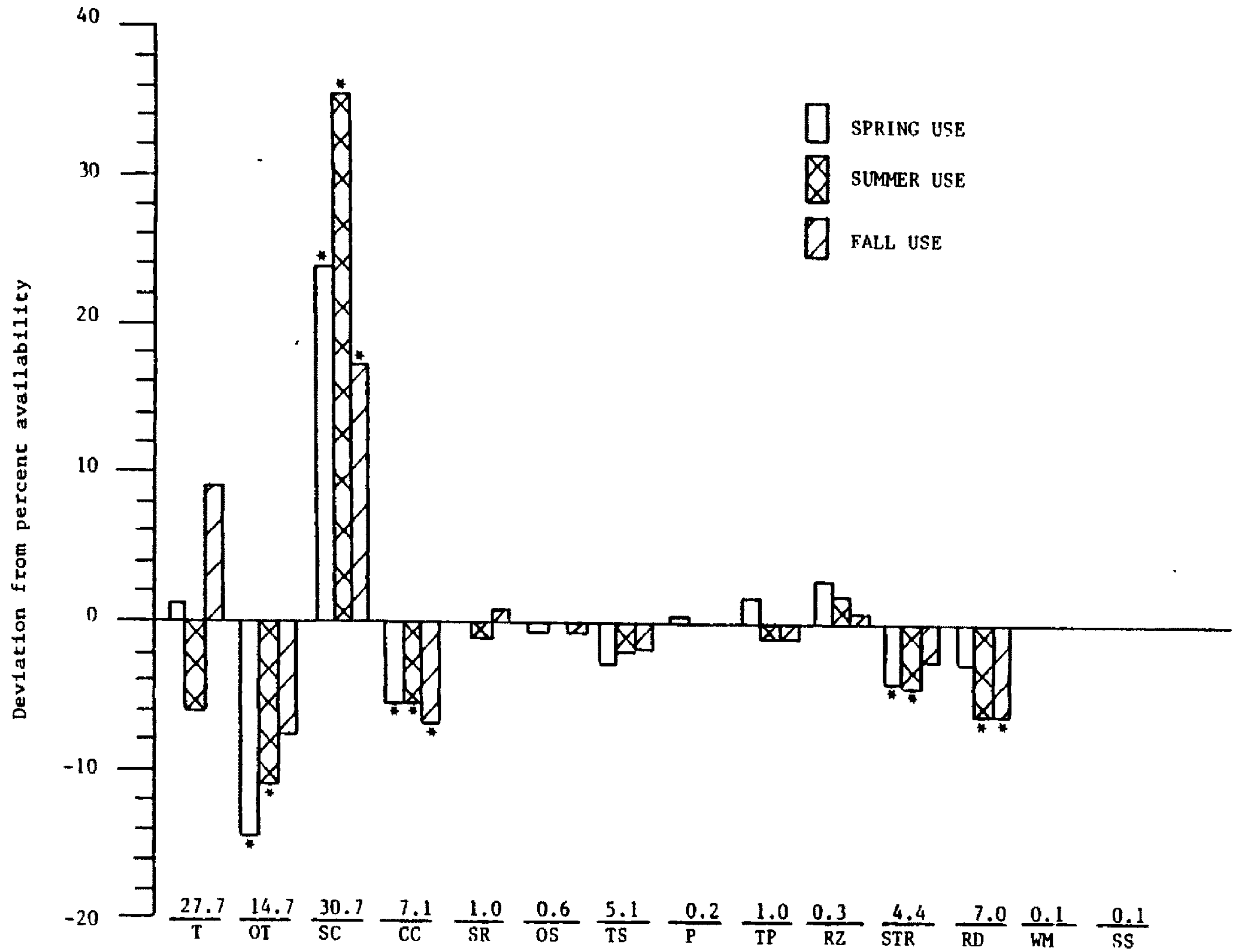

Figure 2. Black bear habitat selection patterns at Priest Lake, 1980-81, determined from radio locations classified by season. An "*" indicates a significant difference ($P \leq 0.10$). Percent availability of respective habitat components is presented above the habitat component abbreviation.

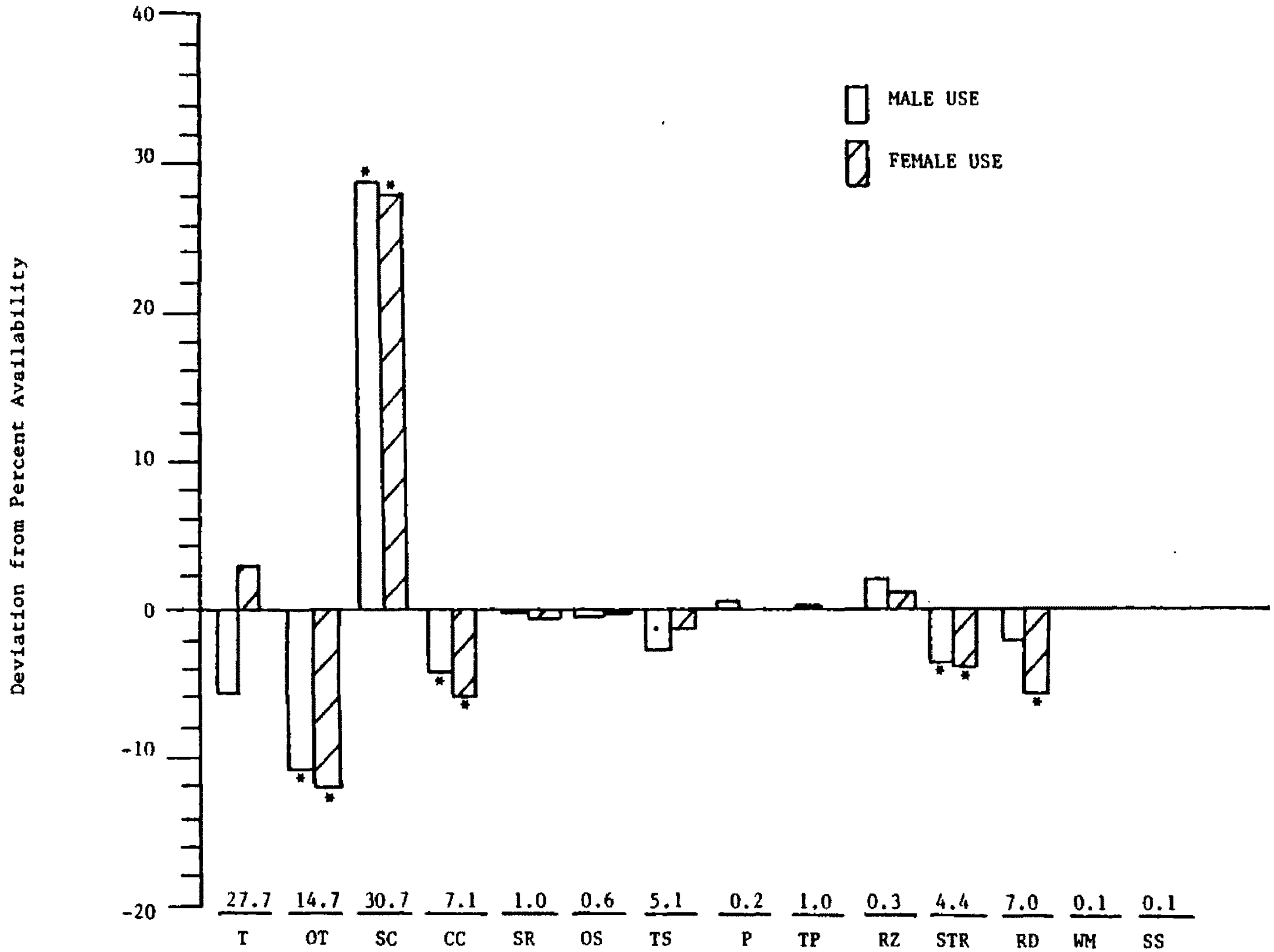

Figure 3. Black bear habitat selection patterns at Priest Lake, 1980-81, determined from radio locations classified by sex. An "*" indicates a significant difference ($P \leq 0.10$). Percent availability of respective habitat components is presented above the habitat component abbreviation.

The selection cut habitat component received the most use by black bears for traveling. Bears that were traveling used the open timber, timbered shrubfield, and scree/talus/rock habitat components least.

In terms of denning, the clearcut, timbered shrubfield, and road habitat components received the least amount of use relative to availability.

Habitat type selection stratified by season - The overall use of habitat types by instrumented black bears differed significantly (X^2=20.2, df=8, $P < 0.01$) between seasons (Fig. 5) (Table 6). The Hemlock/Pachistima h.t. was selected for by instrumented bears during spring, summer, and fall. In terms of use, this habitat type accounted for 196 or 229 locations (85.6%) during spring, 239 of 292 (81.9%) during summer, and 86 of 103 locations (83.5%) during fall (Table 6). The Subalpine fir/Beargrass h.t. also was selected for, but only during summer. Habitat types selected against by instrumented bears included the Grand fir/Pachistima h.t. during spring, summer, and fall and the Subalpine fir/Menzeisia h.t. during summer.

Elevational movements of black bears in relation to the phenological development of key bear food plants - A generalized pattern of the phenological development of five key bear food plants is presented in Figure 6. A strong correlation (R^2=0.92) between the mean monthly elevation at which bears were located (Fig. 7) and the midpoint elevations at which the major food item for respective months was "ripe" (grasses - phenologic stage 1; fruits - phenologic stage 5)

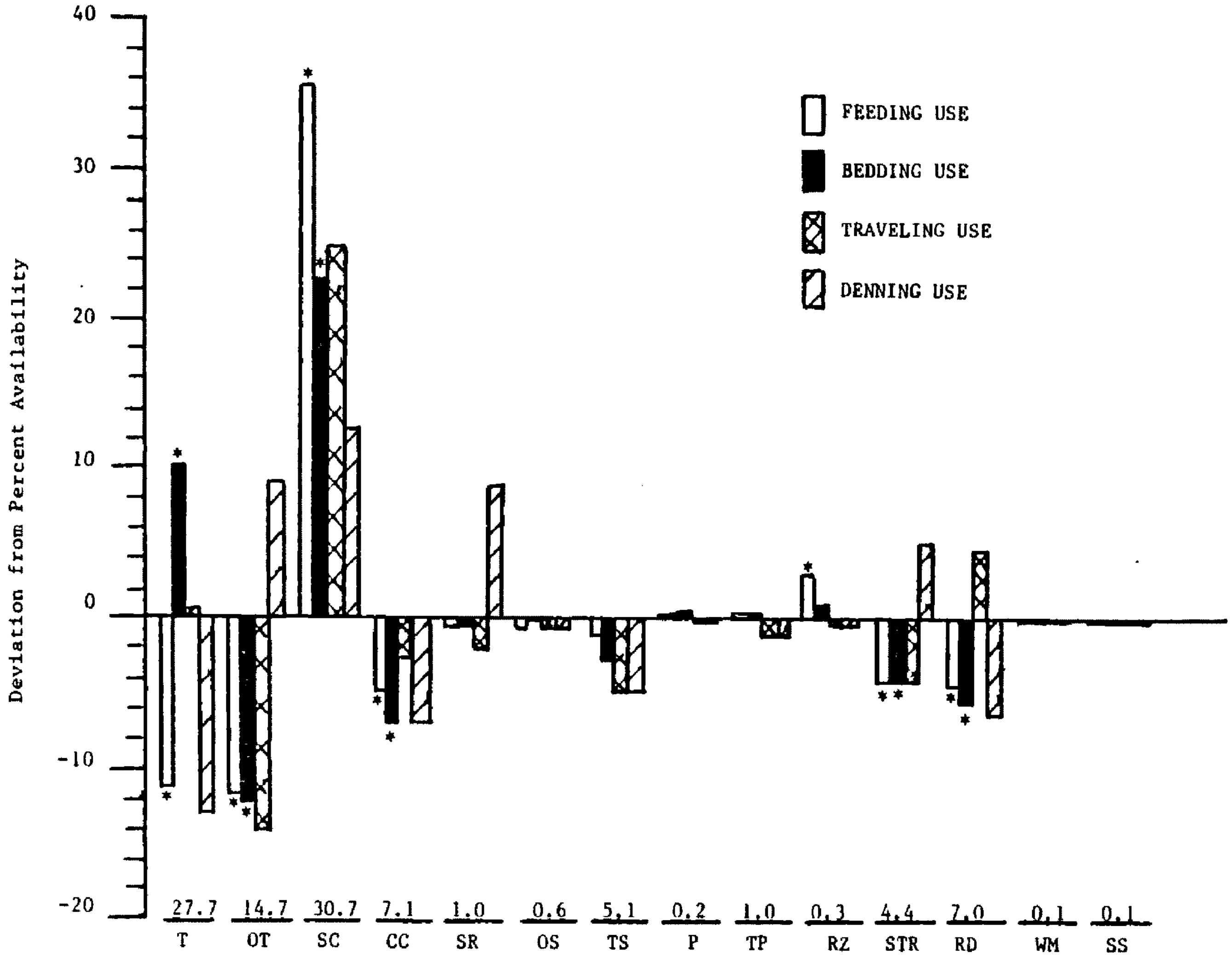

Figure 4. Black bear habitat component use patterns at Priest Lake, 1980-81, determined from radio locations classified by activity. An "*" indicates a significant difference ($P \leq 0.10$). Availability of respective habitat components is presented above habitat component abbreviations.

indicated, as one would suspect, that elevational movements by black bears were in response to the temporal availability of food.

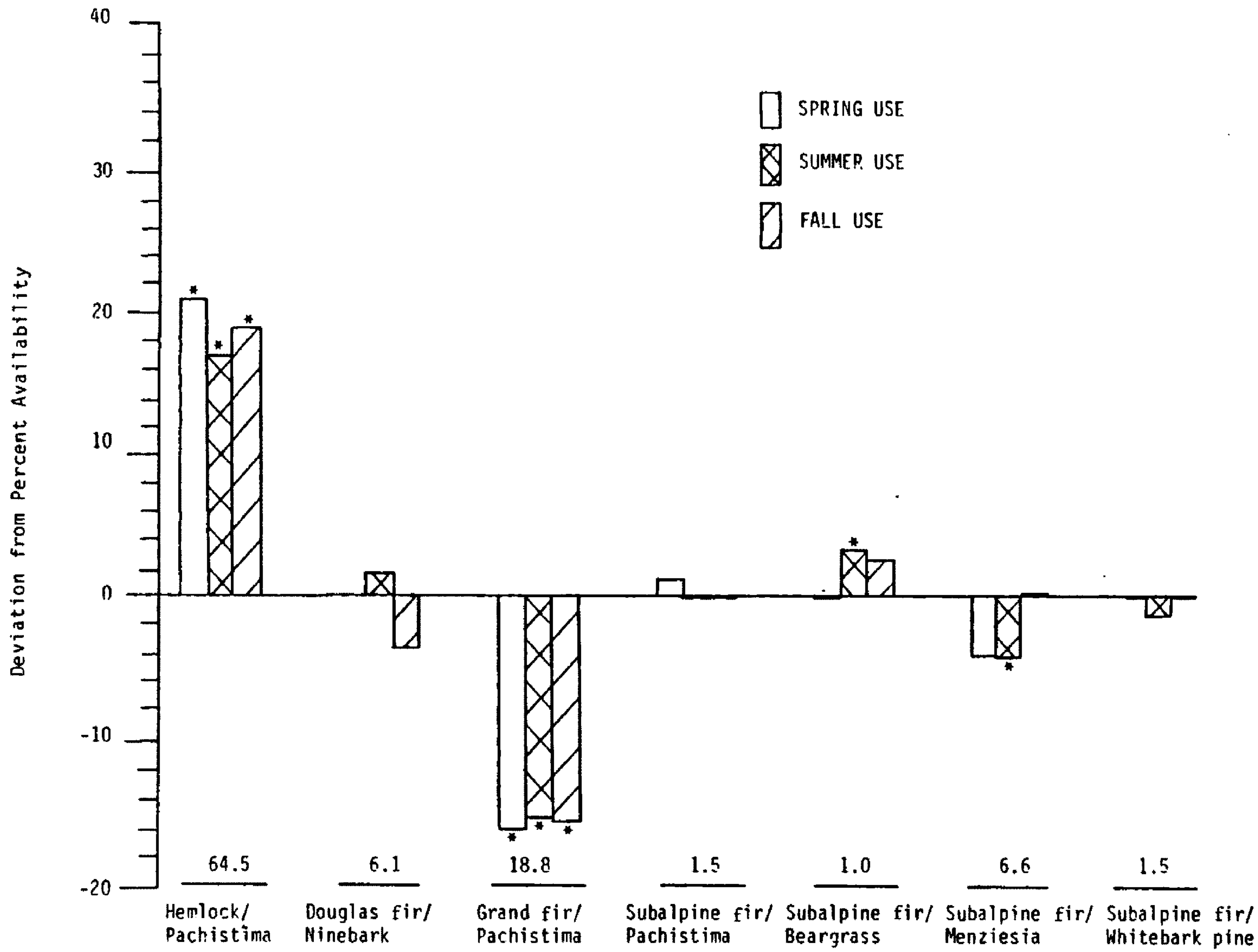

Figure 5. Black bear habitat type use patterns at Priest Lake, 1980-81, determined from radio locations classified by season. An "*" indicates a significant difference ($P \leq 0.10$). Availability of respective habitat types is presented in percent above the habitat type abbreviation.

Table 6. Seasonal use of habitat types by black bears at Priest Lake, 1980-81.

Habitat type	Use[1] overall	spring	summer	fall	availability[2]
Hemlock/Pachistima	83.5	85.6	81.8	83.5	64.5
Douglas fir/Ninebark	6.7	6.1	8.9	1.9	6.1
Grand fir/Pachistima	1.8	1.3	2.2	1.9	18.8
Subalpine fir/Pachistima	1.8	3.1	1.0	1.0	1.5
Subalpine fir/Beargrass	2.9	0.4	4.5	3.9	1.0
Subalpine fir/Menziesia	2.7	2.2	1.7	6.8	6.6
Subalpine fir/Whitebark pine	0.1	1.3	0.0	1.0	1.5
No. of telemetry locations	624	229	292	103	

1. Percent of telemetry locations in each habitat type.
2. Percent of each habitat type available in the combined seasonal ranges of the bears that were monitored.

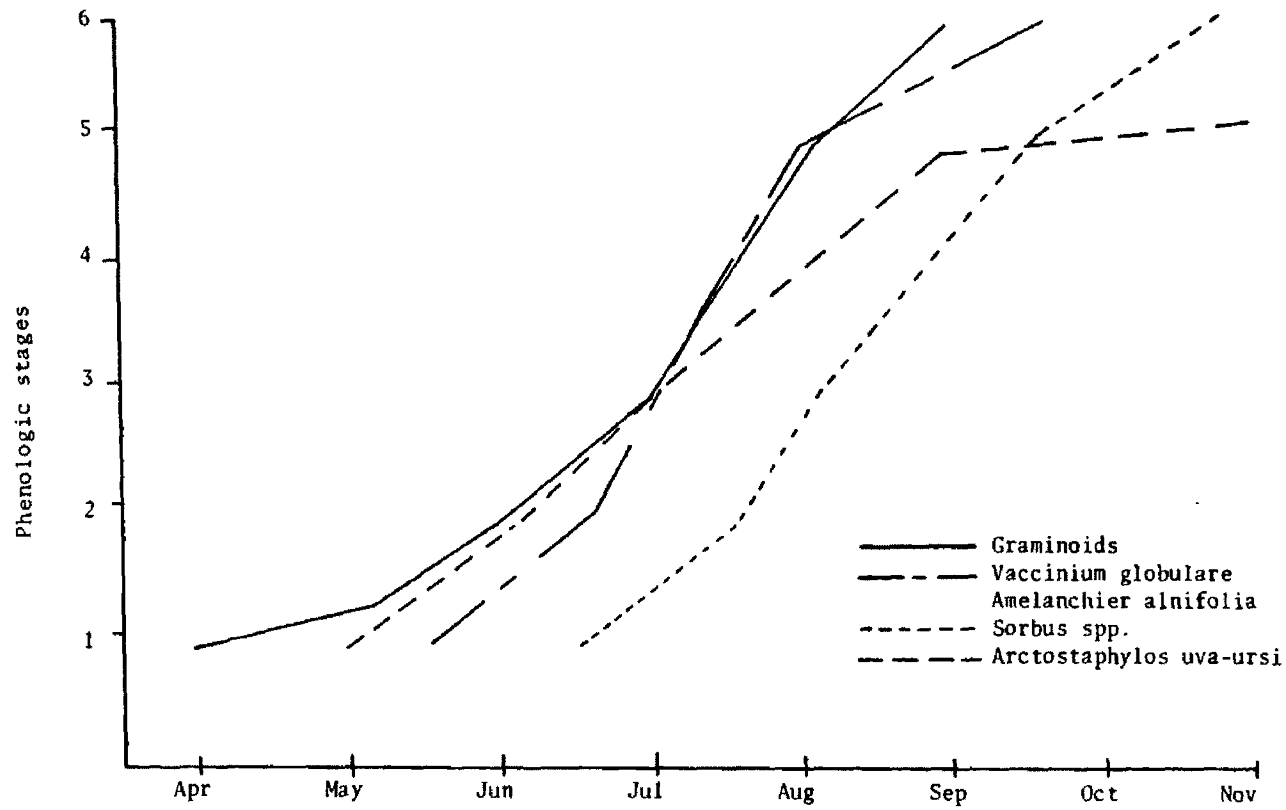

Figure 6. Generalized pattern of the phenological development of five key food plants at Priest Lake, 1981.

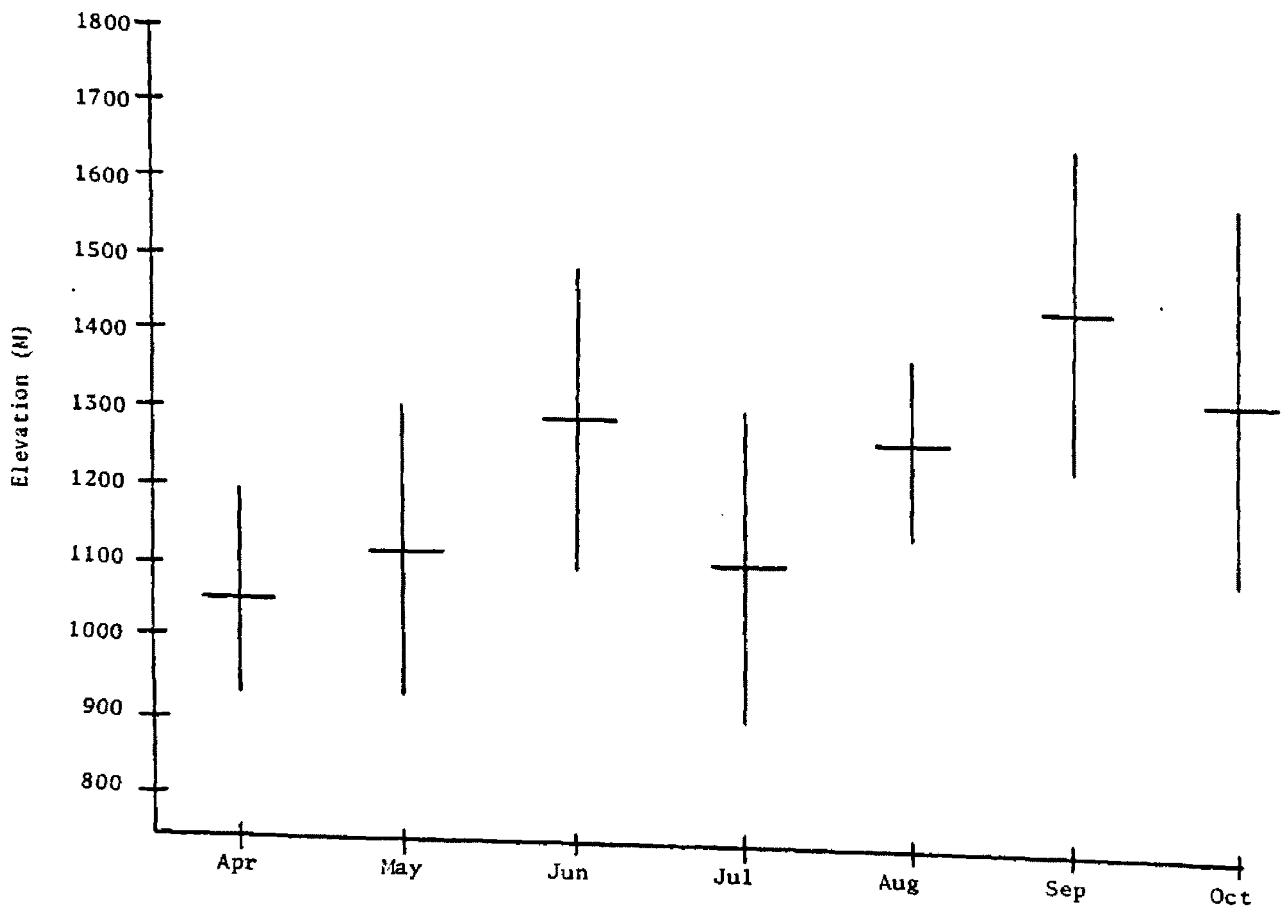

Figure 7. Mean and ± SD of elevations at which instrumented black bears were located in 1981. Differences between April and June, June and July, July and September, and September and October means are significant (F=31,7; df=556; P<0.001) according to Scheffe's (1953) procedure.

DISCUSSION

Seasonal selection of habitat components by black bears.

Black bears at Priest Lake exhibited seasonal changes in their habitat use patterns. Jonkel and Cowan (1971), Kelleyhouse (1980), and Novick and Stewart (1982) have documented similar changes in the seasonal habitat use patterns of black bears in other areas. Martinka (1972) and Amstrup and Beecham (1976) reported that seasonal changes in the habitat use of grizzly bears (*Ursus arctos*) and black bears, respectively, was related to their food habits. Seasonal variation in food habits of black bears, and the temporal availability of key bear foods, was apparently responsible for seasonal changes in habitat use patterns of black bears at Priest Lake, also.

Black bears in the Pacific Northwest have adapted to exploit berry-producing shrub species commonly found in seral plant communities (Shaffer 1971, Jonkel and Cowan 1971, Lindzey and Meslow 1977). Historically, wildfire played the major role in creating and maintaining seral plant communities. Probably the greatest impact wildfire has on northern Rocky Mountain spruce/fir forests and wildlife is removal of the tree canopies, resulting in increased growth and productivity of the shrub stratum (Zager 1980). Several researchers have documented greater and more consistent huckleberry production on burned sites than under the canopy of a mature forest (Martinka 1972, Minore 1975, Martin 1979). Serviceberry (*Amelanchier alnifolia*) has also been shown to increase after fire (Franklin and Dyrness 1973, Mueggler 1965). Hemmer (1975) found serviceberry most dense in old burns where adequate moisture was available. Franklin and Dyrness (1973) characterized mountain ash as a pioneer species that resprouts vigorously after fire.

Studies by Hagar (1960) and Ahlgren (1966) have shown that wildlife responses to logging may follow the same pattern as seen after wildfire, suggesting that disturbance by means other than fire can have a similar effect. Zager (1980) stated that certain timber harvest methods can influence grizzly bear habitat in the same manner as wildfire as well, and that one condition created by wildfire that may be simulated to some extent by logging is an open canopy. Several studies have shown that concentrations of bear foods are provided by seral plant communities that follow logging (Rogers 1976, Lindzey and Meslow 1977, Zager 1980). Mealey (1977), developing criteria for management of grizzly bear habitat, reported selection cuts as having the highest importance (based on availability of key bear foods) among logged components. I found selection cuts to be the most important habitat component at Priest Lake, when considering both habitat use and habitat selection information. This is largely due to the high concentrations of key bear foods provided by the seral plant communities which dominate the selection cut habitat component at Priest Lake.

Although commercial logging commenced in the early 1900's at Priest Lake, most logging activity has occurred since the 1940's. Selection cut logging was the dominant timber regeneration method used between 1940 and 1960; thus most selection cuts on the study area are between 20 and 40 years of age. Zager (1980) noted that the canopy cover of shrubs considered to be key grizzly bear foods in northwest Montana was higher on sites burned by wildfire 35-70 years before (the same species were important to black bears at Priest Lake). Martin (1979) found that the productivity of huckleberries on high elevation sites was highest (in volume) in stands that were burned 25-60 years before. Assuming that wildfire and selective logging have similar ecological effects in terms of their influence on bear habitat, then productivity of key bear foods should be high on selection cuts at Priest Lake.

Concentrations of highly productive fruit-bearing shrubs explains, at least in part, black bear preference for selection cuts during summer and fall when their diet consists mainly of berries. But, black bears at Priest Lake also preferred selection cuts during spring when their diet consisted primarily of grasses. Although grasses were treated as one taxon for food habits analysis, I suspect that pinegrass (Calamegrostis rubescens) constituted a major portion of the spring grasses consumed by black bears because it was widely distributed and was the most abundant graminoid found on the study area. On several occasions, instrumented black bears were observed feeding on pinegrass and were often monitored as they fed in areas devoid of spring foods other than pinegrass. Pinegrass is a rhizomatous species that often proliferates when tree canopy is removed (Pfister et al. 1977). I surmise that the proliferation of pinegrass after selection logging was probably a major factor resulting in the selection of this habitat component by black bears during spring. Scarification caused by road construction (e.g. log roads, skid roads) may also have influenced bear use of selection cuts during spring. Jonkel and Cowan (1971) and Zager (1980) found that certain species of grasses uncommon to both old-growth stands and old burns were typically found on disturbed soil along roads. They also noted that horsetails (Equisetum spp.), common in the spring diet of Priest Lake black bears, responded positively to logging and were commonly found along moist skid roads.

Black bear selection for selection cuts during spring may also be due to the inclusion of huckleberry flowers in their diet at this time of year. Huckleberry leaves and flowers were found in 45% and 29% of the scats collected in May and June 1981, respectively (Beecham 1982). Several of the scats collected were composed entirely of huckleberry leaves. Food habits studies are normally biased against the more delicate plant tissues, such as the flowering parts, because of greater digestibility. Based on the occurrence of leaves and stems of huckleberry in scats, I suspect that bears at Priest Lake were feeding consistently on huckleberry flowers during spring, but that these flower parts were entirely digested and did not show up in our food habits analysis. In June 1981, an instrumented male black bear was observed as he fed on the flowers of huckleberry. The abundance of huckleberry, and hence huckleberry flowers, in selection cuts would provide an almost unlimited source of huckleberry flowers for bears during a portion of spring and result in an increased use of this habitat component.

Several studies have shown the importance of cover in the habitat selection patterns of black bears (Lindzey and Meslow 1977, Novick and Stewart 1982). Mealey (1977) defined cover for grizzly bears as vegetation and/or topography which hides 90% of a bear from the view of a person 400 feet away. Lindzey and Meslow (1976) found that bears selected older cuts with more cover, to ones younger with less cover, even though the younger cuts provided a greater abundance of foods. The shrub stratum in selection cuts at Priest Lake was extremely dense (Appendix D), often seemingly impenetrable. Instrumented bears were rarely seen when they were using selection cuts, and on numerous occasions bears close enough to be heard breathing could not be seen because they were obscurred by brush.

Herrero (1972), considered trees to be significant in the daily existence of the black bear, particularly in respect to safety afforded by tree climbing. Selection cuts at Priest Lake had an average of 543 trees/ha, scattered either singly or in small groups throughout the habitat component; they afforded bears safety by tree climbing. Lindzey and Meslow (1976) reported that a significant percentage of their bear locations in clearcuts were on edges, suggesting that trees were important to bears for safety.

I concur with Lindzey and Meslow (1976) that both cover (i.e. hiding and tree) and food are important in the selection of habitats by black bears. Selection cuts at Priest Lake probably received the greatest amount of use by black bears because they provided the best combination of both food and cover,of all the habitat components.

I observed a different response by black bears to clearcut logging than to selection logging. Instrumented bears avoided clearcuts during spring, summer, and fall. Jonkel and Cowan (1971) reported that black bears neglected to use clearcuts in the Picea-Abies/Pachistima association (Daubenmire and Daubenmire 1968) or areas that had been recently logged. Lindzey and Meslow (1977), in Washington, found black bear use of 6-11 year-old clearcuts less than expected (e.g. selected against), based on availability data, but 15-24 year-old clearcuts were used more than expected. They attributed this difference in use to the lack of cover in the younger cuts. Zager (1980) found that grizzly bears did not use clearcuts in proportion to their availability. He stated that this was the result of several factors which included 1) site treatment and bear food recovery; 2) proximity of visual cover on logged sites; and 3) human disturbance along roads.

Clearcutting has been the dominant timber harvesting method employed at Priest Lake since the 1960's. Slash was burned in most cases, and some sites were scarified extensively to enhance tree regeneration (Zager 1981). He estimated the length of time required for minimally scarified sites in the Priest Lake area to recover, in terms of food and cover for bears, to be 10-20 years, with extensively scarified sites requiring much more time. The oldest clearcuts on the study area were about 20 years of age, with most being younger. Clearcuts at Priest Lake were probably not old enough to provide adequate cover for use by black bears, in most cases. Cover in the 7-25 feet and >25 feet strata of clearcuts was significantly ($P < 0.10$) less than that in selection cuts (Appendix D).

Martin (1979) found huckleberry cover and berry volume in scarified clearcuts the lowest of 8 different types sampled in northwestern Montana. Scarification damages the rhizomes and root crowns of vegetatively reproducing shrubs such as huckleberry (Zager 1980). Clearcuts at Priest Lake had an average huckleberry cover class of 1 (1-5%), compared with an average cover class of 2 (5-25%) for selection cuts. Clearcuts, as opposed to selection cuts, generally received moderate to heavy scarification (Zager 1981). Tisch (1961) reported that recent clearcuts provided very little black bear food in the Whitefish Range of northwestern Montana.

Grasses and forbs, which are important to bears during spring, usually increase in abundance after scarification (Zager 1980). Assuming that they were abundant in scarified clearcuts at Priest Lake, lack of use by black bears during spring was probably a reflection of lack of cover in the cutting units. I found that both food and cover are important requirements in the selection of habitats by black bears.

Habitat diversity appears to be the most important element comprising black bear habitat (Jonkel and Cowan 1971, Lawrence 1979, Kemp 1979). Zager (1980) stated that "wildfire historically burns in a mosaic pattern which results in an interspersion of habitats, and ensures heterogeneity of environments". Wildfire and logging practices that simulate wildfire appear not only to be instrumental in increasing the productivity and abundance of bear foods, but also appear to be instrumental in creating and/or maintaining habitat diversity.

Timber was the second most used habitat component at Priest Lake, although its use by black bears was in proportion to availability. Bray and Barnes (1967), citing earlier studies, noted that forested habitat was an important component of black bear habitat. Herrero (1972) discussed the importance of timber in the evolution of the black bear. Kelleyhouse (1980), in California, reported that mixed conifer forests received considerable use by black bears during all seasons, except late August. Novick and Stewart (1982) found that black bears in California used the conifer forest formation in proportion to availability during spring and summer, and only slightly greater than expected during fall. Lindzey and Meslow (1977) noted that over half of their black bear locations in timber were on edges, suggesting that timber provided resting and/or escape cover for bears that normally foraged in clearcuts. I suspect that timber functions primarily as cover for black bears at Priest Lake. Also, greater use of timber by black bears during the spring and fall, seasons in which instrumented bears spent most of the day bedded, supports this conclusion.

Riparian zones, sidehill parks, timbered/sidehill parks, and roads were used most by black bears during spring. Several researchers have noted the importance of such habitats (especially riparian zones) during spring (Jonkel and Cowan 1971; Kelleyhouse 1980, Zager 1981). These habitat components provide succulent, high quality vegetation including grasses, sedges, forbs, and horsetails common in the spring diets of black bears (Tisch 1961, Poelker and Hartwell 1973, Beecham 1978). Use of these habitat components declined as grasses, sedges, forbs and horsetails dessicated during the summer and fall.

Based on the literature, I expected greater use of riparian zones, wet meadows, and avalanche chutes by black bears during spring than was observed. Riparian zones at Priest Lake were normally narrow and, subsequently, shaded by forest canopy. As a result, understory stratum was usually comprised of plant species similar to that found in the adjacent habitat component. Tisch (1961) reported, in northwestern Montana, that subordinate vegetation along small streams was similar to that found in adjacent stands. At Priest Lake, riparian zones probably offered bears little more in the way of succulent vegetation than do adjacent areas, accounting for less use than I expected.

Use of wet meadows and avalanche chutes by Priest Lake black bears was, also, less than expected. During spring, I expected substantial use of those habitat components because of the spring foods they provide (Tisch 1961, Zager 1980). Wet meadows and avalanche chutes covered approximately 0.2% of the study area, and were normally located at high elevations in the most inaccessible areas. Perhaps, this resulted in a biased estimate by me of their use by black bears.

Habitat component selection classified according to sex of bears

Overall use of habitat components by black bears at Priest Lake differed significantly when stratified by sex. The most dramatic difference was greater use of timber by females, as compared with males. Herrero (1972), discussing the evolutionary strategy of cub protection in black bears, stated that "females with cubs are reluctant to leave trees". Perhaps this behavioral trait was responsible for the differences in use of timber by male and female black bears at Priest Lake. Although 3 of 4 instrumented female bears at Priest Lake were accompanied by cubs during the 1981 field season, use was not significantly different ($Z=0.4$, $P > 0.2$) from that of 1980.

The different use of roads by male and female black bears has strong management implications. Male black bears at Priest Lake used roads in proportion to their availability, whereas female black bears selected against roads. This avoidance of roads by female black bears may, too, be a function of innate maternal instincts of females to avoid open areas when accompanied by cubs. Zager (1980) documented a female grizzly with cubs avoiding roads on his study area in northwestern Montana.

Differential use of roads between sexes may also be related to differences in the mobility of male and female black bears, that is, if roads serve as travel routes as my data suggest. Because male black bear show greater mobility than female black bears (Amstrup and Beecham 1976, Reynolds and Beecham 1980), their use of roads may automatically be greater.

Habitat component selection classified according to black bear activity

There were inherent biases associated with classifying black bear locations according to the activity in which bears were engaged for purposes of habitat analysis. First, even though mortality sensing transmitters were used, it was often difficult to discern between types of activity. This seemed most apparent with bears that were bedded, but occasionally shifted their body position. This resulted in a change in signal mode. I minimized this bias by discarding locations from the habitat analysis in which the bear's activity was not precisely know. Second, radio locations should be evenly distributed temporally. Radio locations for bears at Priest Lake showed good temporal distribution (Table 4). Third, habitat use studies may be biased against night use because of the difficulties in obtaining accurate locations at night. Bears at Priest Lake were crepuscular and diurnal, thus, only black bear nocturnal bedding habitat use patterns are not represented in the analysis.

The selection cut and riparian zone habitat components were both selected by black bears for feeding. As discussed earlier, selection cuts provide bears with both an abundance of seasonally important foods and cover.

The seasonal importance of riparian zones to bears has long been known. At Priest Lake, riparian zones were most important as feeding sites during spring, e.g. that period when bears feed primarily on herbaceous foods. Tisch (1961) found that stream bottoms in northwestern Montana provided bears with an abundance of herbaceous foods. In California, Kelleyhouse (1980) documented use of riparian habitat by black bears for feeding. Most watercourses at Priest Lake supported little herbaceous vegetation because of the influence of closed-canopied timber along them. However, herbaceous vegetation was often abundant along watercourses in which the overstory had been removed through logging or wildfire. Opening of the canopy provided conditions favorable to sun-tolerant species such as grasses, sedges, forbs, and horsetails. Open-canopied riparian zones were relatively uncommon, compared to closed-canopied riparian zones. Their importance to black bears as feeding habitat, especially during spring, may be greatly underestimated. One instrumented male black bear was observed on 3 separate occasions as he fed along a riparian zone that had been selection cut logged. All three locations were within a 50 m radius. In addition, an instrumented female black bear was observed during fall as she fed along a riparian zone within this same selection cut.

Timber, although selected less than expected based on availability data, was the second most frequently used habitat component for feeding by black bears (16% of all feeding locations were in timber). Poelker and Hartwell (1973), Jonkel and Cowan (1971), and Beecham (1980), documented extensive damage to tree cambium by feeding black bears in the timbered areas of western Washington, northwestern Montana and Idaho, respectively. I found little evidence of cambium feeding on my study area. There was one exception, however. Trees (approximately 30) in 2 areas frequented by a radio collared female black bear and cub were heavily damaged as a result of cambium feeding.

Knight et al. (1978) reported that timber was important as feeding habitat to grizzly bears in Yellowstone National Park. He attributed this use mostly to grizzly bears feeding on ants. Ants were common in the diet of Priest Lake black bears (Beecham 1980b) and seemed important to bears during summer. Perhaps, as for grizzly bears in Yellowstone National Park, feeding activity by black bears in timber was restricted primarily to their foraging on ants.

Black bears preferred selection cuts and timber for bedding. Mysterud (in press) described 4 sets of factors involved in the evolution of the bedding system of European brown bears (U.a. arctos) 2 of which are exposure and concealment. He noted that thermoregulatory factors were important in the selection of day bed sites during summer (i.e. all were low temperature sites). Lloyd (1979) reported a 59.4% average canopy closure for grizzly day beds in British Columbia and that 16 day beds had greater than 80% canopy cover, suggesting that thermal cover was important in the selection of day bed sites. Black bears at Priest Lake preferred timbered areas with sparse understory vegetation as sites for day beds. Skoulin (1982) reported that dense forests with limited understory provided bedding elk (Cervus elaphus) with shade and visibility, yet permitted cooling air action near the ground. Even in shrub-dominated selection cuts, bears usually selected a group of mature trees with a sparse understory for bedding.

Mysterud (in press) noted the importance of cover in the evolution of the bedding system for European brown bears, and defined cover as a combination of both vegetative and topographic features. Tree cover appeared to be the common denominator in day bed selection of Priest Lake black bears; nearly all bear beds were at the base of a tree or in close proximity to trees. Knight et al. (1978) reported that timber cover was an important component of most sites used by grizzly bears for day beds.

Timber and selection cut shrubfields apparently satisfied the requirements of day bed site selection by black bears at Priest Lake; 91% of all daybeds were located in these 2 habitat components. The selection cut habitat component probably received intensive bedding use simply because bears used this habitat component extensively for feeding, and found suitable bed sites within the same habitat component.

Selection cuts received the most use by black bears for traveling. I attribute this to: 1) the high levels of use of selection cuts for feeding and bedding was reflected in high levels of use for traveling, e.g. bears often traveled from feeding to bedding sites that were in the same component; and 2) the preponderance of old logging roads and skid roads served as efficient travel routes through selection cuts that were normally choked with brush. Zager (1980) suggested that the high level of road use by coastal grizzly bears in British Columbia (Smith 1978), compared with road use of grizzly bears in northwestern Montana may have been the result of the more dense vegetation along the coast and, thus, greater difficulty in traveling off the roads. Smith (1978) found that bears used old logging roads as travel routes in an area where logging had ceased 8 years earlier.

Black bear denning ecology has been well documented (Erickson et al. 1964, Poelker and Hartwell 1972, Lindzey and Meslow 1976, Hamilton and Marchington 1977, Pelton et al. 1977, Beecham et al. (in press). These studies indicate that black bears can use a wide variety of denning habitats. At Priest Lake, black bears used 5 different habitat components for denning. This suggests that Priest Lake black bears are quite general in their selection patterns for den sites in respect to habitat components. The open timbered and scree/talus/rock habitat components were selected against by black bears for all activities except denning. Both of these habitat components were most common at the mid to high elevations (elevations commonly used by denning black bears at Priest Lake), and provided an abundance of rock cavities. Sixty percent of all den cavities (N=12) at Priest Lake were in rock dens. Beecham (1980) could not ascertain any particular type of preference for denning areas by black bears at Council, Idaho. I surmise that the same situation exists at Priest Lake in respect to habitat components and I conclude, furthermore, that denning habitat is not a limiting factor for the black bear population at Priest Lake.

Habitat type selection stratified by season

The high use and selection of the Hemlock/Pachistima h.t. year-long by black bears was due, I conclude, to several factors. First, because this habitat type was broadly defined in terms of subordinate vegetation, it was widely distributed (64.5%) over the study area and encompassed a wide elevational range (about 740 m to over 1500 m). As a result, the Hemlock/Pachistima h.t. provided a wide variety of seasonally important bear foods. For example, pinegrass was a common understory constituent in the Hemlock/Pachistima h.t. at the lower elevations, providing forage for bears during spring. A variety of fruit-bearing shrubs, with huckleberry being most important, dominated the understory of the Hemlock/Pachistima h.t. at mid-elevations, and provided bears with an abundance of berries through mid-summer. At higher elevations, the Hemlock/Pachistima h.t. was dominated by an understory of huckleberry and beargrass which provided bears with huckleberries into late summer. Finally, mountain ash was abundant in the Hemlock/Pachistima h.t. at the mid-to-high elevations, and bears concentrated their activities there until they denned for the winter. Although the Hemlock/Pachistima h.t. was widely distributed, it predominated at the middle elevations. This coincides roughly with the elevations most heavily logged in the past, mainly through selection logging methods. Therefore, high use of the Hemlock/Pachistima h.t. may merely be a reflection of high use of the selection cut habitat component by bears.

The Grand fir/Pachistima h.t. was selected against by bears during spring, summer, and fall. The Grand fir/Pachistima h.t. occupies the lower, more xeric portions of the Cedar-Hemlock zone, thus, fruit producing shrubs were probably less abundant and less productive, resulting in low bear use of this habitat type.

The Subalpine fir/Menziesia h.t. was avoided during summer, the period in which bears feed primarily on huckleberries. Although huckleberry plants were common in the understory of the Subalpine fir/Pachistima h.t., huckleberry production seemed to be low, probably as a result of intense competition with the dense layer of menziesia common in this habitat type. Poor huckleberry production probably precluded use of this habitat type by black bears during summer.

In comparison, the Subalpine fir/Beargrass h.t. was preferred by black bears during summer. Huckleberry and beargrass dominated the subordinate vegetation in this habitat type, and huckleberry production seemed to be high. Apparently, the availability of huckleberries in this habitat type resulted in its high use by black bears during summer, although other factors may also have been responsible.

Elevational movements of black bears in relation to the phenological development of key bear food plants

In 1981, upon emergence from their dens, bears moved to the low to mid-elevations where succulent forbs and graminoids were abundant. Bears followed the advance of emerging, succulent forbs and graminoids upward until by late June their activities were concentrated at the mid-to-high elevations. In early July, bears moved to the low elevations in response to the ripening of huckleberries there. Bears followed the ripening of huckleberries to the high elevations, concentrating their activities there until mid-September when huckleberries were no longer available.

Male and female black bears deviated in their elevational-use patterns during fall. After the huckleberries began to drop for the season at the high elevations, instrumented females generally moved to the mid-elevations, where they fed primarily on mountain ash and bearberry. Female bears remained at the middle elevations until they denned for the winter. In contrast, instrumented males crossed from the west side of the Selkirk Divide to the east side. Males were apparently capitalizing on huckleberries that were still persisting on the eastern slopes of the Selkirk Divide. Although phenology was not measured on the east side of the Selkirk Divide, huckleberries seemed to linger at least 2 weeks longer than on the west side. Instrumented males returned to the west side of the Divide to den. One exception, however, occurred in 1981 when U-528 remained on the east side to den for the winter.

A strong correlation between the elevations of bear locations, and the phenological development of key bear food plants, suggest that bear movements are in response to temporal distribution of food. This result may be biased, however, because some subjectivity was inherent in the procedures for determining the elevations at which key bear food plants were "ripe". I feel that the relationship between elevational movements of black bears at Priest Lake and food availability was real, in spite of this possible bias. Strong correlations between bear movements and food availability have been reported by Amstrup and Beecham (1976), Rogers (1976), Reynolds and Beecham (1977), Kellyhouse (1980), and Novick and Stewart (1982).

During spring, bears concentrated their activities at elevations in which herbaceous vegetation was young and succulent (phenological stage 1). Mealey (1977) and Sizemore (1980) reported that the digestibility of herbaceous plants was highest in pre-flowering plants, as compared with post-flowering plants. The nutritional value of herbaceous plant material declines as the plants mature (Mealey 1977, Lloyd 1979, Sizemore 1980).

Bears concentrated their activities during summer at elevations in which the huckleberry was ripe. Sizemore (1980) reported that Vaccinium globulare had the highest nutritional availability index of any of the plants sampled on his study area in northwestern Montana. Bears at Priest Lake apparently relied on the high nutritional availability of huckleberry to gain needed weight for winter dormancy. Sizemore (1980) reported a much lower nutritional availability index for mountain ash (1.68) than for huckleberry (2.24). At the onset of fall, diurnal activity abruptly declined (personal observation), and continued to decline until bears denned for the winter.

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

Seral plant communities that provide food mainly from fruit producing shrubs are critical to black bears in northern Idaho. Effective fire suppression over the last 50 years has greatly impacted bear habitat by allowing seral plant communities to progress to mature forest.

Logging practices may simulate the conditions of wildfire to some extent, depending on the harvest methods and post-logging treatments employed (Zager 1980). Selection cuts at Priest Lake appear to simulate wildfire, at least in its influence on black bear habitat. Most selection cuts were found to be between 20 and 40 years old, and had received little if any post-logging treatment (some were broadcast burned). As a result, bear foods in the form of fruit-producing shrubs were extremely abundant. Because of the age of these selection cuts, fruit producing shrubs were very productive, and the height of the shrub canopy provided adequate cover. As a result, black bears at Priest Lake used selection cuts extensively during spring, summer, and fall for all activities.

In contrast, clearcuts were selected against by bears during spring, summer, and fall. Most clearcuts at Priest Lake were less than 20 years old, and most had been extensively scarified. Scarification destroys the rhizomes of vegetatively reproducing plants (Zager 1980). As a result, clearcuts offer little in the way of bear foods or cover.

Riparian zones were favored feeding sites for bears, especially during spring when their diet consisted primarily of succulent, herbaceous vegetation. Riparian zones in which the overstory had been opened, either by wildfire or logging, appeared to have a greater abundance of succulent herbs. Bears seemed to select for riparian zones with more open canopies.

Timber, the next most used habitat component after selection cuts, was used more by females than males. Timber was most important to bears as resting cover; although it may have served as escape and security cover. The protective behavior of female bears for their young may explain why timber was used more by females than by males.

Black bears selected the Hemlock/Pachistima h.t. during spring, summer, and fall. The Hemlock/Paschistima h.t. provided a wide variety of bear foods, especially key shrub food species. The Subalpine fir/ Beargrass h.t., selected during summer also, was dominated by huckleberry in the understory and, thus, provided bears with a source of food during late summer.

A strong correlation between mean elevations of bear locations and the phenological development of key bear food plants suggested that bear movements were in response to the specific seasonal and elevational availability of food.

Recommendations for fire and timber management in northern Idaho to maintain or enhance bear habitat are presented below. This list is based on Priest Lake data and studies used for comparison; it is not all-inclusive. Extrapolation to areas with dissimilar habitats is not advised.

1. Efforts should be made to maintain or enhance the production of black bear food species through let-burn fire management policies and prescribed burns where it is economically feasible in regard to timber resources (e.g., high elevation subalpine

fir stands, stagnating lodgepole pine stands, etc.).

2. Efforts should be made to maintain and improve the production of black bear foods on logged sites. Slash should be broadcast burned or not treated. Soil scarification should be kept to a minimum to prevent damage to vegetatively-reproducing bear food species.
3. Disturbances to black bears should be minimized by coordinating logging activities with the seasonal habitat use patterns of bears. For instance, logging activities near low elevation riparian zones should be restricted during early spring, just as high elevation shrubfields should be avoided in late summer.
4. Timber should be maintained in close proximity to potential or existing feeding areas. Timber was found important to bears as resting cover, especially when it was near feeding areas. Also, timber may serve as escape and security cover. This benefit may be retained by creating "leave patches" and "leave strips" within cutting units. Were feasible, clearcuts with irregular borders are recommended because they provide greater cover.
5. Logging activities should be coordinated to maintain an acceptable level or juxtaposition in different age cuts. The juxtaposition of different age cuts will influence the density and dispersion of bears in an area.
6. Efforts should be made to leave mature, standing trees in cutting units as safety cover for black bears, e.g., they afford safety to bears by tree climbing.

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APPENDIX

APPENDIX A

HABITAT COMPONENT DESCRIPTIONS

Timber

Tree canopy on timbered sites was composed of various combinations of Douglas-fir, western hemlock, western red-cedar, grand fir (Abies grandis), subalpine fir, Engelmann spruce (Picea engelmannii), ponderosa pine (Pinus ponderosa), lodgepole pine (Pinus contorta), and western larch (Larix occidentalis). Tree canopy closure averaged 85% and estimated tree density was 1138 trees/ha.

The understory species composition varied with topographic position, aspect, slope, and soils. The forb and shrub strata in relatively low and middle elevation forests were dominated by the pachistima (Pachistima myrsinites) union of Daubenmire and Daubenmire (1968). This union includes a series of moist-site plants such as queen cup beadlilly (Clintonia uniflora), pathfinder (Adenocaulon bicolor), false Solomon's seal (Smilacena spp.), fairy bells (Disporum spp.), twinflower (Linnaea borealis), lady fern (Atherium filix-femina), and huckleberry (Vaccinium globulare).

The ninebark (Physocarpus malvaceus) union (Daubenmire and Daubenmire 1968) was dominant on more xeric sites at the lower elevations. This union included understory plants such as ninebark, rose (Rosa spp.), ocean spray (Holodiscus discolor), Oregon grape (Berberis repens), and pinegrass (Calamegrostis rubescens).

At higher elevations, where subalpine fir becomes more important, understory composition varied substantially with site conditions. South aspects often had a relatively open canopy with beargrass (Xerophyllum tenax) and huckleberry dominating the understory. Serviceberry (Amelanchier alnifolia) and spirea (Spiraea betulifolia) were also common on these sites. The understory on north aspects may be dominated by a nearly impenetrable menziesia (Menziesia ferrugenia), rhododendron (Rhododendron albiflorum), and huckleberry shrub stratum. The herbaceous layer was often depauperate on these sites.

Open timber

Open timber was most often associated with subalpine fir stands at higher elevations. Although understory species composition was often similar on open canopy sites and comparable closed canopy sites, the understory was generally much more developed and vigorous on open canopy sites. This resulted from the additional light that was able to penetrate the often suppressed understory of closed canopy sites. South aspects were usually dominated by an understory composed of huckleberry and beargrass. The understory on north aspects was dominated primarily by a nearly impenetrable menziesia, rhododendron, and huckleberry shrub stratum. Huckleberry and mountain ash (Sorbus spp.) productivity was often greater on these sites than in closed canopy timber (Martin 1979, Zager 1980). Estimated tree density was 375 trees/ha and canopy closure averaged 43%.

Selection cut

Selection cutting was the dominant timber harvesting method before the 1960's. Shrubfields were generally found where this regeneration system was employed. Scarification was generally light to moderate on these sites and slash was not treated. The species composition of the shrub stratum is similar to that on undisturbed sites. However, the shrub layer was substantially more vigorous on these harvested sites. Opening the canopy stimulated the growth and production of the shrub layer, resulting in a thick tangle of understory vegetation. Huckleberry was very productive on these sites, as were mountain ash and serviceberry, where they occur. Shrub response to the reduced competition and increased light is often noticeable within 5 years after timber harvest.

The forbs and graminoids also respond positively to the increased light at the forest floor. The opportunistic species become locally abundant along skid roads and other severely disturbed areas on the site, but rarely do they dominate these sites.

Canopy closure averaged 42% on sites that had been selectively logged and estimated tree density was 543 trees/ha. Small patches of both timber and open timber were often interspersed throughout this habitat component, but were treated as inclusions within the selection cut shrubfield habitat component.

Clearcuts

Since the 1960's, clearcutting has been the most common timber harvesting method employed in the Selkirk mountains. Slash was burned in most cases and some clearcuts were scarified extensively to enhance regeneration. The shrub strata on these sites was a diverse mixture of species characteristic of the undisturbed forest, and opportunistic species characteristic of disturbed sites. Although huckleberry, rhododendron, and menziesia often dominated undisturbed stands, they were less abundant and vigorous following timber harvest and scarification. Prickly currant (Ribes lacustre), elderberry (Sambucus racemosa), and red raspberry (Rubus idaeus) were more common in cutting units than in adjacent undisturbed timber. A similar pattern was seen among the forbs and graminoids. Horsetails (Equisetum spp.), fireweed (Epilobium angustifolium), pearly everlasting (Anaphalis margaritacea), and the graminoids were often abundant in scarified cutting units, but occurred infrequently in undisturbed stands.

Slabrock

Slabrock was characteristically a naturally open site with exposed, fractured bedrock on moderate to steep slopes at mid-to-high elevations. These sites were dry as a result of topo-edaphic factors. Trees were often entirely absent. Huckleberry, mountain ash, menziesia, rhododendron, pachistima, and beargrass were common understory components. Chokecherry (Prunus emarginata), prickly currant, and Utah honeysuckle (Lonicera utahensis) were locally common. Alder (Alnus sinuata) and forbs such as false hellebore (Veratum viride), angelica (Angelica arguta), arrowleaf grounsel (Senecio trangularis), and licorice root (Liqusticum canbyi) and (L. verticillatum) occurred along creeks that flowed through the habitat component. Graminoids, glacier lilly (Erythronium grandiflorum), spring beauty (Claytonia lanceolata), biscuit root (Lomatium spp.), and beargrass were frequent members of the herbaceous stratum. Mean canopy closure was 7% and estimated tree density was 156 trees/ha.

Open shrubfields

Open shrubfields were open sites found mostly at high elevations that were usually created and/or maintained by wildfire. South aspects were dominated by an understory stratum composed of beargrass and huckleberry. The north aspects were dominated by menziesia, rhododendron, and huckleberry shrub stratum. Mountain ash was locally common on both north and south aspects. Streams provided moist site taxa such as false hellebore, cow parsnip (Heracleum lanatum), angelica, arrowleaf groundsel, and the graminoids.

Timbered shrubfields

Timbered shrubfields were the same as open timbered shrubfields except for sparse timber on these sites. Tree canopy closure on timbered burn shrubfields averaged 14% and the number of trees/ha was 250.

Sidehill parks

Sidehill parks were seasonally moist sites that remained relatively dry for the major portion of the growing season. They were naturally open graminoid and forb-dominated, topo-edaphic climax communities found on shallow soils on the driest aspects. Exposed bedrock was common on these sites. Dry-site plants characteristic of sidehill parks included biscuit root, glacier lilly, yaro (*Achillea millefollium*), penstemon (*Penstemon* spp.) and the graminoids. Mountain juniper (*Juniperus communis*), ocean spray, ninebark, bearberry (*Arctostaphylos uva-ursi*), spirea, and Oregon grape were among the shrub taxa found scattered on these sites.

Timbered Parks

The sidehill park/timber habitat component was a mosaic resulting from the interspersion of sidehill parks and timber. The understory composition of these sites was similar to that described for both the sidehill park and timbered habitat components at low to mid elevations on the dryer aspects.

Riparian areas

Riparian areas were often considered as inclusions in other habitat components because of the difficulty in delineating this component from aerial photographs. Streams on the study area were generally fast moving because of the steep topography. As a result, riparian habitats were usually poorly developed. Angelica, twisted-stalk (*Streptopus amplexifolius*), licorice root, fairy-bell (*Disporum* spp.), and horsetails were common forbs. Graminoids and sedges (*Carex* spp) were also common in this component. The shrub strata in riparian habitats was dominated by alder, menziesia, rhododendron, and huckleberry.

Scree/talus/rock

The scree/talus/rock habitat component included steep, unstable, rock-covered slopes that lacked soil development. Vegetative cover was very sparse on such sites.

Roads

Roads were disturbed, open areas that had been cleared and/or graded to permit vehicular traffic (Zager et al, 1980). Herbaceous vegetation commonly found on these sites included clover (*Trifolium* spp.), pearly-everlasting, strawberry (*Fragaria vesca*), golden rod (*Solidago* spp.), and the graminoids. Horsetails and sedges were common on the more mesic sites. Alder, chokecherry (*Prunus emarginata*), ninebark, ocean spray, snowbrush (*Ceanothus velutinus*), and bearberry were common shrub taxa found in roads.

Snowchute shrubfields

Shrub-dominated snowchutes were created and/or maintained by periodic sudden snow movements on concave sites in steep terrain. These sites were often dominated by a nearly complete cover of alder at Priest Lake. Mountain ash was an important component of some snowchutes; western yew (*Taxus brevifolia*), huckleberry, menziesia, and rhododendron were also locally abundant. The herbaceous layer was often sparse, limited to a few forbs and graminoids. However, cow parsnip, false hellebore, licorice root, sweet cicely (*Osmorhiza* spp.), angelica and others were often locally abundant in canopy openings on these sites.

Wet meadows

Wet meadows were perenially moist, naturally open sites with flat topography. These meadows occurred in basins at the heads of many drainages in the area. Heavy snow accumulations characterized these sites. Therefore, the meadows did not become snowfree until early summer, thereby delaying greenup. Furthermore, snowmelt from the basin headwalls function to keep these sites moist throughout the summer and fall. This habitat component was often intermixed with timber, therefore it was often mapped as an inclusion in a forested component. Sedges, arrowleaf groundsel, false hellebore, licorice root, and burnet (*Sanquisorba sitchensis*) dominated these sites.

Adopted from habitat component descriptions at Priest Lake by Zager (1981).

APPENDIX B

FREQUENCY OF OCCURRENCE AND COVER VALUES FOR 5 KEY BEAR FOOD PLANTS AND ALL FORBS AND SHRUBS FOUND ON SAMPLE PLOTS FOR RESPECTIVE HABITAT COMPONENTS.

Frequency of occurrence and cover values for the 5 key bear food plants and all forbs and shrubs found on sample plots at Priest Lake.

Habitat component	Forbs freq[1]	Forbs cover[2]	Graminoids freq	Graminoids cover	Huckleberrry freq	Huckleberrry cover	Serviceberry freq	Serviceberry cover	Mt. ash freq	Mt. ash cover	Bearberry freq	Bearberry cover	Total shrubs freq	Total shrubs cover
Timber	67	2	67	1.5	100	2	67	1	0	0	0	0	100	4
Open timber	75	1	25	1	100	2	0	0	75	1	0	0	100	4.5
Select-cut	92	2	50	1.5	91	2	50	1	50	1	8	1	100	4
Clearcut	67	2.5	50	2	100	1	67	1	33	1	0	0	67	3
Slabrock	78	1	56	2	100	2	33	1	67	1	0	0	100	3
Open shrub	67	1.5	0	0	100	2.5	0	0	50	T	0	0	100	2.5
Timb shrub	50	T+	0	0	100	3	0	0	75	2	0	0	100	5
Park	100	2	100	3	17	T	20	1	0	0	100	1	100	2
Timb park	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riparian	100	3	91	2	91	1	0	0	18	1.5	0	0	100	3
Scree	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Road	100	2	100	2	92	T	0	0	0	0	0	0	100	2
Wet Meadow	100	3	100	5	50	T	0	0	0	0	0	0	100	2
Av. Chute	100	3	100	2	100	2.5	0	0	100	2.5	0	0	100	3.5

1. Percent frequency of occurrence
2. Median coverage class value for plots in which the plant group or individual plant species was present.

APPENDIX C

PERCENT AVAILABILITY OF HABITAT COMPONENTS WITHIN COMPOSITE HOME RANGES OF MALE AND FEMALE BLACK BEARS, RESPECTIVELY, AT PRIEST LAKE.

Percent availabiltiy of habitat components within the composite home ranges of male and female black bears at Priest Lake.

Habitat component	Percent availability males	females
Timber	26.3	30.7
Open timber	11.6	7.4
Selection cut	41.9	39.4
Clearcut	4.6	7.3
Slabrock	0.0	2.2
Open shrubfield	0.2	0.6
Timbered shrubfield	3.3	2.2
Sidehill park	0.0	0.6
Timbered park	1.2	1.0
Riparian zone	0.3	0.3
Scree/talus/rock	2.7	2.1
Road	7.8	6.2
Wet meadow	0.0	0.1
Avalanche chute	0.0	0.0

APPENDIX D

VERTICAL COVER ESTIMATES ON SAMPLE PLOTS IN THE SELECTION-CUT AND CLEARCUT HABITAT COMPONENTS.

Vertical cover estimates on sample plots in the selection-cut and clearcut habitat components.

Selection-cuts			
Strata			
0-2'	2-7'	7-25'	25'
5	3	3	1
5	5	3	2
5	5	3	T
5	4	4	2
5	3	4	4
4	4	4	3
5	3	3	1
5	3	2	T
5	2	3	1
5	4	3	1
5	5	4	1

Clearcuts			
Strata			
0-2'	2-7'	7-25'	25'
5	4	T	0
5	4	2	0
5	2	0	0
5	2	0	0
5	2	1	0
5	3	T	0

Strata codes:
- T = Trace
- 1 = 1-5%
- 2 = 5-25%
- 3 = 25-50%
- 4 = 50-75%
- 5 = 75-100%

APPENDIX E

MEAN AND ± SD OF ELEVATIONS AT WHICH RADIO-COLLARED BLACK BEARS WERE LOCATED IN 1981. ELEVATIONS ARE IN METERS.

Mean and ± SD of elevations at which radio-collared black bears were located in 1981. Elevations are in meters.

Month	Mean elevation	Standard deviation
April	1057.7	130.5
May	1122.1	190.8
June	1286.1	173.6
July	1113.4	178.3
August	1274.3	129.6
September	1451.0	205.9
October	1345.4	234.4