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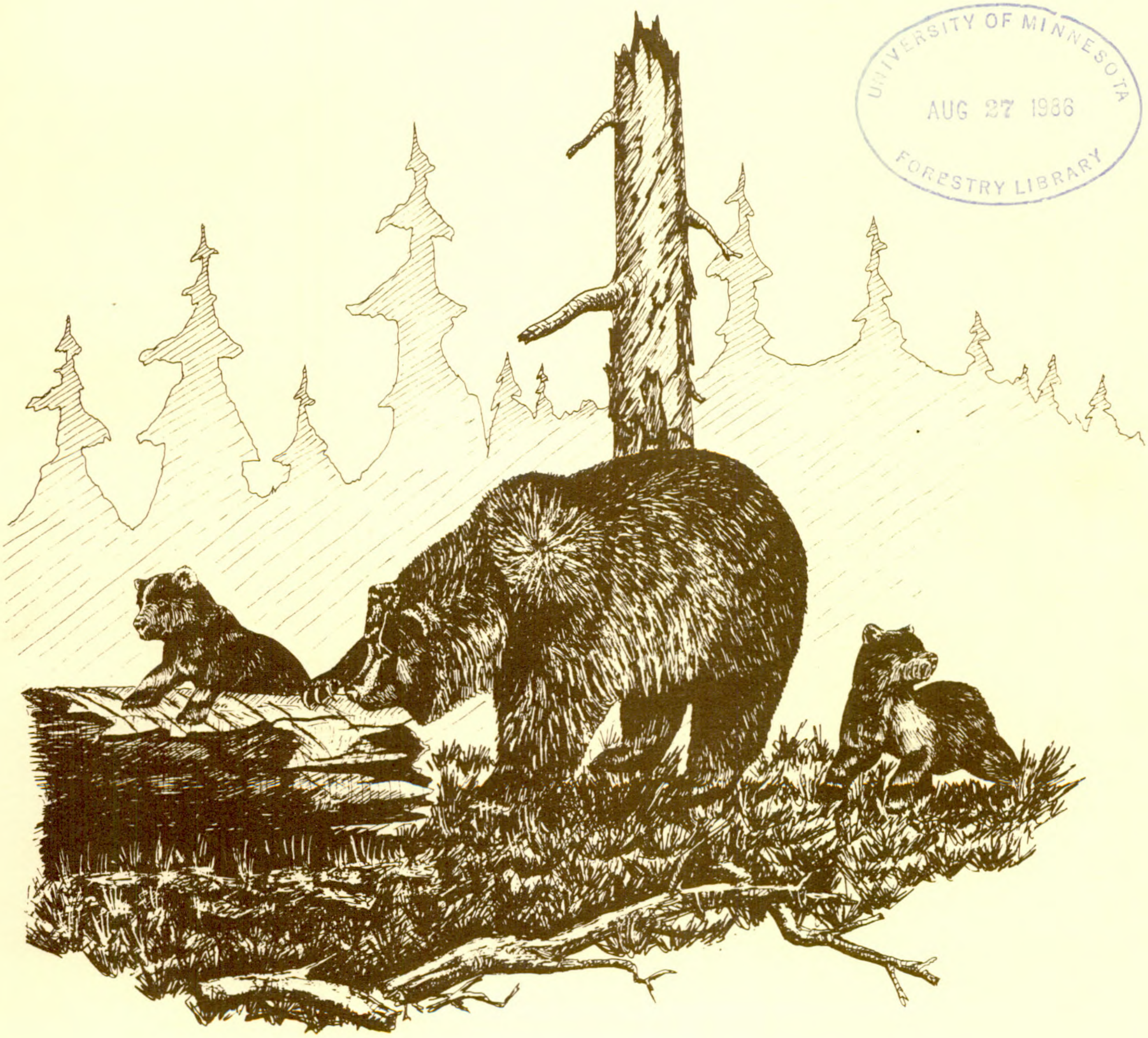

GRIZZLY BEAR FOOD RESOURCES IN THE FLOOD PLAINS AND AVALANCHE CHUTES OF THE BOB MARSHALL WILDERNESS, MONTANA

Richard D. Mace and Gael N. Bissell

ABSTRACT: The vegetative composition of avalanche chutes and flood plains was investigated in the Bob Marshall Wilderness. Within these two components, 14 distinct vegetation types (VT) were identified, described, and ranked according to forage value. For herbaceous food items, the riparian Picea flood plain VT and the Alnus spp. avalanche chute VT ranked highest in forage value. For fruit items, the terrestrial Picea (flood plain) and xeric herbaceous fan (avalanche) VT's ranked highest. The sand bar (flood plain) and xeric (avalanche) VT's ranked highest for modified stems.

INTRODUCTION

Flood plains and avalanche chutes comprise two major grizzly bear foraging habitat components in the Northern Continental Divide Ecosystem (Mealey and others 1977; Zager 1980). Results of grizzly bear research in the northern Rocky Mountains have shown grizzly bears utilize these two components of habitat throughout the spring, summer, and autumn (Singer 1978; McLellan 1982).

The vegetative structure and composition of both flood plains and avalanche chutes are exceedingly complex due to the interactions and gradients of moisture, elevation, aspect, slope, soils, and succession. The complexity of these two components confounds predictions of foraging habitat quality. Because such predictions are important to grizzly bear management, we investigated in detail the vegetative structure and composition of flood plain and avalanche chute complexes. This project was part of an effort to evaluate grizzly bear habitat in the Bob Marshall Wilderness (Mace 1984 and this volume). The specific objectives of this project were (1) to describe in detail the vegetative composition of the major vegetation types within flood plains and avalanche chute components in the southern Bob Marshall Wilderness; (2) to evaluate the grizzly bear food resource within each vegetation type for three foraging strategies; and (3) to rank vegetation types according to their greatest forage value to the grizzly bear. The results and discussion of the flood plain and avalanche chute components are provided separately.

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STUDY AREA DESCRIPTION

The study area is located in the southern portion of the Bob Marshall Wilderness and comprises 40 400 ha (fig. 1). The region is dominated by rugged mountain topography and dissected by numerous streams and one major river system, the South Fork of the Flathead River. The principal drainages include Gordon, Babcock, and Youngs Creeks, which flow westerly into the South Fork.

The vegetation of the region is strongly influenced by the Pacific maritime climate (Daubenmire 1969). As major Pacific air masses move through the region, much of the precipitation (rain and snow) is deposited on or near the Swan Mountain range (west boundary of the study area); however, in the southern Bob Marshall, some of this precipitation is lost to the Mission Mountain range. As a result, the southern Bob Marshall appears drier than northern portions. The distribution of avalanche chutes is also associated with moisture deposition patterns; most avalanche chutes in the study area are located close to the Swan Divide. The primary forest habitat types (h.t.) of the study area are within the spruce (Picea spp.), Douglas-fir (Pseudotsuga menziesii), and subalpine fir (Abies lasiocarpa) series (Pfister and others 1977). Stands of subalpine larch (Larix lyallii) are found above 2 000 m.

METHODS

Field Procedures

Field work was conducted from June through September of 1982 and 1983. Following reconnaisance efforts, major vegetation types of the flood plains and avalanche tracts were delineated based on dominant plant species and vegetation structural characteristics. Vegetation types were subdivisions of the total habitat component flora and were distinguished by obvious spatial arrangements, physiognomic characteristics, and the existing composition of the vegetation.

Following this stratification, plots were placed randomly within each of these vegetation types.

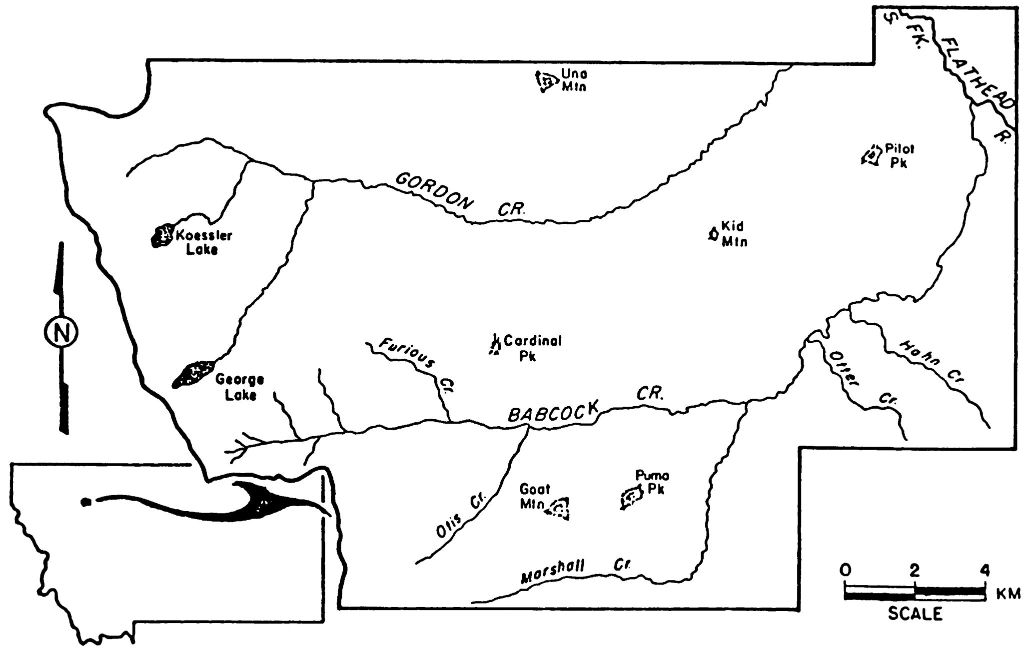

Figure 1.--The study area.

Flood plains were sampled using 375-m^2 (or 1/10-acre) circular plots; avalanche tracts were sampled using 5-m^2 circular plots. The larger plots were selected for the flood plain because this component included timbered vegetation types.

The number of plots taken in each vegetation type was determined by constructing a species-area-curve (Mueller-Dumbois and Ellenberg 1974). Sampling was completed when no new taxa were encountered after three consecutive plots were taken. Complete taxa lists were compiled, although grasses and sedges were combined. Cover values for taxa, nonvascular material, and unvegetated portions were ocularly estimated using the modified Daubenmire cover classes of Pfister and others (1977): 0=absent; T=trace-1 percent; A=1-5 percent; B=5-25 percent; C=25-50 percent; D=50-75 percent; E=75-95 percent; F=95-100 percent. For all plots, tree, shrub, and herbaceous cover per stratum (0-0.9 m; 0.9-2 m; >2 m) were recorded.

Botanical nomenclature followed Hitchcock and Cronquist (1973). Timbered sites were keyed to the appropriate forest habitat type of Pfister and others (1977).

Analytical Procedures

Plant specimens were verified by Peter Stickney (Intermountain Research Station, Missoula, MT). Vegetation data were then assembled into association tables to scrutinize relationships among plots (Mueller-Dombois and Ellenberg 1974). Plot data were entered into a DEC-20 computer to calculate species percent occurrence and average and relative percent covers. Using SP55 programs (Nie and others 1975).

Average percent cover was derived by summing the cover class midpoints for each species and then dividing the summation by total number of plots in the vegetation type. This value was then converted to relative percent cover by converting the total vegetative and nonvegetative covers to 100 percent. The percent occurrence values were also determined for each taxa.

A list of major food plants in the study area was collated using recent literature on grizzly bear food habits from the Northern Rocky Mountains of the United States and southern British Columbia, Canada (Russell and others 1979; Aune and Stivers 1982; Craighead and others 1982; Sumner and Craighead 1973; Mace and Jonkel in press). Food items were placed into one of three major food categories; succulent vegetation, modified stems (roots, bulbs, or corms), or fruit. Each food item was given a seasonal preference rank of 1, 2, or 3, with 3 as high level of use and 1 as low, based on levels of use indicated in the aforementioned studies (table 1).

To quantitatively compare the overall foraging value of the major vegetation types with one another (within both flood plain and avalanche chute components), importance values were calculated using the absolute percent cover of certain bear food items and the preference ranks. First, a "food item importance value" was obtained for each sample plot by multiplying the midpoint of the coverage class for each food item times the food item preference rank. Second, a "vegetation type importance value" was obtained by summing the food item importance values for each plot and then dividing by the total number of plots to obtain the average vegetation type importance value.

Table 1.--Grizzly bear food items and preference ranks used in determining vegetation type importance values

Species	Preference value: Herbaceous	Modified stems	Fruit
FORBS:			
Achillea millefolium	1	2	
Allium cernuum		2	
Allium schoenprasum		2	
Allium spp.			
Angelica arguta	3		
Aster conspicuus	1		
Aster foliaceus	1		
Aster occidentalis	1		
Aster spp.	1	2	
Astragalus alpinus		2	
Astragalus bourgovii		2	
Astragalus robbinsii		2	
Astragalus spp.			
Castilleja spp.	1		
Cirsium spp.	2	3	
Claytonia lanceolata			
Equisetum arvense	3		
Equisetum spp.	3	3	
Erythronium grandiflorum			
Fragaria virginiana	3		
Hedysarum occidentale		2	
Heracleum lanatum	3		
Ligusticum canbyi	2		
Ligusticum spp.	2	1	
Lomatium dissectum		3	
Lomatium cous		3	
Lomatium macrophyllum		3	
Lomatium sandbergii		3	
Lomatium spp.			
Osmorhiza chilensis	3		
Osmorhiza purpurea	3		
Osmorhiza occidentalis	3		
Osmorhiza spp.	3	3	
Oxytropis campestris		2	
Polygomum bistortoides			
Senecio triangularis	2		
Trifolium spp.	3		
Taraxacum spp.	3		
Valeriana sitchensis	2		
Valeriana occidentalis	2		
Veratrum viride	2		
SHRUBS:			
Amelanchier alnifolia			3
Arctostaphylos uva-ursi			2
Cornus stolonifera			2
Prunus virginiana			2
Rhamnus alnifolia			2
Ribes lacustre			1
Ribes viscosissimum			1
Ribes inerme			1
Ribes hudsonianum			1
Ribes spp.			1
Rosa acicularis			1
Rosa woodsii			1
Rosa spp.			1
Rubus idaeus			1
Rubus spp.			1
Shepherdia canadensis			3
Sorbus scopulina			3
Vaccinium scoparium			2
Vaccinium caespitosum			2
Vaccinium globulare			3

Analyses were accomplished for three foraging categories: herbaceous, modified stems, and fruits. Vegetation type importance values were then ranked on an ordinal scale for each foraging strategy. To compare the similarity between vegetation types sampled from different avalanche tracts, coefficients of percent species similarity (Jaccard 1912) were calculated. These similarity coefficients were calculated excluding ephemeral taxa because not all areas were sampled at the same time of year nor within the same year. These coefficients were also calculated using only grizzly bear foods. Genera and species of a given genera were considered different taxa in these analyses. The following formula was used for percent taxa similarity:

$$= \frac{\text{Number of taxa common to both locations (A and B)}}{\text{Number of taxa unique to location A + number of taxa unique to B + number of taxa common to both locations}}$$

RESULTS

Description of Flood Plain Vegetation Types

To comply with other classification systems for valley bottom lands, the flood plains of the study area were divided into two distinct zones (U.S. Department of Agriculture 1978; Pfister and Batchelor 1984). The riparian zone was adjacent to the river channel and susceptible to annual and periodic inundation. The terrestrial zone was that area of terraced valley floor not subjected to flood waters. The terrestrial zone corresponded to relatively flat benches on older alluvium above the riparian zone. Vegetation composition in both zones reflected water table depth, frequency of flood and natural fires, subtle gradients of elevation and temperature, and soil type and depositional pattern. Illustrations of several flood plain vegetation types are presented in figures 2 to 4.

Riparian Zone.--Six vegetation types were identified for the riparian zone of major flood plains. These types represented distinctive seres in the successional pattern on the zone. Each vegetation type was further stratified by its apparent position in the successional process: pioneer, early successional, midsuccessional, late successional, and climax (stable) in convention with Allen (1980).

1. Gravel Bar VT: The gravel bar VT represented the earliest pioneer sere and occupied that portion of the riparian zone directly adjacent to the water channel. Therefore, this vegetation type was inundated during annual spring runoff. Fluvial-deposited pebbles, gravels (approximately 8 inches), and silts supported 30 taxa. Gravel and silt constituted 86 percent of the cover. Dominant taxa were willow (*Salix* spp.), common willow-weed (*Epilobium glandulosum*), clover (*Trifolium* spp.), and purple milk-vetch (*Astragalus alpinus*) (table 2).

Table 2.--Relative percent cover and occurrence (percent cover/percent occurrence) of dominant taxa within eight flood plain vegetation types

Taxa	Gravel bar	Sand bar	*Salix* flat	Mesic herbaceous meadow	Riparian *Picea*	*P. tricho-carpa*	Terrestrial spruce	Xeric gram-inoid meadow
FORBS:								
Trifolium spp.	[1]t/44	2/15			4/41			
Epilobium latifolium	5/70							
Senecio pseudaureus		1/85	3/62					
Achillia millefolium		1/100				1/100		
Lupinus spp.		2/54					t/44	
Oxytropis campestris		2/46						
Equisetum spp.			5/46	1/77	2/59	t/25		
Heracleum lanatum		t/7	5/73	2/62	1/63			
Fragaria virginiana		1/65	3/85	6/82		3/75		
Thalictrum occidentale				17/85	11/63			
Smilacena stellata				1/92				
Angelica arguta				1/92	t/56	t/25		
Galium triflorum					3/74			
Epilobium spp.						4/75		
Taraxacum spp.						2/25		
Astragalus miser						1/75		
Epilobium angustifolium							1/65	
Erigeron spp.							1/65	
Eriogonum umbellatum								1/50
Geum triflorum								1/55
Penstemon spp.								3/85
Potentilla spp.								2/45
SHRUBS:								
Rosa spp.		3/62	1/77	8/100	2/81		t/4	
Arctostaphylos uva-ursi			2/31			30/50	29/91	
Salix spp.	2/37		42/85	t/23				
Ribes spp.			5/81	1/54	t/26	t/25		
Lonicera involucrata			4/85	2/77	2/74			
Linnaea borealis							t/13	
Cornus stolonifera				2/15	2/52	42/75		
Vaccinium caespitosum							41/91	
Artemisia tridentata								2/20
GRAMINEAE/CYPERACEAE	3/74	11/69	43/100	41/100	15/100	30/75	7/100	26/100
NONVASCULAR COVER	86/100	51/100	1/74	5/54	15/100	25/100	2/13	41/100

[1]t = < 0.5 percent cover.

Figure 2.--Panoramic view of the Youngs Creek flood plain showing the mesic riparian zone adjacent to the river channel and the upland terrestrial zone along the benches.

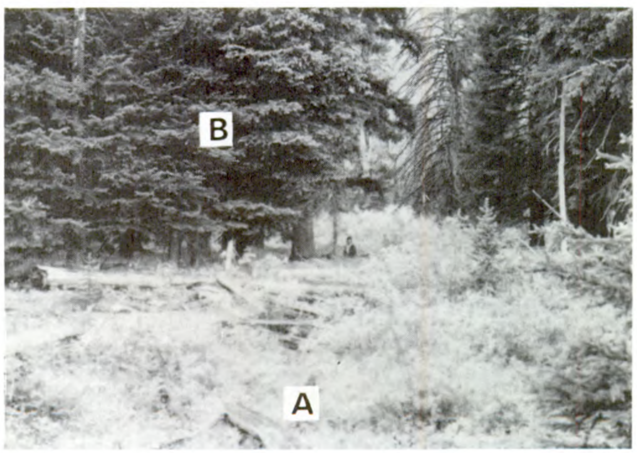

Figure 3.--Mesic herbaceous meadow (A) and riparian Picea (B) VT's within the riparian zone of the flood plain complex.

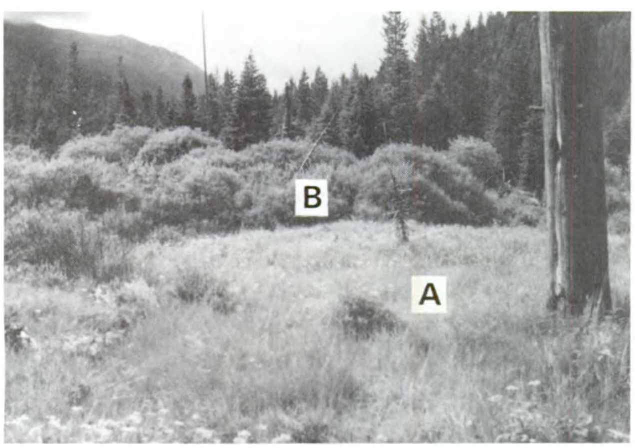

Figure 4.--Sandbar (A) and Salix spp. flat (B) VT's within the riparian zone of the flood plain complex.

Several "key" herbaceous foods occurred in this vegetation type but were of trace coverage (table 3) Foods present in this type of the modified stem category included purple milk-vetch, wild onion (Allium spp.), and slender crazyweed (Oxytropus campestris). Key fruit-bearing taxa were absent in the type.

2. Sand Bar VT. The sand bar VT occurred on fine-grained fluvial sand and silt deposits. This type, although also considered a pioneer sere, was more stable than gravel bars and would only be disrupted by catastrophic floods. Nonvascular cover was 51 percent. Dominant herbaceous taxa of this vegetation type included slender crazyweed, wormleaf stonecrop (Sedum stenopetalum), lupine (Lupinus spp.), and yellow buckwheat (Eriogonum flavum) (table 2).

Twelve key grizzly bear foods occurred in the vegetation type, all of which were of low cover and occurrence. Modified stems such as slender crazyweed, wild onion, and purple milk-vetch were the only conspicuous foods. Grass and sedge cover was 11 percent.

3. Salix spp. Flat VT. Shrubfields dominated by willow occupied mesic and hydric river oxbows, narrow margins and adjacent to river channels, and to a lesser extent mesic openings in spruce stands. Thirteen shrub taxa were found in this early successional vegetation type. Willow showed the greatest cover in all strata (42 percent). Black twin-berry (Lonicera involucrata) and currant (Ribes spp.) were considered codominant with willow in the lower stratum. The dominant herbs (table 2) were cow-parsnip (Heracleum lanatum), horsetail (Equisetum spp.), and streambank butterweed (Senecio pseudaureus). Several grizzly bear food plants exhibited relatively high cover values in willow flats: cow-parsnip, horsetail, and grasses/sedges (Gramineae/Cyperaceae) (table 3).

4. Mesic Herbaceous Meadow VT. Mesic meadows of the riparian zone were complex mosaics of openings and edges within and between spruce, willow, and lodgepole pine (Pinus contorta) vegetation. On certain sites, these meadows formed abrupt edges between two or more vegetation types, but on other sites formed a gradual continuum from the adjacent type. Apparently favorable combinations of light, moisture, and temperature led to a high diversity of plant taxa. Grasses (primarily bluejoint reedgrass [Calamagrostis canadensis]) and sedges had a combined cover of 41 percent. Western meadowrue (Thalictrum occidentale) was the dominant herbaceous species. Other dominant herbs were strawberry (Fragaria spp.), cow-parsnip, and mountain arnica (Arnica latifolia). Eighteen shrub taxa were recorded in this type, of which red-osier dogwood (Cornus stolonifera) and rose (Rosa spp.) exhibited the greatest cover values (table 2).

Eleven herbaceous food plants occurred in the mesic herbaceous meadow VT (table 3). Cow-parsnip, horsetail, and angelica (Angelica arguta) were key food items of relatively high

Table 3.--Relative percent cover and occurrence (percent cover/percent occurrence) of major bear food items in each vegetation type of the flood plain complex

Taxa	Gravel bar	Sand bar	*Salix* spp. flat	Mesic herbaceous meadow	*P. trichocarpa*	Riparian spruce	Terrestrial *Picea*	Xeric graminoid meadow
HERBACEOUS								
Heracleum lanatum		[1]t/7	5/73	2/62	t/25	1/63		
Angelica arguta			t/65	1/92	t/25	t/56		
Ligusticum canbyi			t/4					
Osmorhiza occidentalis			t/8	t/15				
Equisetum spp.	t/15		5/46	1/77	t/25	2/59		
Gramineae/Cyperaceae	3/74	11/69	43/100	41/100	30/75	15/100	7/100	20/100
MODIFIED STEMS								
Astragalus spp.	t/26	t/19	t/27	t/23	1/75	t/7	t/4	
Oxytropus spp.	t/4	2/40						
Allium spp.	t/4	t/54	t/15	1/31	t/50	t/15	t/13	t/5
Lomatium spp.		t/8						
FRUITS								
Amelanchier alnifolia			t/4	t/8			t/17	
Vaccinium caespitosum							41/91	
Rosa spp.	t/4	3/62	1/77	8/100	1/100	2/81	t/4	t/5
Ribes spp.		t/15	5/81	1/54	t/25	t/26		
Sheperdia canadensis			t/4	1/23	2/75	t/15	9/13	
Cornus stolonifera				2/15	42/75	2/52		

[1] t = < 0.5 percent cover.

cover and occurrence. Red-osier dogwood and species of rose (*Rosa* spp.) were dominant fruit-bearing taxa.

5. *Populus trichocarpa* VT. Small (<1.6 ha) stands of black cottonwood (*P. trichocarpa*) colonized fluvial sand and gravel deposits of the riparian zone. This midsuccessional type, which was sampled just south of Big Prairie, appeared to have been heavily grazed and trampled by domestic livestock. The overstory canopy was a relatively equal mixture of black cottonwood, Douglas-fir, and lodgepole pine. Clover, dandelion (*Taraxacum* spp.), strawberry, and Missouri goldenrod (*Solidago missouriensis*) were dominant herbs. Shrubs with the highest cover and occurrence values included red-osier dogwood, kinnikinnick (*Arctostaphylos uva-ursi*), and buffalo-berry (*Shepherdia canadensis*) (table 3).

6. Riparian *Picea* VT. Three habitat types of the spruce series (Pfister and others 1977) were combined because of similar vegetative qualities. Habitat types within this riparian *Picea* VT included spruce/sweet-scented bedstraw (*Galium triflorum*); spruce/queen's cup (*Clintonia uniflora*) with queen's cup absent, bunchberry (*Cornus canadensis*) present; and spruce/starry false Solomon's seal (*Smilacina stellata*). These habitat types existed as small pockets on poorly drained soils of channel oxbows, and have survived nearly two centuries of natural fire (average stand age of 179 years).

Seventy plant taxa were encountered in plots. Dominant taxa, although variable by habitat type, included western meadowrue, streambank butterweed, showy aster (*Aster conspicuous*), bunchberry (*Pyrola* spp.), and western twinflower (*Linnaea borealis*). Alder (*Alnus* spp.), black twin-berry, and red-osier dogwood were dominant shrubs (table 2). The cover and occurrence of bear food items is given in table 2.

Terrestrial Zone.--Flood plain benches displayed much less vegetation type diversity than the riparian zone. Two vegetation types were sampled in this zone.

1. Terrestrial *Picea* VT. Seral, well-drained phases of the spruce climax series existed as large, relatively homogeneous stands on flat benches above the riparian zone. All stands sampled were renewed following the wildfire of 1926 and corresponded to the spruce/dwarf huckleberry (*Vaccinium ceaspitosum*) h.t. Lodgepole pine was the dominant conifer in all strata. Spruce and Douglas-fir stems were present as regeneration in lower strata.

Thirty-five taxa were in sample plots. Dominant shrubs were dwarf huckleberry, kinnikinnick, and buffalo-berry. All herbaceous taxa displayed trace cover values; however, those with the greatest percent occurrence were fireweed lousewort (*Pedicularis* spp.), fleabane (*Erigeron* spp.), and lupine (table 2). Herbaceous and modified-stem bear food items were relatively rare in this type. Buffalo-berry and dwarf huckleberry were important fruit-bearing food items (table 2).

2. Xeric Graminoid Meadow VT. Dry meadows of the terrestrial zone were located on large alluvial fans or existed as small openings within the spruce/dwarf huckleberry h.t. This vegetation type exhibited a pronounced seasonal change, from a late spring/early summer flush to severe desiccation by August.

The xeric meadow VT corresponded to the rough fescue-Richardson's needlegrass (Festuca scabrella-Stipa richardsonii) community type of Johnson (1982) and the rough fescue-Idaho fescue (F. idahoensis) grassland h.t. of Mueggler and Stuart (1980). The big sagebrush (Artemisia tridentata) phase of the aforementioned community type was observed on the Hahn Creek alluvial fan.

Grasses and sedges showed a combined relative cover of 26 percent and occurred in all plots. Dominant herbaceous taxa were sulfur buckwheat (Eriogonum unbellatum), prairiesmoke avens (Geum triflorum), clover, and lupine. Nonvascular ground cover was 41 percent (table 2).

Ranking of Vegetation Type Importance Values by Forage Categories

Herbaceous Forage Category.--Calculations of vegetation type importance values (IV's) for the herbaceous foraging season yielded values from 1 to 54 for eight flood plain vegetation types (table 4). Riparian zone vegetation types generally ranked higher in succulent grizzly foods than did those of the terrestrial zone. The riparian Picea VT, a timbered sere, ranked highest of all flood plain types. Openings in the riparian spruce canopy, the mesic herbaceous meadow VT, ranked second. The terrestrial zone (flood plain bench) was negligible in succulent bear foods.

Plants whose underground parts are eaten by grizzly bears were found in all vegetation types, but were of low cover and occurrence. The sand bar VT ranked highest of all types due to the presence of milk-vetch and slender crazyweed. Interestingly, yellow hedysarum (Hedysarum sulphurescens), whose roots are extensively eaten in the North Fork of the Flathead River (Singer 1978; McLellan 1982), was observed only once in the flood plain component.

Fruit Forage Category.--The terrestrial Picea VT ranked highest of all flood plain types for fruit-bearing shrubs preferred by grizzly bears (table 4). Buffalo-berry and dwarf huckleberry were the primary foods in this type and were of lower cover elsewhere in the flood plain. Buffalo-berry appeared to produce the greatest number of berries in open-timbered stands growing on rocky alluvium. Conversely, dwarf huckleberry stems were more prevalent in highly stocked lodgepole stands and exhibited poor fruit production during the two years of field investigation. Interestingly, this terrestrial Picea VT ranked second of all vegetation types in the temperate, subalpine zones of the study area (Mace, this volume).

Mesic herbaceous meadows and the black cottonwood stands ranked second during the fruit forage season. Red-osier dogwood, buffalo-berry, and species of currant were primary foods in these vegetation types. The remaining five vegetation types of the flood plain complex ranked low for this season.

Avalanche Chutes

Seven avalanche chutes were sampled from various dominant aspects (table 5). Six major vegetation types were distinguished in avalanche chutes: (1) streamside; (2) Alnus spp. shrubfields; (3) Xerophyllum tenax; (4) xeric; (5) mesic herbaceous fan; and (6) xeric herbaceous fan. Several of these vegetation types are illustrated in figures 5 to 7.

Description of Vegetation Types

1. Streamside VT. The streamside VT occurred adjacent to the intermittent and continuously flowing streams of five sampled avalanche tracts. Marshall Creek (north-facing) and Otis Creek (south-facing) did not have streamside VT types. Plots in the streamside VT did not include dense alder shrubfields (described below), although they did include randomly encountered individual shrubs. For all avalanche chutes containing this vegetation type, the streamside VT occupied the least area, ranging from 2 to 8 percent of the entire avalanche chute (table 5).

Dominant herbaceous taxa included arrowleaf groundsel (Senecio triangularis), cow-parsnip, streambank butterweed, and sweet-scented bedstraw (table 6). Lewis' monkey-flower (Mimulus lewisii) and brook saxifrage (Saxifraga arguta) occupied hydric sites. The dominant shrub species in stratum A (0.0-0.9 m) were alderleaf buckthorn (Rhamnus alnifolia), thimbleberry (Rubus parviflorus), and willow.

Important bear food items in this vegetation type included mesic herbaceous forbs such as cow-parsnip, dandelion, arrowleaf groundsel, strawberry, western sweet-cicely (Osmorhiza occidentalis), and licorice-root (Ligusticum spp.) (table 7).

Coefficients of similarity for streamsides varied from 29 to 49 percent when all but ephemeral taxa were included (mean = 37 percent) (table 8). The greatest percent similarity was between the Bigslide and Otter Creek avalanche tracts. When only grizzly bear foods were considered, the average increased to 53 percent (range 28 to 37 percent). The two chutes demonstrating the greatest similarity were Bigslide (east-facing)

Table 4.--Vegetation type importance values and (ranks) for three forage categories (flood plain complex habitat component)[1]

Vegetation type	Forage category		
	Herbaceous	Modified stem	Fruit
Riparian _Picea_	54 (1)	0.5 (4)	5.0 (4)
Mesic herbaceous meadow	36 (2)	2.0 (2)	25.0 (2)
Populus trichocarpa	10 (3)	2.0 (2)	25.0 (2)
Salix flat	6 (4)	1.0 (3)	9.0 (3)
Xeric graminoid meadow	5 (5)	< .1 (6)	< .1 (6)
Sand bar	5 (5)	5.0 (1)	2.0 (5)
Gravel bar	2 (6)	0.5 (4)	< .1 (6)
Terrestrial _Picea_	1 (7)	0.2 (5)	47.0 (1)

[1]Figures in parentheses indicate ordinal ranking scale.

Table 5.--Acreage and relative percent area (acres/percent area) of each vegetation type in seven sampled avalanche tracts

VT	Chute and aspect						
	Marshall, south	Babcock, south	Otis, southeast	Bigslide, east	Otter Creek, west	Jumbo, north	Marshall, north
Streamside	25/3	2/1		5/5	3/7	1/8	
Alnus spp.	15/1	7/3		7/8	1/2	1/8	16/89
Mesic herbaceous fan			6/2		8/17		2/11
Xeric herbaceous fan			6/2		21/45		
X. tenax	488/51	95/42	127/39		3/7		
Xeric	433/45	124/54	182/57	80/87	10/22	6/50	
Burn shrubfield[1]						4/34	
Total	961/100	228/100	321/100	92/100	46/100	12/100	18/100

[1]This VT was not found in any other avalanche tract. The upper part of this chute contained a burned _Abies lasiocarpa/Xerophyllum tenax_ - _Vaccinium globulare_ habitat type (Pfister and others 1977).

Table 6.--Relative percent cover and occurrence (percent cover/percent occurrence) of dominant taxa in six avalanche chute vegetation types

	Vegetation type					
	Xeric n=114	Xeric herbaceous fan n=26	*Xerophyllum tenax* n=93	Streamside n=129	*Alnus* shrubfield n=52	Mesic herbaceous fan n=45
FORBS:						
Balsamorhiza sagittata	3/25					
Achillea millefolium	[1]t/8 2	1/91	t/73			2/38
Sedum stenopetalum	t/60					
Antennaria microphylla	1/49					
Galium boreale		5/25				
Fragaria virginiana		6/78	5/63			
Osmorhiza occidentalis		5/38	2/20		1/15	1/36
Aster spp.		10/75				
Solidago canadensis		5/38				
Xerophyllum tenax			45/82			9/36
Erigeron spp.			5/60			
Senecio triangularis				19/70	/75	15/73
Heracleum lanatum				7/47	8/52	4/40
Senecio pseudaureus				6/59		
Galium triflorum				2/24	2/52	
Taraxacum spp.				2/30		
Veratrum viride					/54	
Thalictrum occidentale			1/35		/50	5/78
Streptopus amplexifolius					1/42	
SHRUBS:						
Amelanchier alnifolia	5/51		1/26			
Rhamnus alnifolia		18/28				
Symphoricarpos albus		5/16				
Vaccinium scoparium			4/21			
Vaccinium globulare			1/11			
Alnus spp. (0.9-2.0 m)					40/89	
Alnus spp. (>2.0 m)				4/15	38/71	
Sorbus spp. (0.9-2.0 m)					3/17	
Salix spp. (0.9-2.0 m)				3/15		
Ribes lacustre						5/22
GRAMINEAE/CYPERACEAE	30/100	21/100	8/60	8/100	/72	26/100
NONVASCULAR COVER	45/100	2/100	20/100	9/100	/100	12/100

[1]t = <0.5 percent cover.

Table 7.--Relative percent cover and occurrence (percent cover/percent occurrence) of major bear food items in avalanche chute vegetation types

	Vegetation type					
Taxa	Streamside	*Alnus* spp.	Mesic herbaceous fan	Xeric herbaceous fan	*X. tenax*	Xeric
HERBACEOUS						
Heracleum lanatum	7/47	8/52	4/40	t/9	t/3	
Angelica arguta	3/43	1/10	1/18	t/9	t/5	
Ligusticum canbyi	[1]t/8	1/14				
Osmorhiza occidentalis		1/15	1/36	5/38	2/20	t/8
Taraxacum spp.	2/30					
MODIFIED STEMS						
Aster spp.				10/75	t/4	t/5
Erythronium grandiflorum	t/6				t/12	t/2
Hedysarum occidentale			t/2		1/28	
Lomatium spp.	t/2		t/4		t/5	t/27
FRUITS						
Sorbus scopulina	3/17	1/8	t/2		1/6	t/1
Vaccinium caespitosum		t/2	t/2		4/21	t/3
Vaccinium scoparium		t/2	t/2		4/21	t/3
Ribes spp.	t/22	3/10	5/22			
Amelanchier alnifolia					1/26	5/51

[1]t = <0.5 percent cover.

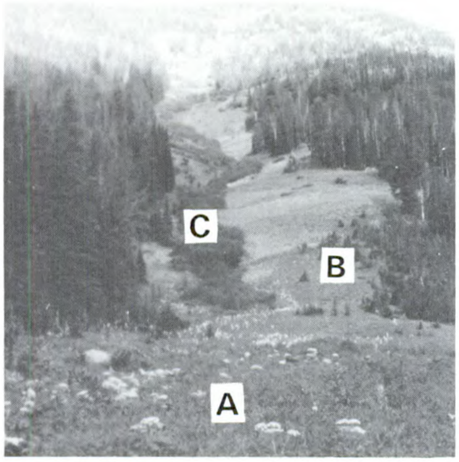

Figure 5.--Mesic herbaceous fan (A), xeric (B), and Alnus spp. (C) VT's of the avalanche chute complex (Otter Creek).

Figure 6.--An extensive area of the Alnus spp. VT of the avalanche chute complex (near Koessler Lake).

Figure 7.--The Xerophyllum tenax VT of the avalanche chute complex (Otis Creek).

and Babcock (south-facing). Only three of 113 taxa were common to all streamsides: western meadowrue, cow-parsnip, and arrowleaf groundsel.

2. Alnus spp. VT. Shrubfields dominated by mountain alder were found on cool and moist sites in all but the south-facing chutes in Marshall and Otis Creeks. North-facing and east-facing portions of avalanche chutes tended to support the most extensive alder stands. In south-facing chutes, alder shrubfields generally were restricted to streamside areas. The Alnus spp. VT usually occupied a low percent area of the avalanche complexes (table 5).

The dominant shrub over 0.9 m was alder; however, 11 other shrubs did occur in this vegetation type. The most common species included willow, fool's huckleberry (Menziesia ferruginea), black twin-berry, and alderleaf buckthorn. Common herbaceous species included American false hellebore (Veratrum viride), arrowleaf groundsel, and western meadowrue (table 6). Mesic herbaceous bear food items such as cow-parsnip, sharptooth angelica, licorice-root, and western sweet-cicely were also common under the canopies of alder and along the shrub ecotones.

The average of 10 similarity coefficients using all taxa was 37 percent. When only bear foods were evaluated, the coefficient increased to 39 percent. The greatest similarity among chutes was 50 percent (table 8).

3. Mesic herbaceous fan. The lower portions of cool and moist aspect avalanche chutes frequently supported mesic herbaceous and graminoid vegetation. Because of the northerly to northwesterly aspect and/or upper elevational position of these chutes, these fans held snow longer than other chutes and exhibited delayed phenological development. Mesic herbaceous fans were found in the west-facing Otter Creek, southeast-facing Otis Creek, and the north-facing Marshall Creek avalanche chutes.

Arrowleaf groundsel, beargrass (Xerophyllum tenax), western meadowrue, and cow-parsnip were dominant herbs (table 6). Grasses and sedges showed a combined coverage of 19 percent and appeared in all sample plots. Nonvascular ground comprised 9 percent cover. Occasional stems of subalpine fir (Abies lasiocarpa), Douglas-fir, and spruce were present.

Key bear foods were much the same as those mesic herbaceous species found in the streamside and Alnus spp. VT's (table 7).

4. Xeric herbaceous fan. The vegetation of several avalanche fans was greatly influenced by surface and subsurface ephemeral stream runoff. On exceedingly convex and generally warm-aspect fans, combinations of taxa slowly graduated from mesic conditions associated with the streamside toward drier conditions near the edges. One example of this drier fan type was at Bigslide.

Table 8.--Individual and average Jaccard percent similarity coefficients for vegetation types of the avalanche chute habitat component (all but ephemeral taxa/grizzly bear foods only)

Streamside VT (n=129)

	Marshall Cr. S. facing n=31	Bigslide E. facing n=26	Otter Cr. W. facing n=23	Babcock Cr. S. facing n=29	Jumbo Cr. N. facing n=20	Otis Cr. SW. facing	Marshall Cr. N. facing	Averages
Marshall Cr.		38/38	34/61	44/70	33/55	Absent	Absent	37/53
Bigslide			49/47	38/75	29/28			
Otter Cr.				31/63	37/54			
Babcock Cr.					34/41			

Alnus Shrubfield VT (N=52)

	Jumbo Cr. N. facing n=8	Bigslide E. facing n=12	Otter Cr. W. facing n=10	Babcock Cr. S. facing n=12	Marshall Cr. N. facing n=10	Otis Cr. SW. facing	Marshall Cr. S. facing	Averages
Jumbo Cr.		40/21	35/50	36/27	27/33	Absent	Absent	37/32
Bigslide			30/36	41/32	33/19			
Otter Cr.				27/22	48/50			
Babcock Cr.					48/27			

Xerophyllum tenax VT (n=93)

	Babcock Cr. S. facing n=55	Bigslide E. facing n=12	Marshall Cr. S. facing n=20	Otis Cr. SW. facing n=6	Otter Cr. W. facing	Jumbo Cr. N. facing	Marshall Cr. N. facing	Averages
Babcock Cr.		28/38	25/33	25/39	Absent	Absent	Absent	32/36
Bigslide			27/18	50/45				
Marshall Cr.				38/40				

Xeric, warm aspect VT (n=114)

	Marshall Cr. S. facing n=34	Bigslide E. facing n=18	Otter Cr. W. facing n=36	Babcock Cr. S. facing n=20	Otis Cr. SW. facing n=6	Marshall Cr. N. facing	Jumbo Cr. N. facing	Averages
Marshall Cr.		45/60	37/43	38/36	33/45	Absent	Absent	34/39
Bigslide			32/21	31/50	28/20			
Otter Cr.				29/29	35/40			
Babcock Cr.					32/45			

Alderleaf buckthorn was the dominant species at sites of high moisture with cow-parsnip, western meadowrue, sharptooth angelica, western sweet-cicely, and blue stickweed (Hackelia jessicae) present beneath the shrub canopy. Wild strawberry, northern bedstraw (Galium boreale), asters, fleabane, sulfur buckwheat, and sticky purple geranium (Geranium viscosissimum) occupied the drier sites. Snowberry (Symphoricarpos albus) and swamp gooseberry (Ribes lacustre) were dry site shrubs.

5. Xerophyllum tenax VT. Vegetation dominated by beargrass varied greatly in areal extent among avalanche chutes. It occupied as much as 50 percent of Marshall Creek's south-facing chute to only 11 to 12 percent of the Otter and Babcock avalanche complexes (table 5). At the Marshall and Otis Creek locations, this vegetation type dominated much of the upper undulating portions as well as the low fanlike areas at the bottoms of the chutes. The Xerophyllum tenax VT was found in all but the north-facing Marshall Creek and west-facing Otter Creek avalanche chutes. Beargrass showed the greatest herbaceous cover value with strawberry, fleabane, western sweet-cicely, and western meadowrue also exhibiting relatively high coverages. Grouse whortleberry (Vaccinium scoparium) was the dominant shrub under 0.9 m. Cover of globe huckleberry (Vaccinium globulare) was the greatest in burned areas. Nonvascular ground had a cover value of 20 percent. Combined, grasses and sedges showed 8 percent cover.

Certain upper-elevation portions of sampled avalanches had been subjected to ground fires within the last 50 years (Babcock and Jumbo Creeks). The most obvious influence of fire on these sites was an increase in shrub presence and cover values. For example, the upper elevation Xerophyllum tenax VT of the Babcock Creek chute (burned 1934) showed twice the number of shrub taxa compared to other similar sites. Due to fire influences, similarity coefficients were low (table 8). Principal bear foods of the Xerophyllum tenax VT included the berry-producing shrub species (particularly where fires had occurred) and grasses and sedges. Other species included such forbs as yarrow (Achillea millefolium), wild strawberry, Indian paintbrush (Castilleja spp.), valerian (Valeriana spp.), and modified stems such as western hedysarum.

Similarity coefficients among vegetation types sampled from four avalanche chutes ranged from 28 to 45 percent when ephemeral taxa were excluded. When considering bear food items only, the similarity coefficients ranged from 21 to 60 percent similarity.

6. Xeric VT. The xeric VT occurred on steep, thin, and well-drained soils in all but the north-facing avalanche chutes. This vegetation type frequently occupied linear bands along the south-facing aspects of the concave avalanche chutes. In the more expansive chutes, the xeric VT was intermixed with the Xerophyllum tenax VT. Where this vegetation type occurred, it occupied more than 40 percent of the avalanche chute (table 5).

Dominant species in the xeric VT included arrowleaf balsamroot (Balsamorhiza sagittata), yarrow, and wormleaf stonecrop. Among shrubs, serviceberry (Amelanchier alnifolia) showed the greatest cover. Grasses, principally Idaho fescue, bluebunch wheatgrass (Agropyron spicatum), showy oniongrass (Melica spectabilis), and sedges had a combined cover of 25 percent. Nonvascular ground cover constituted 32 percent. Except for grasses and sedges, bear food items were not particularly common in this vegetation type. Most notable were modified stems such as wild onion and several species of biscuit-root (Lomatium spp.).

Similarity coefficients derived from five sampled xeric VT's averaged 35 percent for all but ephemeral taxa. When only grizzly bear foods were considered, the similarity increased to 39 percent (table 8).

Ranking of Vegetation Type Importance Values by Forage Category

Herbaceous Forage Category.--For the herbaceous foraging strategy, the highest ranking vegetation type was the Alnus spp. VT (IV = 61) followed by the mesic herbaceous fan, streamside, and xeric herbaceous fan (table 9). The Xerophyllum tenax VT was ranked fourth (IV = 27), and the xeric VT ranked lowest (table 9).

Modified Stems Forage Category.--Importance values for modified stems were relatively low (table 9). The X. tenax VT ranked the highest (IV = 5) due to the occurrence of western hedysarum, milk-vetch (Astragulus spp.), and glacier-lily (Erythronium spp.). The xeric VT ranked second highest and contained digging food items such as wild onion, milk-vetch, fern-leaved and Sandberg's biscuit-root (Lomatium dissectum and L. sandbergii), and glacier-lily.

Fruit Forage Category.--Most avalanche vegetation types exhibited low fall foraging season values because of a general lack of berry-producing shrubs in the nontimbered portions of the tracts. The xeric herbaceous fan VT scored the highest value for the fall foraging season (IV = 26) due to the presence of shrub species such as serviceberry and alderleaf buckthorn.

DISCUSSION

To date, very little information on grizzly bear food habits or habitat use exists for the Bob Marshall Wilderness. Therefore, it was assumed, for this investigation, that grizzly bear food habits and habitat selection in the Bob Marshall Wilderness would be similar to those of other grizzly bears studied in northwest Montana. It also was assumed that grizzly bears would select food resources at the vegetation type level rather than at the component level. This was

Table 9.--Vegetation type importance values of six avalanche tract vegetation types for three foraging strategies[1]

Vegetation type	Forage category		
	Herbaceous	Modified stem	Fruit
Alnus spp.	61 (1)	< 0.1 (4)	3 (5)
Mesic fan	40 (2)	< 0.1 (4)	5 (4)
Streamside	37 (3)	0.1 (3)	3 (5)
Xeric fan	32 (4)	< 0.1 (4)	26 (1)
X. tenax	27 (5)	3.0 (1)	9 (2)
Xeric	3 (6)	1.0 (2)	8 (3)

[1]Figures in parentheses indicate ordinal ranking scale.

corroborated by Stelmock (1981), who stated that:

> [Grizzly bear] habitat use during summer was mainly confined to very specific vegetation types which provided dense cover of favored plant foods. Habitat use patterns closely followed the seasonal variations in quantity and quality of important foods.

This investigation focused on assessing the relative foraging importance to grizzly bears of various vegetation types within both avalanche chutes and flood plains. Results indicate that both flood plains and avalanche tracts are composed of a variety of distinguishable vegetation types within which bear food items varied in composition and abundance. In addition to the forage quality of specific vegetation types, it is important to consider the distribution and juxtaposition of these vegetation types as well as their areal extent.

The more mesic vegetation types within avalanche chutes and flood plains clearly provided an abundance of mesic herbaceous bear foods such as cow-parsnip, sawtooth angelica, western sweet-cicely, and others. Often, these vegetation types occupied the least area. For example, in avalanche tracts, the Alnus spp. VT ranked highest for the herbaceous category, but occupied the least area of most chutes sampled.

In avalanche chute VT's, the xeric fan exhibited the highest IV for the fruit category, primarily because of the abundance of alderleaf buckthorn found in the stream area of the fan. In general, fruit-bearing shrubs were not abundant in any of the avalanche vegetation types sampled except where the types had burned (Babcock and Jumbo). Even in the burns, the abundance of fruit-bearing shrubs was not extensive; however, fruit-bearing shrubs such as globe huckleberry were highly abundant in the timbered stringers located within many avalanche tracts and along the timbered edges. These areas were not sampled in the manner of the avalanche chutes and were considered part of the forest habitat types. Results of sampling forested types are reported elsewhere (Mace, this volume). The highest ranking area for fruit-producing shrubs in the flood plain complex was on the benches above the river channel. The diversity of shrub taxa sought by grizzly bears was less on the benches as compared to the riparian zone. However, the high importance value of these areas was attributed to a few, highly favored fruit-bearing shrubs such as buffaloberry.

Vegetation types in both the avalanche tracts and flood plains generated relatively low importance values for the modified stem category. It appears that because of the small above-ground size and the ephemeral nature of digging food items, the sampling methods used in this study were not sensitive to this food category. Even other components such as slab rock and alpine meadows, which contain a variety of digging foods, yielded importance values less than 5 (Mace, this volume). The consistency of these habitat descriptions within the study area was evaluated using the Jaccard Similarity coefficient (Jaccard 1912). Results of the similarity coefficients indicated that seasonal forage values should be assessed from many areas and not from a single avalanche tract or portion of a flood plain. Similarity coefficients, using a conservative number of grizzly bear food items, were rarely over 50 percent for each avalanche tract vegetation type sampled from different areas. If one were to only intensively sample one avalanche tract, the descriptions would be less than 50 percent similar in bear food composition in comparison to other chutes in the area.

To look at the extent to which avalanche vegetative descriptions could be extrapolated, avalanche tracts in the northern end of the Bob Marshall wilderness were inspected. Comparisons indicated subtle differences in vegetative compositions and occurrences of certain vegetation types. For example, south-facing avalanche tracts of Trickle and Cannon Creeks in the northern Bob Marshall contained mesic herbaceous meadows which were not found in south-facing avalanches in the southern study area. In addition, plant indicators of relatively moist habitats such as pachistima (Pachistima myrsinites) and queen's cup were observed much more often in the northern Bob Marshall than in the southern study area. Finally, it was noted that the north-facing avalanche tracts were more abundant and extensive in the northern wilderness drainages than in the southern ones. Based on these observations, extrapolation of vegetation descriptions and values beyond the study area should be done with caution.

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