LOGGING AND WILDFIRE INFLUENCE ON GRIZZLY BEAR HABITAT IN NORTHWESTERN MONTANA

PETER ZAGER, Biology Department, Muskingum College, New Concord, OH 43762
CHARLES JONKEL, School of Forestry, University of Montana, Missoula, MT 59812
JAMES HABECK, Department of Botany, University of Montana, Missoula, MT 59812

Abstract: Vegetation was sampled on 330 sites known to be used by grizzly bears (*Ursus arctos*). The response to disturbance of 6 shrub species important as grizzly bear foods was determined by comparing their percent canopy cover on disturbed sites with that on undisturbed, old-growth sites. Overall, the canopy cover of these species was higher on sites burned by wildfire 35–70 years ago than on comparable old-growth sites. The canopy cover of these species was generally less on clearcut sites where the slash was bulldozer-piled than on burned sites. The shrub response on clearcut sites where slash was not treated was intermediate; some shrubs increased while others declined. Site treatment is at least partially responsible for this differential response; bulldozer-scarification apparently destroys the vegetative reproductive organs of these shrubs. Habitat use patterns of 4 radio-collared grizzly bears were studied in 1979. Grizzly bears preferred snowchutes, ridgetops, and creek bottoms during the spring; they preferred shrubfields, slabrock, ridgetops, and creek bottoms during the summer/fall. Cutting units and habitat affected by open, travelled roads were avoided throughout the active season. Cutting units used by grizzly bears were generally isolated from human disturbance factors and provided nearby cover (within 50 m) in the form of well-developed shrub strata, leave trees, and cutting unit boundaries.

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Extensive wildfires in the northern Rocky Mountains from 1899 to 1920 created vast areas of seral communities dominated by shrubs. Many shrub communities, especially those at middle elevations, were identified as important producers of grizzly bear foods in northwestern Montana (Tisch 1961, Jonkel and Cowan 1971, Shaffer 1971, Mealey et al. 1977). Fire suppression since about 1920 allowed encroachment of conifers into many of these shrubfields. As conifer encroachment and community development progress, production, if not canopy cover, of certain plants consumed by bears may decline (Mealey et al. 1977, Martin 1979). This would culminate in closed-canopy, old-growth forests where bear food production is relatively low.

Rogers (1976) and Lindzey and Meslow (1977) found an abundance of food for black bears (*Ursus americanus*) on clearcut sites in northern Minnesota and western Washington, respectively; Tisch (1961) reported that clearcuts provided very little black bear food in the Whitefish Range of Montana. Preliminary work in Montana (University of Montana's Border Grizzly Project, unpublished data; Mealey et al. 1977) indicated that certain timber harvest and slash disposal methods may simulate conditions created by wildfire and produce habitat suitable for grizzly bears. The extent of grizzly bear use of cutting units has not been documented, however.

The objectives of this study were to assess relationships between seral plant communities created by wildfire and those created by different logging and slash disposal methods with respect to bear foods, and to determine grizzly bear habitat use patterns as they relate to cutting units and old burns.

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STUDY AREA

Field work occurred primarily on the Flathead National Forest in northwestern Montana on 2 study areas, the North Fork and the South Fork of the Flathead River (Fig. 1). Less intensive field work was carried out in the Mission Range,

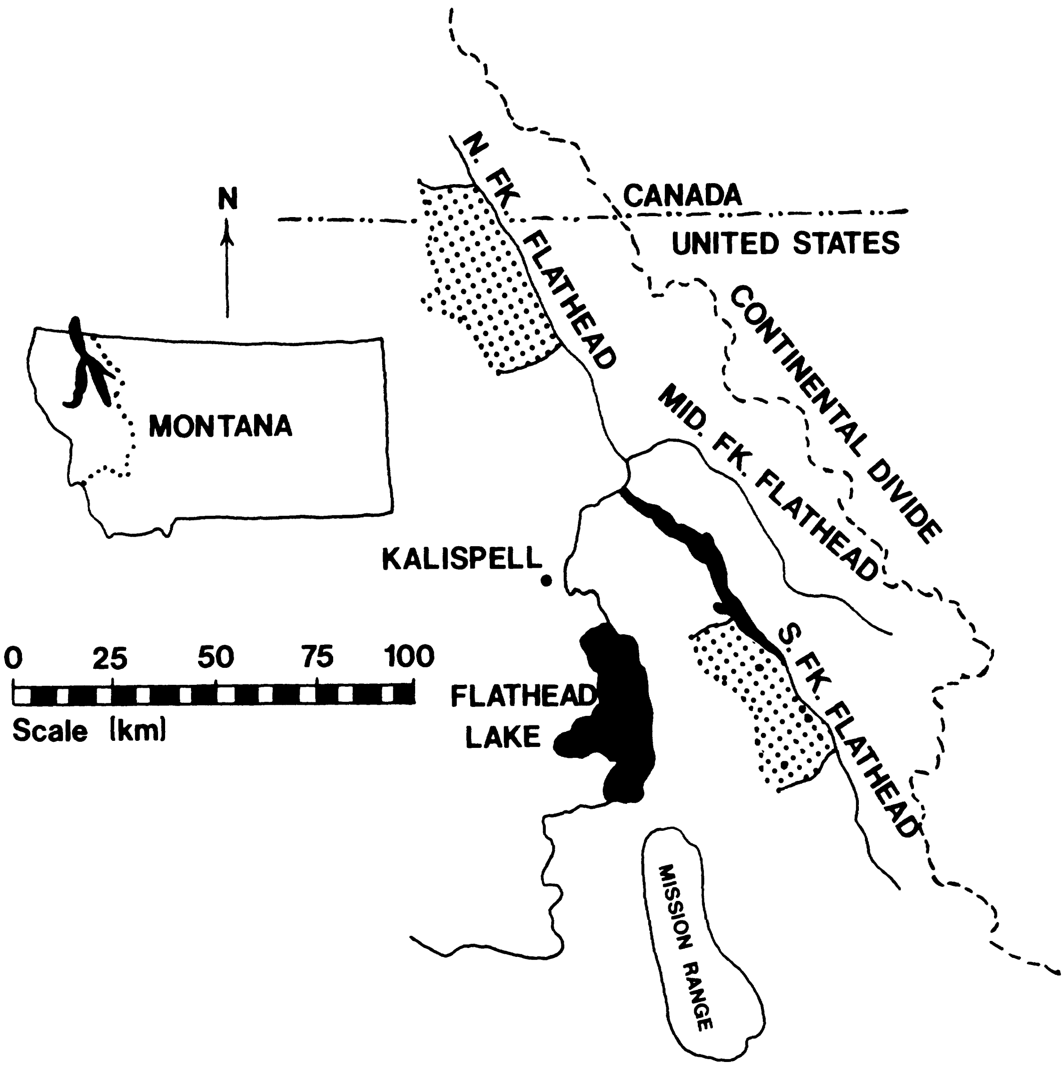

Fig. 1. The grizzly bear habitat study area.

the Yaak River region, and Glacier National Park, Montana, and in the southeastern corner of British Columbia.

The present vegetation of northwestern Montana was described by Singer (1975), Antos (1977), Kessel (1979), and McCune (1979). The landscape was dominated by the subalpine fir (*Abies lasiocarpa*) potential climax series (Pfister et al. 1977). Pockets of western redcedar (*Thuja plicata*) series occurred along a few creek bottoms; the spruce (*Picea engelmannii* × *P. glauca*) series dominated the North Fork floodplain. Much of the North Fork study area was burned during the late 1800's and early 1900's (Ayers 1900, Leiberg 1900, Forsythe 1975). The evidence of wildfire was reduced by organized fire suppression since about 1920. The North Fork region, particularly the creek bottoms, was logged heavily in the early 1950's because of a spruce bark beetle (*Dendroctonus obesus*) outbreak. Presently a mountain pine beetle (*D. ponderosae*) infestation in the fire-initiated lodgepole pine (*Pinus contorta*) forests provides impetus for timber harvest. Wildfires at the turn of the century affected the South Fork area less. However, substantial portions of the adjacent Great Bear Wilderness and Bob Marshall Wilderness burned. Logging in the South Fork was minimal until 1954; logging has increased rapidly since then.

Table 1. Brief descriptions of habitat components in study areas on the North Fork and South Fork of the Flathead River, northwestern Montana.

Habitat component	Description
Cutting Unit	Open or variously timbered sites where timber was harvested regardless of the harvest system or stand age.
Meadow	Naturally open sites with relatively flat topography found at all elevations.
Ridgetop	Drainage divides that are distinguished from adjacent slopes by convex topography.
Riparian Zone	All hydrologically active areas.
Road	Areas that have been cleared and/or graded to permit vehicular traffic.
Scree/talus	Steep, unstable slopes covered with loose rock.
Shrubfield	Sites dominated by shrubs as a result of wildfire, repeated disturbance, or topo-edaphic factors.
Sidehill Park	Steep, xeric sites generally dominated by perennial graminoids.
Slabrock	Rock outcrops with various plant communities intermixed.
Snowchute	Steep, concave, linear topographic features where periodic snow movement limits vegetation to forbs, graminoids, and shrubs.
Timber	Communities with greater than 30% tree canopy cover.

METHODS

Handling of Bears

Grizzly bears were captured with Aldrich foot snares in or adjacent to baited cubby sets. Bears were immobilized with a 1:1 mixture of phencyclidine hydrochloride (Sernylan) and promazine hydrochloride (Sparine) administered intramuscularly with a Palmer Cap-chur gun. After standard measurements were taken, bears were fitted with Telonics radio-transmitters in the 164-MHz range. Attempts were made to locate each bear daily by ground and/or aerial triangulation. Daily activity patterns were determined by periodically monitoring individual bears continuously for periods up to 48 hours. Locations were plotted on U.S. Geological Survey topographic maps (1:24,000). Most locations were inspected onsite after the bear moved out of the area to verify precise locations and activities.

Vegetation Sampling

To study plant response to disturbance, 100-m^2 sample plots were measured on 330 sites. The criterion for study site selection was current use by grizzly bears as determined by radio-telemetry. Direct evidence of grizzly bear use (scats, tracks, and digs) aided plot placement. Where direct evidence was unavailable, 1 sample plot representative of the area was taken. Modified reconnaissance methods (Pfister and Arno 1980) were used to sample the vegetation of areas used by grizzly bears between approximately 15 June and 30 September 1977, 1978, and 1979. If the sample site was logged or burned, a pair of plots was selected, 1 in the cutting unit or burn and 1 in adjacent undisturbed timber when possible, thus providing an untreated plot for comparison. The type and time since disturbance, site treatment, distance to escape cover (any combination of vegetation and topography that will hide 90% of a bear from view at 120 m), and relative productivity and vigor of grizzly bear food plants were recorded for each site.

Frequency (the percentage of plots that contained a given species) and average canopy cover were calculated for 6 shrub species designated as key grizzly bear foods because they were consistently found in grizzly bear scats collected from the study area between 1976 and 1979 (Border Grizzly Project, unpublished data). More detailed data on the frequency and percent cover of shrubs and forbs on the study plots appear in the original report.

Habitat Use Assessment

A composite base map (1:24,000) of the study area was assembled to assess grizzly bear habitat use patterns. Cutting units were delineated by U.S. Forest Service personnel. Wildfire history was plotted on the North Fork map; adequate information was unavailable for the South Fork area. The relative availability of each habitat component (community types based on vegetation, topography, and human influences; see Table 1) within the minimum home range (Mohr 1947) of individual bears was determined according to methods described by Marcum and Loftsgaarden (1980). Relative habitat use was based on 360 radio-locations for 4 grizzly bears during the 1979 field season. Bear movement data from 1977 and 1978 were insufficient for a similar analysis. Radio-locations were stratified by season: spring included den emergence to 31 July; summer/fall included 1 August to den entrance.

Differences between habitat component availability and grizzly bear use were tested with the chi-square test-of-fit (Nie et al. 1975). "Preferred" habitat components were used disproportionately more than expected based on availability; "avoided" habitat components were used less than expected.

Habitat use in relation to travelled roads and cutting units was determined in a similar manner.

RESULTS AND DISCUSSION

Plant Response to Disturbance

Wildfire.—The response of shrubs to wildfire was determined by comparing plant communities on burns 35–70 years old with those in undisturbed, old-growth stands (stands apparently not burned within the last 100 years). Shrub canopy cover for most taxa was greater on old burns than in old-growth stands (Table 2). Declines in globe huckleberry (*Vaccinium globulare*) on some old burns is probably inconsequential since fruit production often increases on burns (Martin 1979), and it remains an understory dominant. Whortleberry (*V. scoparium*) cover declined substantially following both wildfire and logging because its shallow rhizomes make it vulnerable to relatively minor disturbances. The data also indicate that buffaloberry (*Shepherdia canadensis*) declined following disturbance, probably a result of its infrequent occurrence on sample sites.

In fact, few shrubs, regardless of their importance as grizzly bear foods, declined in cover on old burns. We observed that most of the shrubs on our study area resprouted from underground reproductive organs such as rhizomes and root crowns after disturbance. Such plants resprout readily following all but the hottest wildfires, thereby retaining soil, nutrients, and wild life habitat (Lyon and Stickney 1976, Martin 1979). This is not surprising because northern Rocky Mountain forests have a long history of wildfires (Habeck and Mutch 1973). The species comprising these forest understories have had thousands of years to adapt to periodic wildfire. However, effective fire suppression since 1920 significantly influenced northern Rocky Mountain forests (Habeck and Mutch 1973, Arno 1980) and grizzly bear habitat. Suppression has allowed unimpeded plant succession, especially on mesic montane sites (e.g. subalpine fir/beadlily (*Clintonia uniflora*) and subalpine fir/menziesia (*Menziesia ferruginea*) habitat types (Pfister et al. 1977)). This results in "conifer encroachment" into many shrubfields with mixed impacts on wildlife. Though grizzly bears use mature forests for escape cover, production and canopy cover of important food plants (especially fruiting shrubs) is relatively low on these sites. The effect of fire suppression at higher elevations and on drier aspects (subalpine fir/wood rush (*Luzula hitchcockii*) and subalpine fir/beargrass (*Xerophyllum tenax*) habitat types) is not as readily apparent. Harsh environmental conditions slow conifer regeneration (Pfister et al. 1977), and thus encroachment, for decades. Hence, grizzly bear food production may remain high for extended periods.

Table 2. Shrub revegetation response to 3 kinds of disturbance in 4 habitat types used by grizzly bears in northwestern Montana.

		Change in % canopy cover[a]		
Habitat type	Shrub species	Wildfire	Clearcuts, no piled slash	Clearcuts with piled slash
Subalpine fir/ beadlily	Serviceberry	+0.2	+6.8	−0.9
	Red-osier dogwood	+14.5	−0.5	−0.5
	Buffaloberry	0	−0.5	−0.1
	Mountain-ash	+0.4	−3.1	−4.1
	Globe huckleberry	−8.3	−4.1	−16.3
	Whortleberry	+2.0	−3.9	−2.9
Subalpine fir/ menziesia	Serviceberry	0	0	+3.0
	Buffaloberry	−3.0	−3.0	−2.5
	Mountain-ash	+2.9	+8.1	+0.2
	Globe huckleberry	+4.5	+4.9	−10.3
	Whortleberry	+11.6	−2.4	−1.9
Subalpine fir/ beargrass	Serviceberry	+7.9		
	Buffaloberry	+0.5		
	Mountain-ash	+0.8		
	Globe huckleberry	+11.8		
	Whortleberry	+4.3		
Subalpine fir/ wood rush	Mountain-ash	−0.9	−1.3	
	Globe huckleberry	−3.0	−5.3	
	Whortleberry	+3.4	−5.8	

[a] Increase (+) or decrease (−) in % canopy cover on plots when compared with that on plots in undisturbed, old-growth stands in the same habitat type.

In summary, it appears that effective wildfire suppression has a significant negative impact on grizzly bear habitat and food production on mesic sites. Suppression has had less effect on environmentally harsh, high-elevation sites. However, continued fire suppression will probably result in declining food production on these sites as well.

Timber Harvest.—Some of the conditions created by wildfire (reduced tree canopy, reduced competition, and altered soil moisture and nutrient regimes) appear to be simulated by certain logging and slash disposal methods. Therefore, plant communities resulting from these disturbances should be similar in those characteristic to old burns. To assess the relationship between wildfire and logging, plant communities on old burns were compared with those on clearcuts 15–35 years old. Comparisons were limited to sites in the subalpine fir/beadlily and subalpine fir/menziesia habitat types.

Most key shrubs declined in canopy cover on clearcut sites where slash was piled with a bulldozer prior to burning (CCDP sites), in contrast to the pattern of burns (Table 2). Serviceberry (*Amelanchier alnifolia*) and mountain-ash (*Sorbus scopulina*) were the only key shrubs increasing in cover on CCDP sites; their cover increased slightly on 1 habitat type. Though certain timber harvest methods seem superficially similar to natural processes, piling slash with a bulldozer does not closely simulate natural phenomena (Vogl and Ryder 1969). Soil disturbance by scarification, skidding logs, and piling slash destroys the rhizomes and root crowns of many vegetatively reproducing plants, resulting in the overall decline. Concurrently, exposed mineral soil provides suitable conditions for species that commonly disperse by seed (e.g., *Rubus* spp., certain graminoids), resulting in their general increase.

Extreme temperatures created by burning slash piles also damage rhizomes and root crowns while essentially baking the soil (McLean 1969, Wright 1972, Miller 1977). Vogl and Ryder (1969) found that extremely high temperatures under burning slash piles altered the physical structure of the soil, resulting in substantial changes in relative frequency of understory species as well as lower density and slower growth of conifers.

The degree of disturbance can have a major influence on plant recovery for many years after logging. Several cutting units in the North Fork study area were scarified extensively around 1955. The understory on these sites was still dominated by graminoids and a few scattered shrubs. Key food shrubs, though common in adjacent undisturbed forest, were essentially absent from these cutting units. Where food shrubs occurred in the units, they were found adjacent to stumps and rocks where the soil was not disturbed during slash piling operations. Telfer (1977) also found that dense forbs and grasses often dominated scarified sites for years before shrubs and trees re-established dominance. Bailey and Poulten (1968) reported that at least 45% of a tractor-logged area supported vegetation different from that in the "normal" post-burn community. Skid trails and old landings were evident 10-20 years after logging. They believed most of the vegetation change resulted from soil removal and compaction.

The response of food shrubs found on clearcuts that were not scarified (CCNS) sites was intermediate between that on old burns and on CCDP sites. On CCNS sites, the percent cover of globe huckleberry, red-osier dogwood (*Cornus stolonifera*), and serviceberry was generally greater than that found on CCDP sites, but not always greater than that on old burns (Table 2). These shrubs were found throughout CCNS sites, except on skid roads and other severely disturbed areas. Since slash is not piled with a bulldozer, soil removal and disturbance of root crowns and rhizomes are substantially less than on CCDP sites. Hence, the resulting communities on CCNS sites resemble post-wildfire communities.

Bailey and Poulten (1968) reported reduced soil disturbance and thus little vegetation change on sites that were logged with high-lead, cable yarding systems rather than bulldozers. Lindzey and Meslow (1977) found abundant black bear foods on sites with untreated slash that had been harvested 15 years earlier in Washington.

Based on these data, shrub communities on CCNS sites are more similar to those found on old burns, with respect to bear foods, than are CCDP sites in the subalpine fir/beadlily and subalpine fir/menziesia habitat types. Major reasons for this are the reduced soil scarification on CCNS sites, resulting in less damage to vegetatively reproducing plants, and avoidance of the extremely high temperatures that occur under burning slash piles on CCDP sites. From a forest manager's perspective, slash accumulations commonly found on CCNS sites pose unnatural fire hazards and conifer regeneration problems. Broadcast burning of slash is 1 solution to these problems. Concurrently, the growth and production of several key grizzly bear food plants is stimulated (Martin 1979).

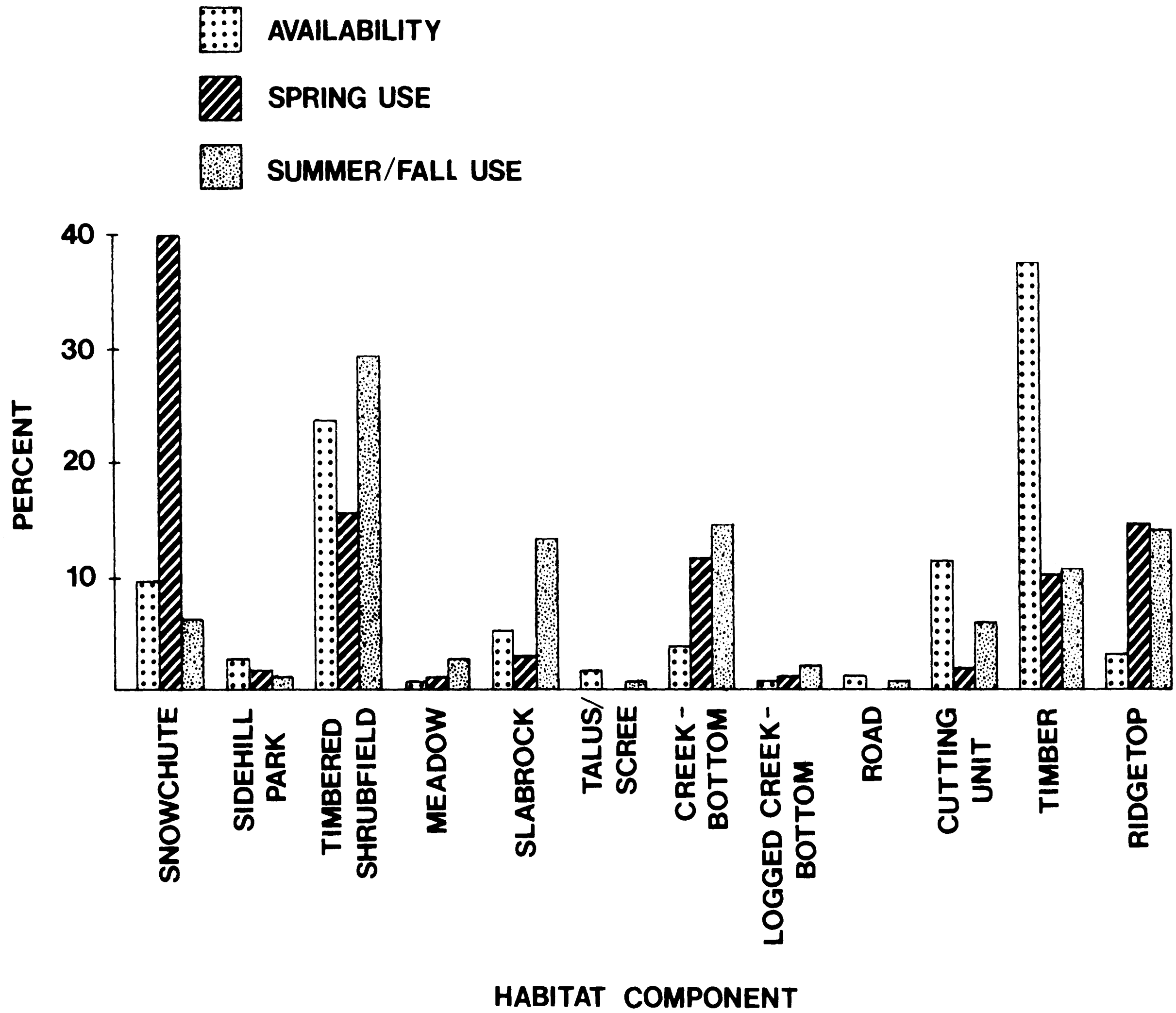

Fig. 2. Grizzly bear habitat utilization patterns in the South Fork of the Flathead River study area, 1979.

Habitat Use

Data on grizzly bear habitat use were available only for the 1979 South Fork field season. Equipment failures, lack of personnel, and far-ranging bears precluded gathering comparable data during 1977 and 1978. Data for 4 radio-collared grizzly bears were pooled for this discussion. Though 4 bears is a small sample, we believe it represents 25-35% of the population in the South Fork study area (Border Grizzly Project, unpublished data), and that the habitat use trends are valid.

Seasonal Use Patterns. — Although all habitat components were used by grizzly bears annually, certain components were preferred and others avoided. During spring the bears preferred snowchutes and ridgetops while avoiding timber and cutting units; during summer/fall they preferred shrubfields (including burns), slabrock, creek bottoms, and ridgetops while avoiding snowchutes, timber, and cutting units (Fig. 2). A more pronounced preference for sites created or maintained by wildfire was probably masked by their inclusion in the shrubfield category with open-canopied (less than 30% canopy cover), old-growth stands. This was necessary because of problems differentiating these communities with available aerial photography. The result is a conservative estimate of the importance of old burns as grizzly bear habitat. The fact remains that shrubfields were preferred.

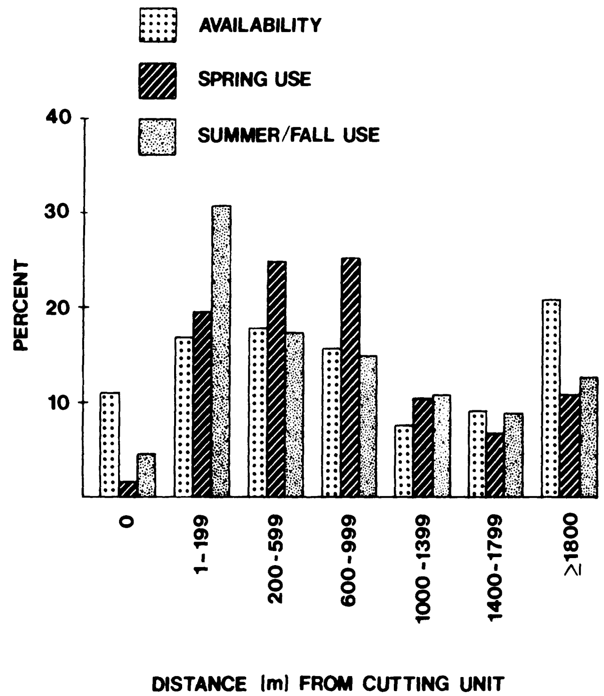

Fig. 3. Grizzly bear habitat utilization patterns in relation to cutting units in the South Fork of the Flathead River study area, 1979.

Inasmuch as most grizzly bear weight gain occurs during the summer/fall while they feed almost exclusively on berries (Border Grizzly Project, unpublished data), we expected an even stronger preference for fruit-producing shrubfields. However, summer 1979 was unusually dry. Berry productivity on vegetation sample plots was very low, especially on the drier aspects. Grizzly bears apparently responded by feeding extensively on succulent forbs in creek bottoms and other mesic sites throughout the summer/fall.

Use of Cutting Units and Roads.—Overall, cutting units were avoided by grizzly bears, but habitat adjacent to cutting units (1–199 m) was preferred during the summer/fall (Fig. 3). Preference for habitat 1–199 m from cutting units was partly by default. Approximately 12% of the South Fork study area had been logged; this proportion increased substantially when considering only low-elevation sites supporting merchantable timber. Additionally, 2 radio-collared bears extensively used old burns adjacent to clearcuts, occasionally venturing into the cutting units to feed on creek bottom forbs. Bear movement data also indicated the frequent use of timbered stringers between harvested units as travel corridors. On several occasions, grizzly bear day beds were found in these stringers, magnifying their importance. The apparent avoidance of cutting units and utilization of habitat adjacent to cutting units illustrates the importance of maintaining contiguous timber cover along creek bottoms and between harvested patches. Stringers will become increasingly important as resource development proceeds within grizzly bear habitat. Stringers are rapidly becoming the only travel corridors available to grizzly bears.

Smith (unpubl. pap., Simon Fraser Univ., Vancouver, B.C., 1978) attributed high levels of grizzly bear activity in habitat adjacent to clearcuts to difficulties travelling through extreme concentrations of slash. Slash accumulations on our study area did not approach those typically found in coastal British Columbia. Therefore, slash is probably not a significant deterrent to cutting unit use in northwestern Montana. This pattern of cutting unit avoidance is similar to that exhibited by elk (*Cervus elaphus*) in western Montana. However, elk may use the margins of clearcuts at night (L.J. Lyon, For. Sci. Lab., Missoula, Mont., pers. commun.); 24-hour monitoring of grizzly bear activity did not indicate increased cutting unit use at night.

Nevertheless, some grizzly bears used certain cutting units. Evidence of grizzly bear use was found on both CCDP sites and CCNS sites. Even though cutting units were systematically searched, most sign in cutting units was found along partially grown-over skid roads and creek bottoms that were apparently being used as travel routes. The bears were feeding on forbs, graminoids, and huckleberries along these routes. Smith (unpubl. pap., Simon Fraser Univ., Vancouver, B.C., 1978) also found grizzly bears used skid roads as travel routes.

Because of this apparent disregard for site treatment and resultant plant communities, we do not believe food availability is the single factor determining grizzly bear use of cutting units. Two factors that did seem to influence grizzly bear use of these areas were the cutting unit location in relation to system roads that were open for travel, and the distance to escape cover. Of the cutting units used by grizzly bears, 71% (28 of 39) were located along open secondary roads

(roads along minor creeks) or closed roads. For example, an unmarked grizzly bear was observed feeding on graminoids in a 2-year-old clearcut bordering a closed road (C. Servheen, Border Grizzly Project, pers. commun.). Grizzly bear sign was also found throughout a 9-year-old, 140 ha cutting unit. The site was accessible only by foot and supported a vigorous shrub stratum that supplied effective cover and abundant foods.

Grizzly bear use of cutting units along primary roads (roads along the North and South forks of the Flathead River and their major tributaries), where the probability of human disturbance is greater, was generally restricted to those portions of the units farthest from the road. Sign was found only on skid roads at the upper margins of these units, adjacent to timber that presumably served as cover. Apparently, increased human disturbance associated with primary roads effectively removed a large portion of these units as suitable habitat.

Cutting unit size and shape have an indirect influence on grizzly bear use because they affect the proximity of escape cover. The overall availability of cover within cutting units was not determined. Measuring cover availability in the form of cutting unit boundaries is relatively simple using maps and aerial photographs. However, the availability of leave trees and well-developed shrub strata, which can also serve as cover, cannot be accurately measured with these sources. Bears were monitored in cutting units 39 times; their specific locations within the units could be determined 34 times. Of these 34 radio-locations, 19 (56%) were within 25 m of escape cover, regardless of the relationship to roads, and 28 (82%) were within 50 m of cover. Mature, closed-canopy timber was not necessary to provide this cover. On several occasions, instrumented bears were continuously monitored while in cutting units. Only once was the bear actually seen. Well-developed shrub strata, leave trees, and cutting unit boundaries provided effective cover. Conversely, Smith (unpubl. pap., Simon Fraser Univ., Vancouver, B.C., 1978) reported grizzly bears move rapidly to timber when frightened in clearcuts.

Grizzly bears used different-sized cutting units approximately in proportion to their availability. Nearly half (45%) of the cutting units used by grizzly bears were smaller than 40 ha. However, sign was also found in units larger than 160 ha. Most of these were long, narrow units along the tributaries of the North Fork that resulted from spruce sanitation and salvage harvests in the late 1950's. Timbered escape cover remained nearby on these sites. Mealey et al. (1977) found evidence of spring grizzly bear use in clearcuts smaller than 20 ha that included leave trees. Larger units without leave trees were not used, presumably because of lack of cover. They did not report summer/fall use of clearcuts. Lindzey and Meslow (1977) found that black bears preferred cutting units harvested 15–25 years previously while avoiding clearcuts harvested 7–12 years earlier. Use was apparently dependent upon the availability of escape cover.

In summary, utilization of cutting units is apparently not based on the availability of food items alone. Cutting unit location in relation to open roads and the availability and proximity of escape cover are also important factors in determining grizzly bear use of these sites. Size and shape of cutting units may have an indirect effect on grizzly bear use in that they determine the proximity of cover.

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