

# WILDFIRE'S INFLUENCE ON GRIZZLY BEAR FEEDING ECOLOGY IN BANFF NATIONAL PARK, ALBERTA

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**Abstract:** Grizzly bear (*Ursus arctos*) habitat use in the Front Ranges of Banff National Park is described in terms of vegetation types and their successional status. The alpine zone was not important to foraging grizzly bears. Feeding in mature forest was recorded for only 1 major food, horsetails (*Equisetum arvense*), even though mature forest covered about one-third of the study area. Rather, grizzly bears fed for most foods in a variety of open and seral vegetation types in the subalpine zone. Factors limiting forest development included avalanching, cold air drainage, high water table, xeric site conditions (southerly exposure, well-drained soil, chinook wind) and, especially, wildfire. Of a 148 km<sup>2</sup> mapped area, 59% was regeneration from 5 fires that burned between 1868 and 1936. Fire's role in creating many feeding areas was indicated by the presence of snags and deadfall. Moreover, a comparison of areas that appeared to differ only in time since the last fire suggested that wildfire has had a role in establishing other seemingly successional mature open plant communities as well. Fire suppression has been effective since 1936; the study area currently is experiencing the longest fire-free interval recorded during the period ± 1580–1985. Successional trends suggest a loss of grizzly bear feeding habitat in the absence of recurring wildfire.

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The grizzly bear's propensity to range in areas like the arctic barren grounds, the alpine tundra or, in earlier times, the chaparral and grasslands of California has earned it the reputation of an open habitat species (Herrero 1972). In our study area in Banff National Park, Alberta, grizzly bear feeding activity rarely was recorded in the alpine zone. However, grizzly bears made extensive use of forest openings in the subalpine zone, such as dry meadows, shrub-fields, and avalanche paths. We have described these and other feeding habitat types used by grizzly bears (Hamer 1985; Hamer and Herrero, this volume). Here we report the fire history of our study area and the use that grizzly bears made of certain postfire habitat types. We also discuss other factors such as chinook wind, slope, and avalanching that appeared to have a role in creating or maintaining the open habitat used by foraging bears.

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## STUDY AREA

The study area occupies approximately 250 km<sup>2</sup> in the eastern slopes of Banff National Park within the Front Ranges of the Rocky Mountains. The Continental Divide is 45 km to the west. A general de-

scription of the study area was provided by Hamer and Herrero (this volume).

Precipitation in the study area, according to extrapolations by Janz and Storr (1977:325), likely is less than 75 cm over more than half the area and less than 50 cm, or semiarid, in the lower Cascade Valley. This rain shadow effect, in conjunction with the warm, westerly chinook (foehn) winds that characterize the Rocky Mountains east of the Continental Divide, contributes to low soil moisture and slow regeneration of forests after wildfire on many southeast- through west-facing slopes. The chinook results from Pacific air flooding across the mountains. The air loses much of its moisture as it rises to cross the Rockies. On the eastern side of the mountains the temperature increases as the air descends mountain slopes; very strong, gusty winds occur (Janz and Storr 1977).

## METHODS

Grizzly bear food and habitat use was studied between 1976 and 1980 as described by Hamer and Herrero (this volume).

Fire history was studied in a 148-km<sup>2</sup> core area. Fires were recognized through analysis of approximately 750 increment cores and 60 cross-sections, or wedges. Increment core-derived ages were analyzed by adapting Arno and Sneek's (1977) method for reconciling discrepancies in a master fire chronology. We correlated increment-boring age at 30 cm height with the corresponding fire year established from fire scars. The approximate number of years required for trees to grow to 30 cm, once established, then was used to assign a range of boring-derived ages to a known fire year when there was no local confirmation

by fire scars and to an estimated date for fires where no scars could be found at all. In the latter case, the estimated fire year was reported as being approximate (e.g.,  $\pm 1703$ ). If increment core-derived ages did not indicate that the stand was essentially even-aged post-fire regeneration, then the stand was reported as being multiaged (e.g., 1800–60). Climax spruce (*Picea* spp.) stands were designated as being as old as or older than the oldest tree sampled (e.g., 350+ years).

## FIRE HISTORY

The regeneration following 6 fires, plus an area of multiaged forest (originating between  $\pm 1800$  and  $\pm 1860$ ), was mapped, as were climax forest stands, mostly of spruce (Fig. 1). Although regeneration could be mapped, the actual areas burned by the fires of  $\pm 1703$ , 1868, and 1879, plus areas burned by at least 16 other fires documented for the period  $\pm 1580$ –1863, could not be determined because regeneration following these fires was reburned by more recent fires. Most wildfires in the study area apparently were sufficiently intense to destroy essentially all trees within the burn, leaving little information on previous fire history. Of the 148.5-km<sup>2</sup> area mapped (Fig. 1), 59% is regeneration from 5 fires that burned during 1868–1936 (Table 1). Taking all fires documented for the period  $\pm 1580$ –1936, the mean interval between fires was 15 years, and the longest interval was 45 years. No fires have burned since 1936, a period of 49 years.

## WILDFIRE-FEEDING HABITAT RELATIONSHIPS

The following kinds of subalpine vegetation occurred in our study area: dry grass meadows; dry shrublands; mesic to subhygric shrubfields; open or immature forest; and mature forests, with spruce, lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*), and alpine larch (*Larix lyallii*) variously represented. We discuss the importance of these general vegetation forms as grizzly bear feeding habitat and examine their relationship to the fire history of the study area.

### Dry Grass Meadows

We have described how dry meadow slopes supplied grizzly bears with graminoids (grasses, sedges, and rushes), bearberries (*Arctostaphylos uva-ursi*), ants under stones, and roots of yellow hedysarum (*Hedysarum sulphurescens*) (Hamer and Herrero, this volume). These sites generally were steep, southeast-through west-facing slopes above 2,000 m. Some of these meadows clearly were the result of recent fire, with snags and deadfall in the site and forest encroaching from the periphery. Other meadows, however, had no deadfall and either were being invaded slowly by trees or were successional mature grassland. In some sites, red-belt injury may have been maintaining an equilibrium that prevented the forest from growing into the main extent of the meadow (for example, note the distinct, linear tree line in the upper right center of Fig. 2). In addition to chinook-

Table 1. Areas (km<sup>2</sup>) of regeneration from fires, multiaged forest, and climax stands (mostly spruce), as mapped in Figure 2. Areas were calculated on 3 dimensions by computer programs (see Hamer 1985).

Stand	Area	Stand	Area	Stand	Area
$\pm 1703$	1.0	$\pm 1580, \pm 1664$	0.2	335+	0.4
1800–60	10.4	130+	1.5	350+	25.3
1868	6.1	130+, 240+	2.3	360+	0.1
1879	4.6	150+	0.4	380+, 340+	1.6
1889 <sup>a</sup>	52.7	155+	0.9	380+–470+	4.3
1929	14.0	160+	0.1	400+, 470+	3.9
1936 <sup>a</sup>	10.8	300+	0.1	430+	0.1
		315+	0.4	470+	0.2
		320+	1.9		
		325+	2.9	Others	0.4
		330+	1.9		
				Total	148.5

<sup>a</sup> The total area burned by the 1936 fire was about 52 km<sup>2</sup>; the total area burned by the 1889 fire was about 122 km<sup>2</sup> (White 1982). The 1936 fire burned into the study area from the west; the 1889 fire burned into the study area from the main Bow Valley (Johnston Creek area) over Edith Pass and Elk Lake summit (White 1982).

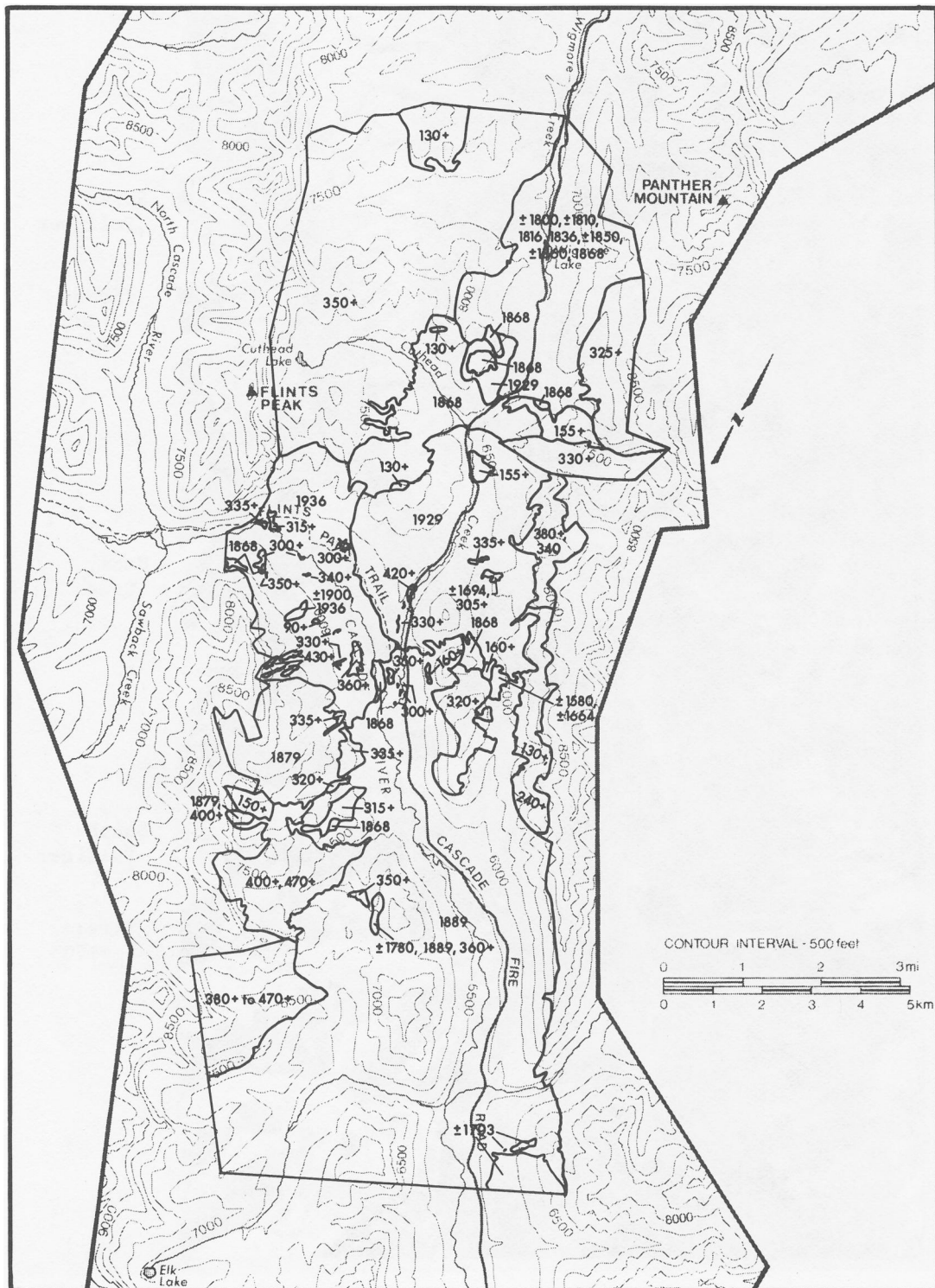


Fig. 1. Regeneration from 6 fires, an area of multaged forest originating between 1800 and 1860, and climax stands, mostly of spruce. Climax stands are designated as being as old as or older than the oldest tree sampled (e.g., 350+).

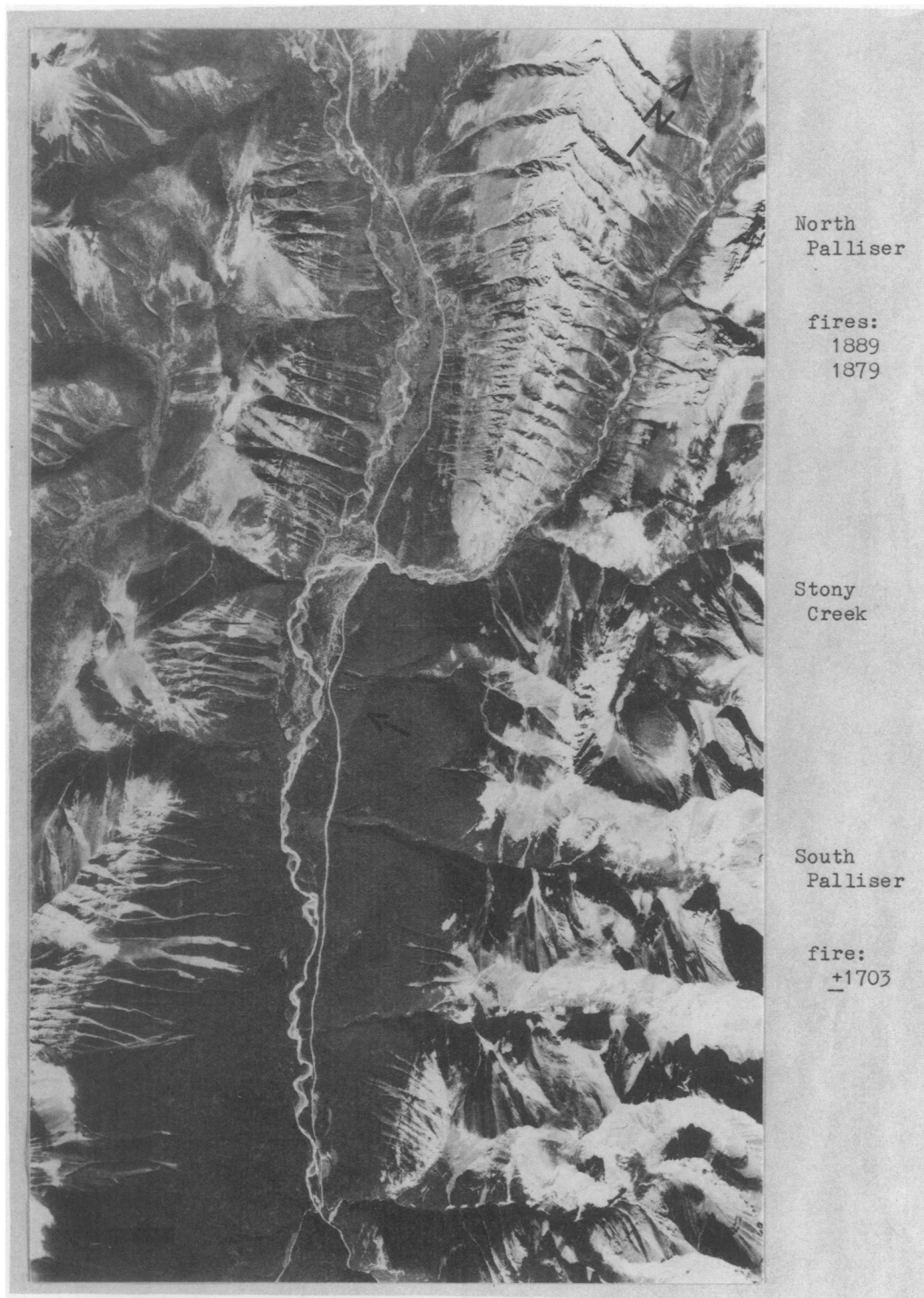


Fig. 2. Air photograph (about 1:71,000) showing the influence of fire history on forest cover in the Cascade Valley. Major features include the Cascade River (running top center to bottom center) and a major tributary, Stony Creek (entering from right and upper right). The Palliser Range forms the east (right) side of the Cascade Valley. The  $\pm$  1703/1889 fire line is visible (arrow). National Air Photo Library No. A23010-159, August 1972 (Can. Govt. copyright). Scale bar equals 1 km.

caused red-belt injury, intense summer insolation; steep, south-facing, droughty slopes; and thin, immature soils may contribute to xeric site conditions that maintain subalpine sites in a treeless state (e.g., Stringer 1973, Robins and Susut 1974).

Some of the dry meadows in our study area were subject to avalanching. The role of avalanching in maintaining grasslands of this kind was noted by Stringer (1973) and Walker et al. (1982). However, many dry meadow slopes in our study area clearly were not influenced by snow slides and evidently were maintained by other factors.

Although some of the dry meadows not maintained by avalanching appeared to be successional mature, adjacent forest may spread slowly inward as it creates favorable microclimate for further regeneration of trees and shrubs. Our study area suggested such a situation and the possible role of wildfire in maintaining these long-lived dry meadows. The southwest-facing slopes of the Palliser Range have about 8 km of long, narrow, dry meadows where grizzly bears feed on bearberries, graminoids, ants, and roots of yellow hedsarum. These meadows are within the areas burned in 1879 and 1889. At least some of the meadows obviously are fire-dependent as indicated by snags and deadfall. The Palliser Range also continues south for an additional 7 km on the south side of Stony Creek (Fig. 2). The southern portion, however, is heavily forested, and has not burned since  $\pm$  1703. (During the summer of 1985, a lightning-caused fire started to burn in this area but was put out quickly by Parks Canada.) This forested portion apparently was little used as a feeding area by the radio-collared bear whose home range included this area. This bear was relocated in the forested, southern portion of the range for 1 day, compared to 9 days of relocations on the northern, grassland portion of the range. The 2 portions of this range are illustrated in Figure 2.

The main distinguishing feature between the 2 portions of the range was the different fire history. Both portions had substrates composed primarily of calcareous colluvium (Walker et al. 1982) and had similar aspect and slope steepness. Ecological classification of these 2 areas included some units that differed only on the basis of current vegetation, not geomorphology or soil (e.g., SB4/9 vs. SB5/9; Holland and Coen 1983). If this comparison is valid, almost 100 years of postfire growth on the northern portion of the range has resulted in forest re-establishment only on the lower slopes and in less wind-

exposed microsites, whereas almost 300 years of post-fire growth on the southern portion has led to nearly complete forest cover.

Another factor, possibly important in creating the grizzly bear habitat found in the northern portion of the Palliser Range, is that the fires of 1879 and 1889 may have been a "double burn." Similar sequences of burns are known to eliminate coniferous seed sources, as has been described in the Rocky Mountains in the United States (e.g., Wellner 1970).

### Dry Shrubland Meadow

Buffaloberry (*Shepherdia canadensis*)/hairy wild rye (*Elymus innovatus*) shrubland accounted for 15% of our classified buffaloberry feeding records (Hamer and Herrero, this volume). This vegetation type was fire successional, with abundant snags and deadfall. It occurred on exposed, xeric sites where lodgepole pine was regenerating more slowly than in adjacent, less exposed forest. Of our feeding records in this dry shrub type, 43% were in the 1936 burn, 43% in the 1929 burn, and 14% in the 1889 burn.

### Mesic Shrubfields

Mesic to subhygric willow (*Salix glauca*, *S. ferrae*) shrubfields were used by grizzly bears feeding on buffaloberries and roots of pink hedsarum (*H. alpinum*). The north- and east-facing upland spruce/willow regenerating forest, which was responsible for 37% of our buffaloberry feeding records (Hamer and Herrero, this volume), was obviously fire-dependent. Snags and deadfall from the 1936 fire littered these feeding areas, and scattered, immature spruce usually occurred. These sites likely were succeeding to a spruce/feathermoss (*Hylocomium splendens*, *Pleurozium schreberi*) forest. Comparable habitat 5–7 km southeast in the 1889 burn was dominated by a closed-canopy spruce forest that was not identified as buffaloberry feeding habitat except where the canopy was opened by snow avalanching. These 2 portions of the study area, except for the difference in fire history (1889 vs. 1936), had the same ecological classification (PR2/8, Holland and Coen 1983). It thus appears that spruce/willow-buffaloberry feeding habitat is highly fire-dependent, with regenerating shrubfields 40–45 years old being important and forest 85–90 years old being little used for buffaloberry feeding. Martin (1983:163) recorded a similar pattern for *Vaccinium* production where 25- to 60-year-old burns produced more fruit than sites that had burned

60–100 years ago. She attributed the lower productivity of the older forests to their significantly denser forest canopy.

The willow/dwarf birch (*Betula glandulosa*) avalanche slopes, which accounted for 21% of our buffaloberry feeding records (Hamer and Herrero, this volume) may have been partially fire-dependent as well. The feeding areas occurred in the 1889 burn. Wildfire predisposes otherwise stable slopes to avalanching by removing the forest (Winterbottom 1974). Currently, mature forest is developing between the avalanche paths, at the base of the slopes, and at isolated spots within the avalanche paths. Forest regeneration may continue, especially because the relatively arid climate, and therefore less snowpack, means that avalanching likely occurs infrequently in this area.

Evidence of recent wildfire was found in some of the willow-dwarf birch shrubfields where grizzly bears dug roots of pink hedysarum. Other sites apparently were successional mature, with forest encroachment likely prevented by cold air drainage (Trotter 1972), annual flooding, or high water table associated with side-hill seepage. However, as with the dry meadows, it is possible that forest was gradually encroaching into some of the apparently mature shrubfields (see Hamer 1985). Digging sites with scattered spruce regeneration were classified as open spruce/willow habitat (11% of our pink hedysarum digging records); 92% of these records occurred in the 1929 burn.

Further evidence suggesting a role for recurring wildfire in maintaining willow/dwarf birch digging habitat is seen in Figure 2. As with the distribution of dry meadows, there is an apparent difference between the north and south halves of this aerial photograph in terms of river bottom vegetation. The abundance of willow/dwarf birch shrubfields along the Cascade River is seen clearly in the north half. In the south half, however, where fires last burned almost 200 years earlier ( $\pm 1703$  vs. 1889), willow shrubfields cover much less area. Generally, the shrubfields in the southern portion are only a thin line within a few tens of meters of the river's immediate influence of flooding and disturbance. Yet these 2 halves of the valley bottom consist of similar floodplains, aprons, and fans (Holland and Coen 1973). Both portions also have substantial amounts of gently sloping river bottomland where willow-dwarf birch shrubfields could develop. Because the northern portion had abundant pink hedysarum dig-

ging sites whereas the southern portion was largely mature spruce forest, and because fire history was the main apparent difference, this comparison suggests an important role for wildfire in maintaining both seral and persistent shrubfields.

#### Open and Immature Forest

In addition to the spruce/willow open forests discussed above, grizzly bears commonly fed in 2 other open or immature forest types: immature pine or spruce/buffaloberry forest and open, high-elevation stands of spruce-subalpine fir-larch/grouseberry forest. The latter habitat was used by bears feeding on grouseberries (*Vaccinium scoparium*) and low-bush blueberries (*V. myrtillus*). Our records of grizzly bears feeding on *Vaccinium* fruits came from the 1889 burn on east-facing slopes above 2,000 m, where forest regeneration has been slow. The forest canopy coverage was 25% or less. The open nature of the feeding sites seemed positively related to fruit production, agreeing with Martin's (1983:162) results for *V. globulare* in Montana, where production was less than 134 l/ha in any site where the tree canopy exceeded 30%, "presumably because shading prevented flower formation." In comparison, Martin's 2 best sites produced 1,399 and 1,111 l/ha. Arimond (1979) also found that blueberries (*Vaccinium* spp.) in Minnesota produced significantly more fruit in sites with lower tree density. If forest regeneration continues in our study area, fruit production presumably will decline. Although Martin's most productive sites burned 25–60 years previously, our *Vaccinium* sites burned about 90 years ago (1889). But because these sites were at high elevations and had easterly exposures, they have been slow to develop mature trees or a closed canopy. This is consistent with Martin's (1983:163) statement that "conditions that retard or inhibit the development of a tree canopy should prolong the productive life of wildfire-burned sites."

Pine or spruce/buffaloberry forest accounted for 22% of our classified buffaloberry feeding sites. These observations were in recently burned sites. Regeneration from the fires of 1936, 1929, and 1889 accounted for 93% of the observations. These buffaloberry forests likely will succeed to spruce/feathermoss forest (Corns and Achuff 1982:80, 90, 105), a type in which we recorded no buffaloberry feeding.

Figure 2 indicates probable succession to spruce/feathermoss forest and its apparent lack of use by

grizzly bears for buffaloberry feeding. The mature closed forest in the south half of the Palliser Range (i.e., in regeneration from the  $\pm 1703$  fire) was classified as spruce/feathermoss forest where it occurred in the mapped portion of the study area (Fig. 1). The radio-collared grizzly bear that ranged in this area was never relocated there during the buffaloberry season. The northern half of the Palliser Range, however, had relatively open, immature pine and spruce/buffaloberry forest that regenerated after the 1889 fire. This open forest is visible in Figure 2 east of the road but below the dry meadows. Our radio-collared bear was relocated in this northern portion of open forest on 14 different days during the buffaloberry season of 1979. Without recurring wildfire, the northern portion presumably will succeed to spruce/feathermoss forest and will lose its importance as grizzly bear feeding habitat. The abundance of spruce regeneration in this northern, open forest supports this idea.

#### Mature Forest

Although a large proportion of our buffaloberry feeding records were from forested habitat, none were from mature spruce stands. Mature spruce forests apparently were seldom used as grizzly bear feeding habitat, except for horsetails. Horsetail feeding sites seemed to occur independently of forest cover and were found in habitat ranging from open, wet meadows to stream sides under a mature spruce canopy (Hamer and Herrero, this volume). Nineteen percent of our horsetail feeding records were from sites where the forest was at least 300 years old.

#### DISCUSSION AND CONCLUSIONS

Except for horsetails, most grizzly bear feeding habitat in our study area was found in open or seral vegetation. Many of these open communities were the result of past fires, although some nonforested subalpine communities appeared to be successional mature. However, a comparison of areas that seemed to differ only in time since the last fire suggested that many of these seemingly mature communities also may have been wildfire-related. Many nonforested subalpine communities therefore may be developing into mature spruce forest that according to our results is little used by foraging grizzly bears.

In moister environments, such as Glacier National Park, B.C. (Hamer 1974), or Waterton Lakes National Park (Hamer et al., unpubl. data), avalanching

has a major role in opening the forest canopy and maintaining important grizzly bear feeding habitat. In our comparatively dry study area, however, avalanching was a relatively minor factor. Avalanched shrubfields accounted for 21% of our buffaloberry feeding records, and avalanching influenced a minor proportion of the dry meadows.

Because the plant communities in grizzly bear feeding habitat often appeared to be succeeding to forest types determined to be unimportant to foraging bears, it seems that grizzly bear feeding habitat will decrease in the absence of recurring wildfire. If this is the case, an eventual decline in grizzly bear density is expected.

The absence of wildfire in southeastern Jasper National Park since the turn of the century was tentatively held responsible for the low number of grizzly bears that Russell et al. (1979) recorded there. These authors estimated 1 grizzly bear/86–102 km<sup>2</sup>, a density considerably lower than the 1 grizzly bear/18–30 km<sup>2</sup> reported for Glacier National Park, B.C. (Mundy and Flook 1973), and Glacier National Park, Mont. (Martinka 1974).

Zager et al. (1983) argued that wildfire in their northwest Montana study area benefitted grizzly bears by removing the forest canopy and creating fruit-producing shrubfields. Most fruit-producing shrubs in their study area resprouted, postfire, from underground rhizomes or root crowns and occurred at higher densities in burns than in undisturbed forest in the same habitat class. Grizzly bears used these shrubfields disproportionately more than predicted from availability during summer/autumn, even though fruit production during 1 year of their data collection was very low due to drought (Zager et al. 1983). In normal years, areas recently burned by wildfire were expected to produce more fruit than forested communities or old burns (Martin 1983).

Because the grizzly bear has a propensity for open or seral habitat, a reduction in open areas could result in conditions more appropriate for the forest-dwelling black bear (*U. americanus*) (Herrero 1972). This partly could explain observations such as Jonkel and Cowan's (1971:22), where grizzly bears were commonly sighted north of their study area in a region where large forest fires had burned repeatedly during the previous 30–40 years. In this region, treeless areas extended "in many places for several miles." In contrast, black bears outnumbered grizzly bears by 15:1 in their black bear study area, where climax spruce-subalpine fir forest covered approximately 80% of the area. In our study area, where 59% of the core

area was regeneration from 5 fires that burned during 1868 and 1936, no black bears were found (Hamer et al. 1981) even though they occurred in adjacent portions of Banff National Park. Our study area is experiencing the longest fire-free interval recorded during the last 400 years. Because grizzly bear feeding habitat is succeeding to little used mature spruce forest, the grizzly population may decrease if wildfires or prescribed burns do not occur.

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