



Grizzly bear activity and human-induced modifications in Pelican Valley, Yellowstone National Park
by Kerry Allan Gunther

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management

Montana State University

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Abstract:

Grizzly bear (*Ursus arctos horribilis*) activity, distribution, habitat use, predation, and earn on use were documented through visual observations in Pelican Valley, Yellowstone National Park, from 1984 through 1988. The impact of recreational activity on grizzly bear behavior, and visitor compliance with bear management regulations and safety warnings were also investigated. Of 961 bear sightings recorded, 83% were identified to species. Most (98%) bears identified to species were grizzly bears. There appeared to be a spatial separation between black bears (*Ursus americanus*) and grizzly bears within the study area. From 14 to 23 individual grizzly bears and 1 to 2 black bears were observed each year. Six to 7 breeding-age females frequented Pelican Valley during the study. Cub production in the valley averaged 3.8 cubs/year; mean litter size was 1.9 cubs/litter. Bear sightings were composed of 66% unclassified adults, 20% females with cubs-of-the-year (COY), 4% females with yearlings, and 11% subadults. The frequency of bear sightings was highest from 16 May through 15 July ($x = 3.7$ bear sightings/year), decreased slightly from 16 July through 15 August ($x = 2.7$ bear sightings/day), then declined significantly after 15 August ($x = 1.3$ bear sightings/day). Bear activity increased from an average of 36 min active/sighting during May and June to 84 min active/sighting during August. Major peaks in diurnal activity occurred at 0600 hours and 2000 hours. Females with COY and subadult bears were more day active than other observed bears. The average distance bears moved from forest cover while being observed was 290 m. Bears used the silver sagebrush (*Artemisia cana*)/Idaho fescue (*Festuca idahoensis*) habitat type and *Trifolium* spp. microsite type in significantly greater proportion than availability. Grizzly bears attempted predation on elk (*Cervus elaphus nelsoni*) calves in 21%, 13%, and 4% of all bear sightings in May, June, and July, respectively. Grizzly bears were successful in killing elk calves in 71%, 42%, and 7% of the observed hunts in May, June, and July, respectively. The mean distance from forest cover of carcasses scavenged by grizzly bears was 327 m. Pelican Valley was managed for 3 levels of backcountry use: open (both day use and overnight camping allowed), restricted use (day use between 0900 hours and 1900 hours only), and closed (no visitor use allowed). The average flight distance of grizzly bears to tree cover following disturbance by backcountry users was 422 m. When the valley was open to visitors, bear activity in areas greater than 500 m from forest cover was significantly reduced, and bears avoided areas around occupied backcountry campsites. No differences in diurnal hourly activity patterns were observed among the open, restricted, and closed periods. During an encounter with a grizzly bear, foot parties were more likely to be charged than people on horseback. All incidents in which hikers were charged by bears involved groups of less than 3 people. Only 17% of the observed hiking parties followed the recommended group size of 4 or more people. Compliance with the area closure and day-use-only regulations was 99% and 83%, respectively.

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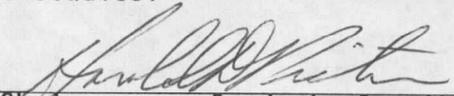
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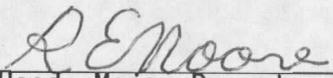
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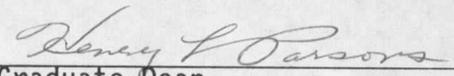
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ABSTRACT

Grizzly bear (*Ursus arctos horribilis*) activity, distribution, habitat use, predation, and carrion use were documented through visual observations in Pelican Valley, Yellowstone National Park, from 1984 through 1988. The impact of recreational activity on grizzly bear behavior, and visitor compliance with bear management regulations and safety warnings were also investigated. Of 961 bear sightings recorded, 83% were identified to species. Most (98%) bears identified to species were grizzly bears. There appeared to be a spatial separation between black bears (*Ursus americanus*) and grizzly bears within the study area. From 14 to 23 individual grizzly bears and 1 to 2 black bears were observed each year. Six to 7 breeding-age females frequented Pelican Valley during the study. Cub production in the valley averaged 3.8 cubs/year; mean litter size was 1.9 cubs/litter. Bear sightings were composed of 66% unclassified adults, 20% females with cubs-of-the-year (COY), 4% females with yearlings, and 11% subadults. The frequency of bear sightings was highest from 16 May through 15 July ($\bar{x} = 3.7$ bear sightings/year), decreased slightly from 16 July through 15 August ($\bar{x} = 2.7$ bear sightings/day), then declined significantly after 15 August ($\bar{x} = 1.3$ bear sightings/day). Bear activity increased from an average of 36 min active/sighting during May and June to 84 min active/sighting during August. Major peaks in diurnal activity occurred at 0600 hours and 2000 hours. Females with COY and subadult bears were more day active than other observed bears. The average distance bears moved from forest cover while being observed was 290 m. Bears used the silver sagebrush (*Artemisia cana*)/Idaho fescue (*Festuca idahoensis*) habitat type and *Trifolium* spp. microsite type in significantly greater proportion than availability. Grizzly bears attempted predation on elk (*Cervus elaphus nelsoni*) calves in 21%, 13%, and 4% of all bear sightings in May, June, and July, respectively. Grizzly bears were successful in killing elk calves in 71%, 42%, and 7% of the observed hunts in May, June, and July, respectively. The mean distance from forest cover of carcasses scavenged by grizzly bears was 327 m. Pelican Valley was managed for 3 levels of backcountry use: open (both day use and overnight camping allowed), restricted use (day use between 0900 hours and 1900 hours only), and closed (no visitor use allowed). The average flight distance of grizzly bears to tree cover following disturbance by backcountry users was 422 m. When the valley was open to visitors, bear activity in areas greater than 500 m from forest cover was significantly reduced, and bears avoided areas around occupied backcountry campsites. No differences in diurnal hourly activity patterns were observed among the open, restricted, and closed periods. During an encounter with a grizzly bear, foot parties were more likely to be charged than people on horseback. All incidents in which hikers were charged by bears involved groups of less than 3 people. Only 17% of the observed hiking parties followed the recommended group size of 4 or more people. Compliance with the area closure and day-use-only regulations was 99% and 83%, respectively.

INTRODUCTION

Backcountry recreational use in Yellowstone National Park (YNP) increased by 53% from 36,219 visitor use nights (VUN) in 1973 to 55,331 VUN's in 1977 (YNP records). Backcountry use then averaged 52,662 VUN's per year from 1978 through 1982, a 45% increase from 1973. As use of backcountry in YNP increased, park managers became concerned over the potential impact of high levels of recreational use on grizzly bear activity in backcountry areas.

Craighead (1980) recommended delineation of critical bear habitat in the Yellowstone ecosystem and restriction of certain types of human activity within these areas. Beginning in 1983, the park seasonally restricted recreational use in specific areas of prime bear habitat. The purposes behind these restrictions, referred to as Bear Management Areas, included: 1) minimizing bear-human interactions that may lead to habituation of bears to people (habituation often results in the bear being removed from the population due to concern for human safety), 2) preventing human-caused displacement of bears from prime food sources, and 3) decreasing the risk of human injury in areas with a high density of bear activity (National Park Service 1982).

In 1984, a 5-yr study to evaluate the effectiveness of using Bear Management Areas as a management tool was initiated. The primary objectives of the study were to: 1) determine the level and distribution of grizzly bear activity in Pelican Valley; 2) document general grizzly bear behavior in the valley including diurnal activity patterns, habitat use, predation, and carrion use; 3) determine if backcountry recreational activity displaced bears from productive

nonforested habitat; 4) determine if backcountry recreational activity disrupted grizzly bear diurnal-activity patterns; and 5) evaluate visitor compliance with bear management regulations and safety warnings.

STUDY AREA

The study area encompassed approximately 4,850 hectares (ha) of nonforested habitat in the Pelican Creek drainage located in the east-central portion of YNP (Fig. 1). Elevations in the study area ranged from 2,377 m to 2,939 m. Most of the study area, however, was relatively flat with elevations between 2,377 m and 2,438 m.

Geology

Three major geologic episodes influenced the formation of Pelican Valley (Keefer 1972). These episodes began when volcanic activity in the Yellowstone area (approximately 600,000 yr ago) released large amounts of magma from underground chambers. Following release of the magma, the area overlying the emptied chambers collapsed creating the Yellowstone caldera:

After formation of the caldera, rhyolite lava flows began seeping from fractures in the bottom of the crater and partially covered the caldera floor. This renewed volcanic activity continued until sometime between 60,000 yr and 75,000 yr ago.

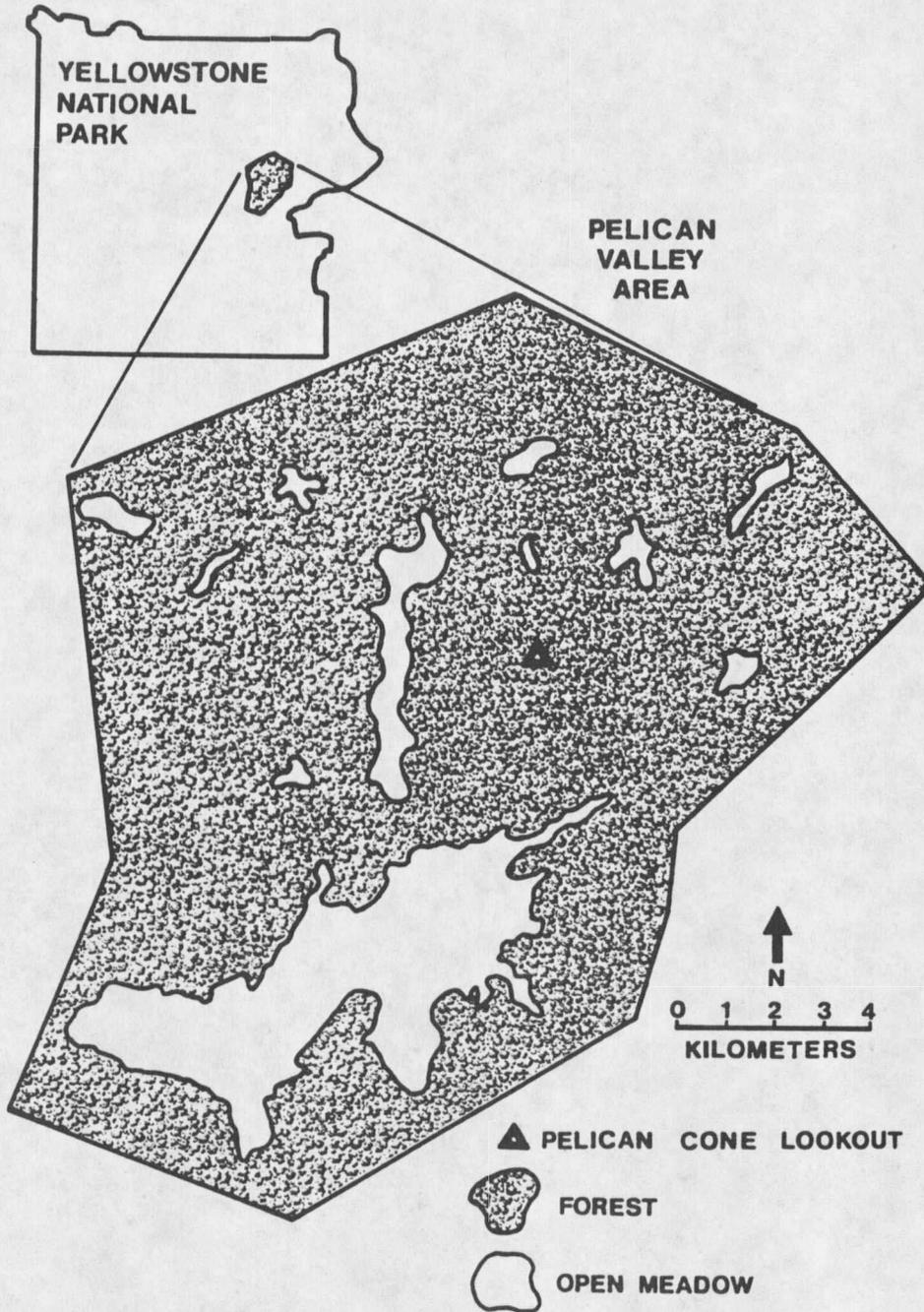


Fig. 1. Nonforested areas in Pelican Valley visible from Pelican Cone Fire Lookout, Yellowstone National Park, 1984-88.

Yellowstone was glaciated at least 3 times. The most recent of these, the Pinedale glaciation, covered almost 90% of present-day YNP. Ice and rock debris left behind by the retreating Pinedale glacier, 12,000 yr to 15,000 yr ago, formed a natural dam which flooded parts of the caldera. The large lake created by the dam extended over the area which now forms Pelican Valley. When the dam broke, partially draining the lake, fertile lacustrine deposits were left behind on the Pelican Valley floor (U.S. Geological Survey 1972).

Climate

Climate in YNP is characterized by long, cold winters, and short, cool summers. Records from the Lake Yellowstone weather station located approximately 8 km west-southwest of the study area show that the mean annual temperature from 1940 through 1970 was 0.2 C (Dirks and Martner 1978). Mean monthly temperatures range from -12 C in January to 13 C in July. The average annual precipitation for 1940 through 1970 was 46.5 cm. Mean monthly precipitation levels range from 5.3 cm in January to 2.9 cm in July. Winds generally blow into the valley from the southwest across Yellowstone Lake and have a cooling effect on summer temperatures but no apparent effect on local precipitation (Martner 1977). National Oceanic Atmospheric Administration (NOAA) records (1984 through 1988) show that mean monthly precipitation in the study area was above average during the first 4 summers of the study and below average during the last summer of the study. Pooled summer (May through September) monthly precipitation levels were 5.3 cm, 12.2 cm, 10.6 cm, and 0.2 cm above normal during the 1984, 1985, 1986, and 1987 field seasons respectively (no NOAA records for June of 1986). Precipitation during the summer of 1988 was 9.0 cm below normal.

Flora

The vegetation of Pelican Valley is a mosaic of community types dominated by grasses, sedges, forbs, and silver sagebrush (Graham 1978, Despain in press). Riparian (streamside) areas are abundant in the valley and provide succulent vegetation during the post-growing season when most herbaceous vegetation has become desicated (Mealey 1975).

Despain (in press) identified 6 nonforested habitat types (h.t.) in Pelican Valley:

1) Silver sagebrush/Idaho fescue (A. cana/Festuca idahoensis, ARCA/FEID) h.t. The ARCA/FEID h.t. is a wet area type dominated by silver sage and idaho fescue. Tufted hairgrass (Deschampsia cespitosa) and species of sedge (Carex spp.) are also common. This type tends to be associated with areas of high water table such as stream banks, seeps, or areas of perched water tables in old lake sediments.

2) Tufted hairgrass/sedge (D. cespitosa/Carex spp., DECE/Carex spp.) h.t. The DECE/Carex spp. h.t. is a grassland type on poorly-drained soils commonly found in drainages where silts and organic matter have accumulated, often accompanied by sedge bogs. Tufted hairgrass shares dominance with various species of sedges such as black-and-white scaled sedge (Carex albonigra) and slenderbeaked sedge (C. athrostachya). American bistort (Polygonum bistortoides), meadow pussy-toes (Antennaria corymbosa), and graceful cinquefoil (Potentilla gracilis) are usually present.

3) Sedge bog h.t. Sedge bog is a wet area type dominated by various species of sedges such as water sedge (C. aquatilis) or inflated sedge (C. vesicaria). Around the fringes of this type are usually the DECE/Carex spp. h.t., and wet forest h.t.'s.

4) Sedge bog-tufted hairgrass/sedge (DECE/Carex-Carex spp.) h.t. complex. The DECE/Carex-Carex spp. h.t. complex is an area with a fine intermixed mosaic pattern of the Carex spp. and DECE/Carex spp. h.t.'s.

5) Idaho fescue/bearded wheatgrass h.t., sticky geranium phase (F. idahoensis/Agropyron caninum-Geranium viscosissimum, FEID/AGCA-GEVI) h.t. complex. The FEID/AGCA-GEVI h.t. complex is a moist phase of Idaho fescue/bearded wheatgrass h.t. with sticky geranium and graceful cinquefoil usually present. Pocket gopher activity is often quite high in these meadows and places are occasionally found where Idaho fescue is nearly absent and a number of taller forbs are common, such as western stickseed (Lappula redowskii), yampa (Perideridia gairdneri), giant frasera (Frasera speciosa), and goldenrod (Solidago missouriensis). California brome (Bromus carinatus), timber oatgrass (Danthonia intermedia), and Reynolds sedge (C. raynoldsii) are also common.

6) Hot springs h.t. The hot springs h.t. is an area with hot spring deposits, warm ground, and a much modified vegetation, usually very short.

The forest types surrounding the valley bottom range from seral lodgepole pine (Pinus contorta) to mature stands of Engelmann spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa) (Despain 1973). These forest zones provide cover, bedding sites, and occasional food for bears (Mealey 1975). The surrounding forests also contain forest seral stages, the result of wildfires that burned in the area in 1933, 1934, 1953, 1974, and 1981 (YNP records). These various successional stages provide a diversity of plant foods.

Fauna

Large herbivores are abundant in Pelican Valley during the spring, summer, and fall, and, at times, they become a food source for bears. Elk are the most abundant large ungulate in the valley and become food for bears both through predation (predominately on calves) and as carrion. Most elk that summer in Pelican Valley migrate from the northern winter range (Craighead et al. 1972, Houston 1982). These elk calve both in the valley and on migration routes along the way (M. M. Meagher, Natl. Park Serv., pers. commun.). The calving period in YNP takes place from about mid-May through mid-June (Rush 1932, Johnson 1951). In aerial surveys of the Pelican Valley elk herd conducted in May and July of 1987, counts ranged from 702 to 1,292 elk (Harting and Singer 1988). The July calf:cow ratio was only 19 calves per 100 cows but was thought to represent less than one-half of the actual rate. In areas of YNP with less shrub cover to conceal calves, ratios from 47 to 61 calves per 100 cows were recorded.

Pelican Valley contains a resident population of approximately 300-500 bison (Bison bison) (M. M. Meagher, Natl. Park Serv., pers. commun.). Bison become food for bears as carrion, predominately in spring, but also occasionally in the summer and fall. Moose (Alces alces shirasi) and mule deer (Odocoileus hemionus hemionus) are found in the valley in lesser numbers and may occasionally become food for bears. In 1984, I observed two bighorn sheep (Ovis canadensis canadensis) on Pelican Cone, and, in 1988, 2 white-tailed deer (Odocoileus virginianus ochrorus) in Pelican Valley; however, bighorn sheep and white-tailed deer are probably too rare in the study area to be of any importance to bears.

Additional animal food resources for bears include small mammals and fish. Pocket gophers (Thomomys talpoides) and voles (Microtus sp.) represent the most important small mammals to bears in the valley (Mealey 1975, Youmans 1979). Pelican Valley contains at least 109 km of cutthroat trout (Oncorhynchus clarki) and longnose sucker (Catostomus catostomus) spawning streams that are shallow enough to be accessible to bears for catching spawning fish, a food source high in fat and protein (Hoskins 1974, 1975; Mealey 1975; Graham 1978; Natl. Park Serv. 1984).

Secondary consumers inhabiting the study area that compete with grizzly bears for food, especially carrion, include the black bear (Ursus americanus) and coyote (Canis latrans). Other secondary consumers observed in the valley include pine marten (Martes americana) and weasels (Mustelidae) as well as avian predators and scavengers.

Pelican Valley's riparian bottoms, variety of vegetation community types, interspersed open meadows and forest cover, spring bison mortality, elk calving areas, pocket gophers, and spawning streams combine to make the valley an area with a high level of grizzly bear activity (Graham 1978, Youmans 1979, Natl. Park Serv. 1982).

Recreational Use

Pelican Valley is a popular recreational area for backpacking, horse packing, day hiking, and fishing. The study area contained 13 backcountry campsites and 66 km of hiking trails. The campsites had a combined total capacity of 228 people and 285 stock (pack and saddle animals) per night (Table 1).

During the 11 years preceding (1973 through 1983) the 1984 establishment of the Pelican Valley Bear Management Area, overnight use

Table 1. Campsite number, Universal Transverse Mercator (UTM) location, person limit, and stock limit for backcountry campsites in Pelican Valley, Yellowstone National Park, 1984.

Campsite number	UTM location	Capacity	
		Number of people	Number of stock
5A1	4940.7N, 559.8E	12	15
5C1	4938.4N, 564.6E	12	15
5P1	4935.8N, 559.1E	20	25
5P2	4937.0N, 561.3E	20	25
5P3	4939.7N, 561.5E	20	25
5P4	4940.2N, 562.3E	20	25
5P5	4948.4N, 560.0E	12	15
5P6	4949.3N, 556.0E	20	25
5P7	4949.6N, 563.5E	20	25
5R1	4939.1N, 563.5E	20	25
5R2	4940.4N, 564.7E	20	25
5T2	4933.6N, 559.3E	20	25
5W1	4930.1N, 558.2E	12	15

in the valley averaged 1,632 VUN's per year (Natl. Park Serv. 1984). Records of day use in the valley were not available for the years prior to 1981. From 1981 through 1983 combined overnight and day use averaged 84 people and 11 horses per day during the peak season (July and August).

After designation as a Bear Management Area in 1984, Pelican Valley was closed to recreational use each year through 3 July. Closing Pelican Valley during the spring and early summer helps to prevent displacement of bears from prime habitat during a critical period (Natl. Park Serv. 1986a).

On 31 July 1984, all campsites (backpacker and stock sites) in Pelican Valley were closed after a backpacker, camping alone, was pulled from her tent and killed by a grizzly bear. On 4 July 1985, 4 stock campsites in Pelican Valley were reopened. In 1986, all campsites in Pelican Valley were again closed, and in an effort to further reduce human disturbance of bears and to increase visitor safety, day use after 3 July was limited to the hours between 0900 and 1900. The 1986 regulations were part of the mitigating procedures of the Interim Management Plan for Operations at Fishing Bridge and Grant Village (Natl. Park Serv. 1986a). All campsites remained closed after the Final Environmental Impact Statement (EIS), Development Concept Plan, for the Fishing Bridge Developed Area was approved in 1988 (Natl. Park Serv. 1988).

METHODS

Monitoring Bear Activity In Pelican ValleyBear Observations

Bears and people were observed from the Pelican Cone Fire Lookout (elevation 2,939 m) from 18 June - 22 September 1984, 6 June - 18 August 1985, 10 June - 7 September 1986, 15 May - 7 September 1987, and 18 June - 22 July 1988.

The lookout, a stationary, nonintrusive vantage point, allowed viewing of most of the nonforested areas in the surrounding drainages. Scans were made with binoculars (11x80); a 2,000-mm telescope with a usable magnification of 44- to 77-power allowed detailed observations. Hills, as well as the treeline around the edge of the valley, created blind spots which in some cases blocked the view of nonforested areas for up to 1,000 m behind the obstruction.

Since grizzly bears in YNP are generally most active during nocturnal and crepuscular hours (Schleyer 1983, Harting 1985), the nonforested areas were scanned once every half hour from 0500 hours to 1100 hours and from 1800 hours to 2145 hours. Between 1100 and 1800 hours, the valley was scanned once every hour. Observations could not be made at night nor in forested areas. Fog, low lying clouds, haze, heatwaves (magnified by the telescope), and heavy precipitation sometimes limited observations. Each summer the observation period slowly increased with the lengthening daylight hours until summer solstice (21 June), then slowly decreased for the remainder of the field season. Since bears could be observed only during daylight

hours, only bears exhibiting crepuscular or diurnal activity patterns are included in this study. Most bears should be included, however, since bears exhibiting nocturnal activity patterns generally have crepuscular activity peaks (Schleyer 1983, Harting 1985).

When bears were spotted, they were watched continuously except for short periods when the rest of the valley was scanned for other bears. Bears observed together, such as females with young, breeding pairs, or subadult groups, were recorded as 1 bear sighting.

The following data were recorded for each bear sighting: date; time; Universal Transverse Mercator (UTM) grid location (determined from USGS 7.5-min series orthophotoquad maps); number of bears; species; size; coloration; age class; activity; length of time observed; maximum distance from cover; total distance traveled; vegetation type; proximity to backcountry campsites; and interactions with other bears, other wildlife, or people (Appendix A). Travel routes of bears observed were drawn onto USGS 15-min topographical quadrangle maps.

Identifying Species Of Bear

All bears observed were classified as grizzly bears, black bears, or unknown bear species. Presence or absence of a prominent hump (shoulder muscle mass), head profile, and behavioral characteristics, such as ranging far from tree cover, were used to distinguish between grizzly bears and black bears (Herrero 1977, 1985; Schullery 1986). None of these distinguishing characteristics are 100% certain; however, most bears sighted from Pelican Cone in August 1984, as well as some bears observed from 1985 through 1988, were field checked by patrol rangers. Rangers approached to within 100 m and observed the bears

with binoculars or spotting scopes. Classifications by rangers were in complete agreement with classifications by the Pelican Cone observer.

Eighty-three percent of 961 observed bears were identified to species. Of these, 98% were grizzly bears and only 2% were black bears. Most bears that could not be identified to species were observed under poor viewing conditions during crepuscular time periods. Grizzly bears in the Yellowstone ecosystem are active primarily during crepuscular and nocturnal time periods (Schleyer 1983, Harting 1985) whereas black bears are active primarily during crepuscular and diurnal time periods (Schleyer 1983, Mack 1988). For data analysis, I assumed that the proportion of grizzly bears in the sample of observations that could not be identified to species was similar to the proportion of grizzly bears from the sample that was identified to species. Data from bears classified as grizzly bears and unknown bear species were pooled for analysis. Pooling of the data should result in only a 2% error in species classification. Black bear observation data was omitted from analysis in this paper except for the "Individual Bears," "Species of Bear," and "Predation" sections.

Identifying Individual Bears

The minimum number of individual bears using the area was estimated. Since few radiocollared bears frequented the area, bears were identified by species, size, color, age class, unusual markings, or family groups (subadult pairs and females with cubs, yearlings, or 2-yr olds). The primary basis for this estimate was the highest number of single bears observed at any one time (or within a short time period at widely separated locations so that there was no chance of duplication), plus the number of different noncollared family groups

(distinguished by the number of young and pelage-color combinations) and radiocollared bears observed in the area.

Breeding-Age Females

Female grizzly bears with cubs-of-the-year (COY) should, in theory, make up approximately one-third of the adult female population. The other two-thirds of the females will generally be accompanied by yearlings or will be reproductively available. The number of breeding-age females frequenting an area can be estimated by counting the number of different females with COY over a 3-yr period (Knight and Eberhardt 1985). A running 3-yr sum was used to estimate the number of breeding-age females frequenting Pelican Valley during the study.

Population Structure

Five categories of bears were distinguished from Pelican Cone: 1) females with COY (COY < 1/4 of the adult female's size); 2) females with yearlings (yearlings = 1/4 to 1/2 of the adult female's size); 3) females with 2-yr olds (2-yr olds = 1/2 to 3/4 of the adult female's size); 4) unclassified adults (single bears > 90 kg); and 5) subadult bears (small bears < 90 kg, most often observed with a sibling).

Activity Pattern Monitoring

Bear-activity min (BAM) were recorded for each min that bears were observed in the open. BAM were divided into 1-hour time blocks for activity pattern comparisons.

Weather

Weather data used for seasonal comparisons was recorded daily at the Lake Ranger Station located approximately 8 km west-southwest of

the study area. The daily amount of precipitation, maximum temperature, and minimum temperature were the only types of weather data recorded at this station. Due to the cooling effect of Yellowstone Lake (Martner 1977), temperatures recorded at the Lake Ranger Station were probably cooler than actual temperatures in Pelican Valley.

Distance From Forest Cover

For each bear sighting, the maximum distance that bears moved from forest cover was recorded. Distances were determined by estimation, measurement on USGS 1:62,500 topographic maps, or measurement on 1:24,000 orthophotoquad maps.

Habitat Use

Vegetation in Pelican Valley has been classified and mapped by Graham (1978) and Despain (in press). Although Graham mapped the valley to a finer scale, the broader classification system used by Despain was better suited for this study since his vegetation categories were more easily distinguished from the top of Pelican Cone. From the lookout, 6 nonforested h.t.'s and 1 microsite type were distinguished. If bears used each vegetation type randomly, the percentage of BAM within each vegetation type would approximate the percentage of the total area each vegetation type occupied. Habitat use vs. availability analysis methods followed procedures described by Neu et al. (1974).

Vegetation Phenology

During 1986 and 1987, a vegetation phenology monitoring program was conducted in conjunction with the study. The phenology monitoring

was designed to determine how changes in plant phenology might affect the amount of bear activity in Pelican Valley. Roadside areas were monitored once per week to determine if a major change in plant phenology coincided with any change in the number of bear sightings recorded. Roadside areas were used to reduce costs, travel time, and human impact on high-use bear areas within the valley. Since the roadside areas monitored were located within 1.6-3.2 km of the southern edge of the study area and were at a similar elevation, they were fairly representative of the valley as a whole. Four h.t.'s as described by Despain (in press): ARCA/FEID, Carex spp., DECE/Carex spp., and DECE/Carex-Carex spp., comprise 98% of the study area. Four roadside areas representing these h.t.'s were selected and used to monitor changes in the plant phenology of the important bear plant foods in the area. Plants were classified as to stage of development according to criteria defined by Brazda (1953) as follows:

1) succulent--no flowers evident; 2) succulent--flowers developing or developed; 3) succulent or curing--flowers mature or degenerating; 4) in or beginning to seed. Only plant species considered important to bears (Mattson and Despain 1985) were monitored. All common plant species that were considered important to bears were identified in each of the 4 roadside h.t.'s.

One day each month, plants from areas inside Pelican Valley were checked and classified as to stage of development. The Pelican Valley phenology monitoring was used to determine if the roadside stage of plant phenology coincided with the actual stage of phenology within Pelican Valley.

Food Habits

Scat Collection and Analysis--In July and August 1987, scats were collected from locations where I observed grizzly bears foraging. Scats were collected and analyzed by the Interagency Grizzly Bear Study Team in conjunction with a grizzly bear feedsite examination study (Knight et al. 1988). Scat analysis methods followed procedures described by Blanchard (1985).

Feeding Site Analysis--From May through August 1987, investigations were conducted at locations where I observed grizzly bears foraging (Knight et al. 1988). Procedures used in the ground investigation of feeding sites are described by Blanchard (1985).

Predation--Attempts at predation by grizzly bears were recorded on predation field forms (Appendix B). An attempt at predation was defined as a bear sighting in which the bear(s) chased, stalked, or otherwise searched for various prey. A hunt was considered "in progress" until the bear(s) successfully killed or completely stopped chasing prey for the remainder of the bear sighting.

During attempted predation on elk, chase durations of less than 1 min were estimated to the nearest 5-sec interval. Chases of greater than or equal to 1 min were timed to the nearest minute. The length of chases of 200 m or less were estimated. Travel routes of chases greater than 200 m were drawn onto USGS 15-min topographic quadrangle maps and measured. Attempts by grizzly bears to prey on species other than elk were simply recorded as successful or unsuccessful.

Evaluating Visitor Impact On Grizzly Bear Activity

Bear Observations

Bear observations were divided into 3 categories which represented different levels of backcountry use: open periods (both day use and overnight camping allowed), restricted day-use periods (day use between 0900 and 1900 hours only; no overnight camping allowed), and closed periods (no recreational use allowed). Due to consideration for visitor safety, a set schedule for testing each regulation could not be followed. As part of the Pelican Valley Bear Management Area Program initiated in 1984, the study area was closed each spring through 3 July to prevent displacement of bears from prime habitat (Natl. Park Serv. 1986a). The valley opened 4 July but was reclosed following bear-caused human fatalities or injuries, confrontations between bears and recreational users, or the presence of carcasses or concentrated bear activity along trails. After 1985, all campsites in Pelican Valley were closed, and after 3 July, day use was limited to between 0900 hours and 1900 hours. The restricted day-use-only regulation was implemented in an effort to further reduce human disturbance of grizzly bears and to increase visitor safety by reducing the chance of encounters between recreational users and bears (Natl. Park Serv. 1986a).

Recreational Activity

Human use of the valley was monitored at the same time as bear use. Backcountry users were first located with binoculars and then observed for a short time with a telescope to determine the number of people and type of use. Data collected included number of people in

each party, number of stock (pack and saddle animals), type of use (day or overnight use), campsite number, current visitor-use regulations, and compliance with regulations and safety warnings. Trail registers were not used because they generally have a low rate of compliance, especially among horseback riders (Wenger and Gregersen 1964, Blanchard 1978). Backcountry permits are not completely reliable records of overnight use as inclement weather often results in shortened trips or nonuse of the obtained permit (Chester 1976). Administrative use is not recorded on trail registers or backcountry permits.

Bear-Human Encounters

Interactions between grizzly bears and recreational users were recorded on bear-human encounter field forms (Appendix C). A bear-human encounter was defined as any incident where a human's presence caused a bear to react or where a bear's presence caused a human to react.

Displacement Of Bears From Nonforested Areas

Chi-square analysis was used to test the hypothesis that the distance which observed bears moved from forest cover was independent of recreational activity in the valley.

Proximity To Backcountry Campsites

In 1984, 5 of the 13 campsites in the study area were visible from Pelican Cone. In 1985, 2 of these 5 campsites were closed; all were closed thereafter. The number of bear sightings within 400 m of backcountry campsites was recorded when the campsites were occupied and unoccupied. Chi-square analysis was used to test the hypothesis that the observed frequency of bear sightings within 400 m of campsites was

independent of campsite occupancy. The frequency data from the 5 campsites were pooled to increase sample size and the power of the test. All 5 campsites were located at the edge of forest cover and ARCA/FEID habitat. A heterogeneity test indicated that the 5 sets of data could be justifiably pooled.

Statistical Analysis

For statistical analysis, multiple linear regression, Mann-Whitney U, Kruskal-Wallis, Chi-square, heterogeneity, and Fisher exact tests followed procedures described by Zar (1974). $P < 0.05$ was considered to be significant.

RESULTS

Bear Activity in Pelican Valley

During 309.5 observation days, 1,382 bears were observed in 961 bear sightings (family groups and breeding pairs were recorded as multiple bears but as one bear sighting). Bears were observed at distances from 1.6 km to 12.1 km from Pelican Cone and at elevations from 2,377 m to 2,755 m.

Species Of Bear

Of 961 bear sightings recorded, 777 (81%) were grizzly bears, 17 (2%) were black bears, and 167 (17%) could not be identified to species (Table 2).

There appeared to be a spatial separation between black bears and grizzly bears within the study area. Most grizzly bears (72%) were observed within Pelican Valley proper while most black bears (65%) were observed in the smaller meadows and drainages surrounding the main valley. The upper reaches of Raven Creek, north of the main valley, accounted for 41% of all black bear sightings but only 3% of all grizzly bear sightings.

Individual Bears

The minimum number of individual grizzly bears observed each year in Pelican Valley ranged from 14 (1984) to 23 (1986) ($\bar{x} = 18.2 \pm 3.5$ SD, Appendix Table 17). The minimum number of individual black bears

observed each year ranged from 1 (1986) to 2 (1984, 1985, 1987, and 1988) ($\bar{x} = 1.8 \pm 0.4$ SD).

Table 2. Number of grizzly, black, and unknown species of bear observed in the nonforested areas of Pelican Valley, Yellowstone National Park, 1984-1988.

Year	<u>Grizzly bears</u>		<u>Black bears</u>		<u>Unknown species</u>	
	Number	Percent	Number	Percent	Number	Percent
1984	119	84	5	4	17	12
1985	151	78	3	2	39	20
1986	215	80	4	2	48	18
1987	206	81	3	1	46	18
1988	86	82	2	2	17	16
Total	777	81	17	2	167	17

Population Structure

Grizzly bear sightings in Pelican Valley were composed of 59% unclassified adults, 7% mating pairs, 20% females with COY, 4% females with yearlings, and 11% subadults (Table 3). A total of 557 unclassified adults were observed. The percentage of unclassified adult observations was highest in May (71%), then decreased gradually from June (68%) through July (55%) and August (50%). Sample size of observations during September was too small to make valid comparisons.

Table 3. Number of observations of grizzly bear mating pairs, unclassified adults, females with cubs of the year (COY), females with yearlings, and subadults recorded from May through September in the nonforested areas of Pelican Valley, Yellowstone National Park, 1984-1988.

Month	Mating pairs		Unclassified adults		Females with COY		Females with yearlings		Subadults		Total by month	
	N	%	N	%	N	%	N	%	N	%	N	%
May	4	14	20	71	0	0	2	7	2	7	28	3
June	45	14	218	68	20	6	13	4	27	8	323	34
July	13	3	220	55	99	25	22	6	46	12	400	42
August	0	0	92	50	66	36	0	0	26	14	184	20
September	0	0	7	78	0	0	0	0	2	22	9	1
Total	62	7	557	59	185	20	37	4	103	11	944	100

Sixty-two observations of grizzly bear male-female associations in which the male displayed sexually aggressive behavior were recorded. Of all bear sightings, 14%, 14%, and 3% in May, June, and July, respectively, were of mating pairs. No mating pairs were observed in August or September. Three apparent copulations were observed. Time in copulation ranged from 18 min to 29 min. Dates of observed copulations were 12 June, 19 June, and 22 June. Observed behavior patterns of mating pairs were significantly different from those of single adult bears. Mating pairs were observed from 21 May - 27 July. Behavior pattern comparisons with single adult bears were made for the same time period. Mating pairs spent significantly more time in the open (mating pairs $\bar{x} = 50 \text{ min} \pm 49 \text{ SD}$, $n = 61$, vs. single adults $\bar{x} = 39 \text{ min} \pm 48 \text{ SD}$, $n = 447$, Mann-Whitney $U = 11,125$, $P = .02$), traveled significantly further while in the open (mating pairs $\bar{x} = 1,014 \text{ m} \pm 1,312 \text{ SD}$ vs. single adults $\bar{x} = 641 \text{ m} \pm 824 \text{ SD}$, $U = 9,751$, $P = .03$), and moved significantly farther from tree cover (mating pairs $\bar{x} = 341 \text{ m} \pm 319 \text{ SD}$ vs. single adults $\bar{x} = 245 \text{ m} \pm 290 \text{ SD}$, $U = 10,884$, $P = .01$) than did single adult bears.

A total of 185 female bears with COY were observed. A running 3-yr sum of the number of individual female grizzly bears with COY observed during this study indicated that 6 to 7 different breeding age females frequented Pelican Valley, at least during years when they were accompanied by cubs (Table 4). An average of 2 ($\pm 1.2 \text{ SD}$) grizzly bear females raised cubs in the Pelican Valley area each year of the study (Table 4). The mean number of cubs observed was 3.8 ($\pm 3.0 \text{ SD}$) per year. Litter sizes observed in the valley averaged 1.9 ($\pm 0.6 \text{ SD}$) cubs per female. Female bears with COY were not observed in Pelican Valley during May, comprised only 6% of the observed bears during June, but comprised 25% and 36% of the observed bears during July and August,

respectively. Dates of first sightings of females with COY were 19 June 1984, 27 July 1985, 12 June 1986, 11 June 1987, and 25 June 1988. Females with COY made up from 5% (9 of 193 sightings in 1985) to 42% (113 of 267 sightings in 1986) of all bear sightings in a given year. The number of different female grizzly bears with COY observed each year was weakly correlated to the whitebark pine nut production from the fall of the previous year ($df = 4$, $r = 0.86$, $P = 0.06$). The number of female grizzly bears accompanied by cubs was higher following years of moderate to high pine nut production than following years of pine nut scarcity (Table 5).

Table 4. Number of female grizzly bears with cubs of the year (COY), COY, and mean litter size observed in the nonforested areas of Pelican Valley, Yellowstone National Park, 1984-1988.

Year	Number of females with COY	Total number of COY	Mean litter size
1984	2	3	1.5
1985	1	2	2.0
1986	4	9	2.3
1987	1	2	2.0
1988	2	3	1.5
Total	10	19	1.9

Thirty-seven female bears with yearlings were observed. During May, June, and July, females with yearlings comprised 7, 4, and 6 percent of the observed bears, respectively. Females with yearlings were not observed in August or September.

Table 5. Yearly comparison between the number of observations of female grizzly bears with cubs of the year (COY) recorded in Pelican Valley, Yellowstone National Park, and the whitebark pine cone production in the Yellowstone ecosystem from the fall of the previous year, 1984-1988.

Year	Number of females with COY	Whitebark pine cone production from previous fall (mean cones/transect) ^a
1984	2	170
1985	1	60
1986	4	257
1987	1	13
1988	2	25

^aWhitebark pine cone production data from Knight et al. 1989.

Subadult bears were observed on 103 occasions. The percentage of sightings of subadult bears gradually increased from 7% in May, to 8% in June, to 12% in July, and to 14% in August. Sample size of observations during September was too small to make valid comparisons.

Activity Patterns

The frequency of grizzly bear sightings was highest from 16 May through 15 July (\bar{x} = 3.7 bear sightings/day), decreased slightly from 16 July through 15 August (\bar{x} = 2.7 bear sightings/day), then declined considerably after 15 August (\bar{x} = 1.3 bear sightings/day, Table 6).

Observed bears were active in nonforested areas an average of 36 min per sighting during May and June. Activity increased to a mean of 70 min per sighting in July and 84 min per sighting during August. Activity then decreased to a mean of 39 min per sighting in September.

Table 6. Number of observations of grizzly bears (GR) and black bears (BL) in the nonforested areas of Pelican Valley, Yellowstone National Park, during 2-week periods from May through September, 1984-1988.

		<u>1984</u>		<u>1985</u>		<u>1986</u>		<u>1987</u>		<u>1988</u>		<u>Total</u>		<u>Number of Observation</u>		<u>Mean Observations Per Day</u>	
		GR	BL	GR	BL	Days		GR	BL								
May	16 - 31							28	1			28	1	7	4.0	0.1	
June	1 - 15			38	2	18		43	1			99	3	25.5	3.9	0.1	
	16 - 30	28	1	37		82	2	39		38	2	224	5	64.5	3.5	0.1	
July	1 - 15	32	3	42	1	40		91		49		254	4	68	3.7	0.1	
	16 - 31	20		36		39		35		16		146		61.5	2.4		
August	1 - 15	49	1	36		49	1	11				145	2	44.5	3.3	0.04	
	16 - 31			1		33		5	1			39	1	27.5	1.4	0.04	
Sept.	1 - 15					2	1					2	1	6.5	0.3	0.2	
	16 - 30	7										7		4	1.8		

Major peaks in diurnal activity occurred at 0600 hours and 2000 hours (Fig. 2). Only 6% (n = 56,480 BAM) of the observed activity occurred between 1200 hours and 1600 hours. Activity patterns of subadult bears and females with COY differed from those of all other bears observed (Fig. 3). The peak in morning activity occurred later for subadults (0900 hours) and females with COY (0800 hours) than for females with yearlings (0600 hours) and all other observed bears (0600 hours). The percentage of observed activity minutes during the late morning and afternoon hours (1000 hours-1700 hours) was also greater for subadults (22% of observed activity, n = 6,846 BAM) and females with COY (35% of observed activity, n = 20,052 BAM) than for females with yearlings (2% of observed activity, n = 3,049 BAM) and all other bears observed (12% of observed activity, n = 26,533 BAM).

Habitat Use

Bear activity was not distributed randomly throughout the nonforested areas of Pelican Valley. Habitat type, presence of concentrated food sources such as carrion or dense clover patches, distance from forest cover, and proximity to human activity centers all appeared to influence the distribution of bear activity in the valley.

The average distance bears moved from forest cover while being observed was 290 m \pm 323 SD. Thirty-eight percent (n = 944) of the observed grizzly bears remained within 100 m of forest cover while being observed (Table 7). Forty percent of the observed bears were active in areas from 100 m to 500 m from forest cover, and 22% were active in areas farther than 500 m from cover.

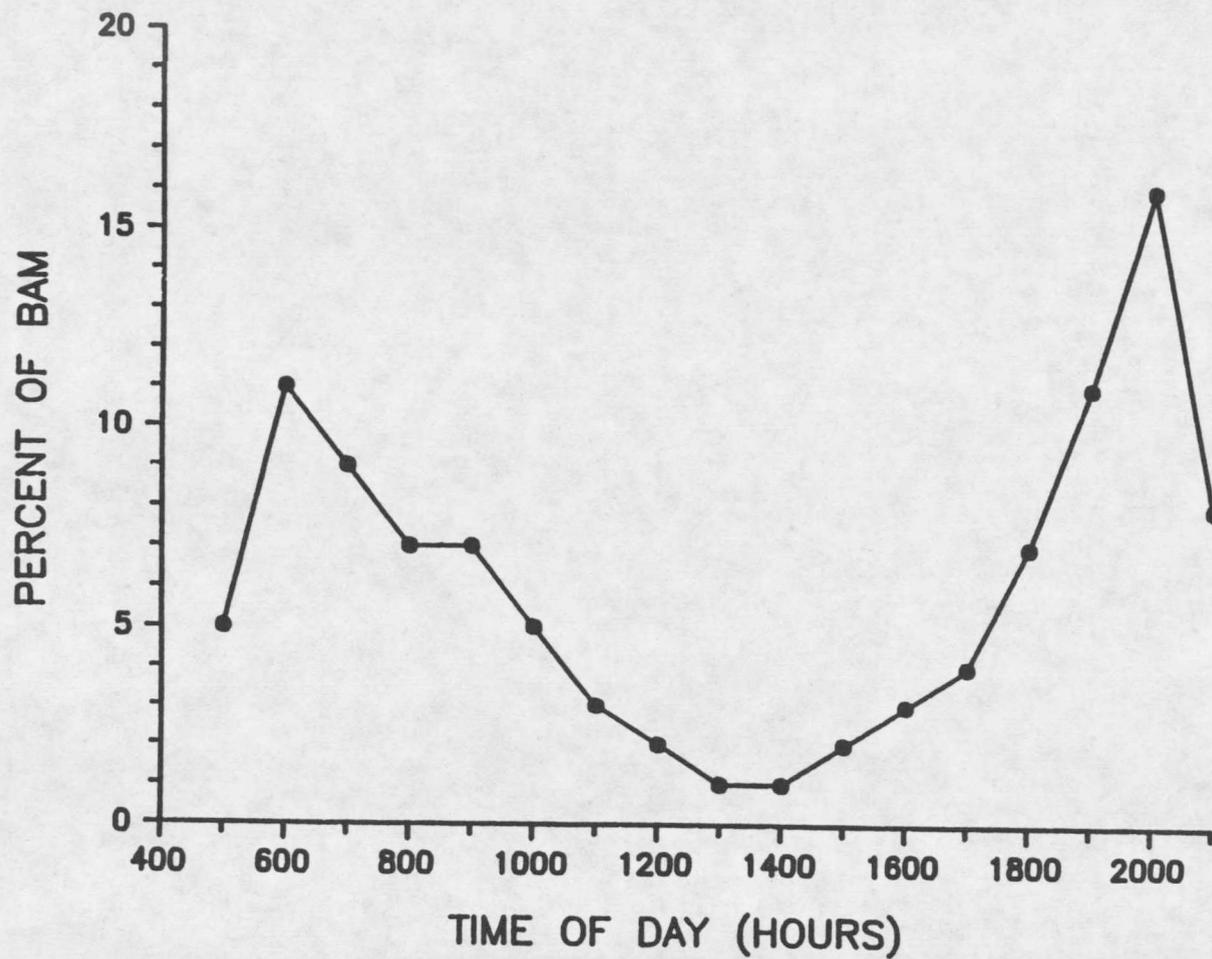


Fig. 2. Diurnal activity profile of grizzly bears in Pelican Valley, YNP, from May through September, 1984-88. Points indicate the percentage of total bear activity minutes (BAM) observed per 1-hour time block.

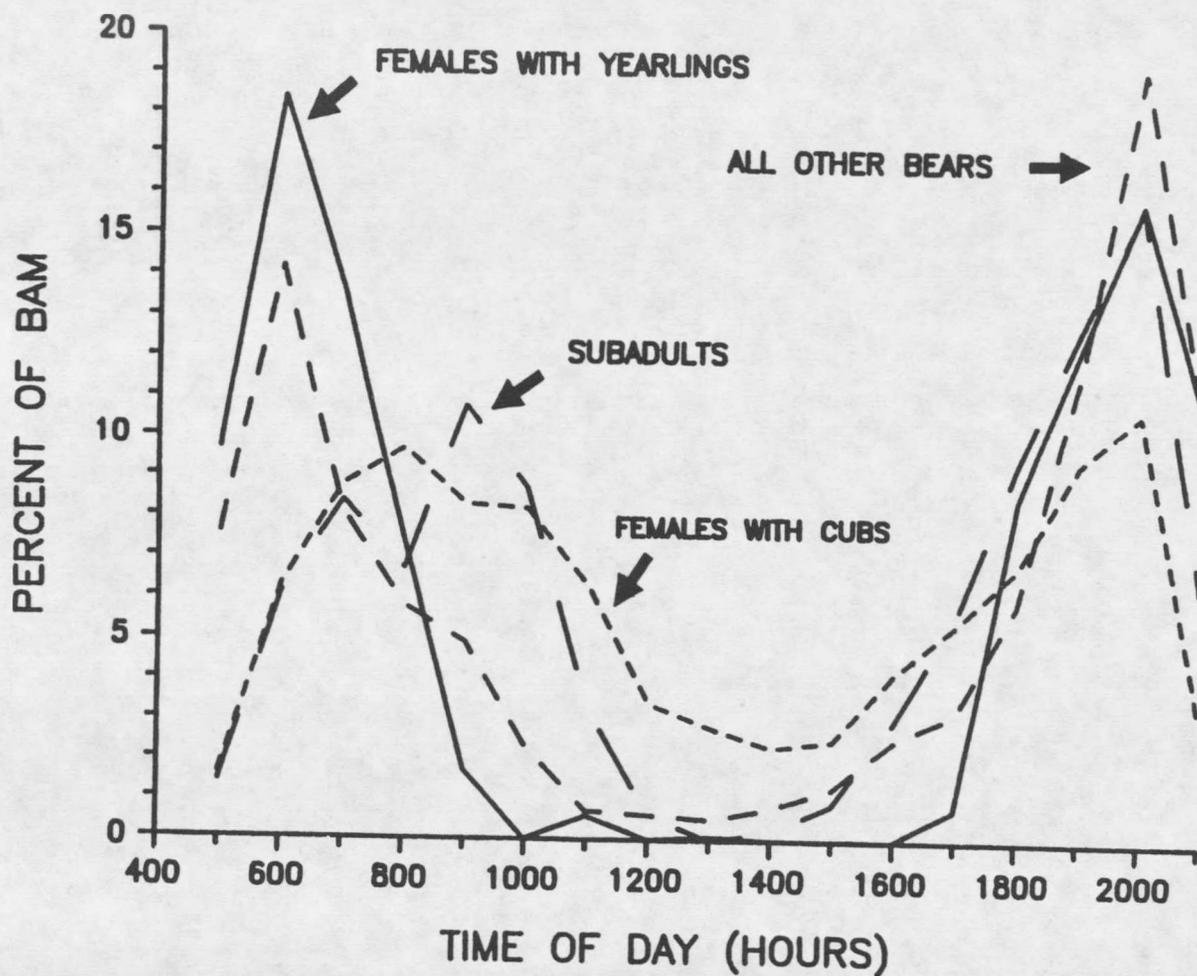


Fig. 3. Diurnal activity patterns of grizzly bear cohorts in Pelican Valley, YNP, from May through September, 1984-88. Points indicate the percentage of total bear activity minutes (BAM) observed per 1-hour time block.

Table 7. Distance of observed grizzly bears from forest cover in Pelican Valley, Yellowstone National Park, 1984-1988.

0 - 50 m		51 - 100 m		101 - 300 m		301 - 500 m		501 - 1,000 m		>1,000 m	
N	%	N	%	N	%	N	%	N	%	N	%
225	24	132	14	283	30	98	10	180	19	26	3

Bears did not use all vegetation types in proportion to availability ($\chi^2 = 15,676.3$, $df = 6$, $P < 0.001$, Table 8). The ARCA/FEID h.t. accounted for 52.2% of the nonforested area in Pelican Valley visible from Pelican Cone. Overall, this type was the most frequently used vegetation type in the valley, accounting for 53.1% of recorded BAM. The ARCA/FEID h.t. was used in significantly greater proportion than availability during May through July and less than availability during August through September.

The DECE/Carex spp.-Carex spp. h.t. complex accounted for 26.5% of the nonforested area visible from Pelican Cone. This type was used significantly less than availability during all months except September when it was used in significantly greater proportion than availability.

The Carex spp. h.t. accounted for 12.6% of the nonforested area visible from Pelican Cone. This h.t. was used significantly more than proportionate availability during July and significantly less than proportionate availability during all other months.

Table 8. Proportion of use versus availability of observed bear activity minutes in different nonforested vegetation types in Pelican Valley, Yellowstone National Park, 1985-1988.

Vegetation Type	Observable acres	Proportion of total observable acres	Observed bear activity minutes	Expected bear activity minutes	Proportion of total bear activity minutes	Confidence interval on proportion of occurrence (90% family confidence coefficient)
ARCA/FEID	3,070	0.522	24,903	24,469	0.531	$0.525 < \pi < 0.537$
DECE/ <u>Carex</u> - <u>Carex</u> spp.	1,560	0.265	9,102	12,422	0.194	$0.190 < \pi < 0.199$
<u>Carex</u> spp.	740	0.126	5,904	5,907	0.126	$0.122 < \pi < 0.130$
DECE/ <u>Carex</u>	220	0.037	864	1,734	0.018	$0.017 < \pi < 0.020$
<u>Trifolium</u> spp. microsite	190	0.032	6,031	1,500	0.129	$0.125 < \pi < 0.133$
FEID/AGCA-GEVI	80	0.014	52	656	0.001	$0.0006 < \pi < 0.001$
Thermal Areas	20	0.003	21	141	0.004	$0.0002 < \pi < 0.0006$

The DECE/Carex spp. h.t. accounted for 3.7% of the nonforested area visible from Pelican Cone. This h.t. was used in significantly greater proportion than availability during May, in proportion to availability in June, and significantly less than availability during July through September.

Three areas containing small, dense patches of clover could be distinguished from Pelican Cone. These areas comprised approximately 3.2% of the study area. The Trifolium spp. microsite was used in significantly greater proportion than availability during May through September. Use of this vegetation type was greatest during August and September when it accounted for 25.2% and 27.8% of recorded BAM, respectively. When feeding on clover, bears from different social groups were observed to feed within close (25 m) distances of each other. This tolerance was noted only for clover and carrion.

The FEID/AGCA-GEVI h.t. complex and thermal area h.t. accounted for 1.4% and 0.3%, respectively, of the nonforested area visible from Pelican Cone. These areas were used significantly less than proportionate availability during all months of the study.

Food Habits

Vegetation.--A total of 22 vegetal foods important to grizzly bears were identified in the nonforested areas of Pelican Valley (Table 9). Vegetal foods found in Pelican Valley included 11 graminoid and 11 forb species.

In July and August 1987, 54 scats were collected from locations where grizzly bears were observed grazing. Graminoids and clover dominated the percentage frequency of occurrence and the percentage volume content of scats collected. Percent frequency/volume of graminoids and clover were 87.0/53.2 and 77.8/35.7, respectively.

Percent frequency/volume of other species consumed, in order of frequency, were whitebark pine nuts (Pinus albicaulis) 7.4/4.8, ants (Formicidae) 7.4/0.7, elk thistle (Cirsium scariosum) 5.7/3.7, mammals 5.6/1.3, dandelion (Taraxacum spp.) 1.9/0.2, mushrooms (Basidiomycotina) 1.9/0.2, and horsetail (Equisetum arvense) 1.9/0.2.

Table 9. Bear vegetal food species present in the nonforested areas of Pelican Valley, Yellowstone National Park, 1984-1988.

Forbs	Graminoids
<u>Cirsium scariosum</u>	<u>Agropyron</u> spp.
<u>Epilobium</u> spp.	<u>Bromus</u> spp.
<u>Equisetum arvense</u>	<u>Calamagrostis</u> spp.
<u>Equisetum</u> spp.	<u>Carex</u> spp.
<u>Fragaria</u> spp.	<u>Deschampsia</u> spp.
<u>Mertensia ciliata</u>	<u>Elymus glaucus</u>
<u>Perideridia gairdneri</u>	<u>Festuca</u> spp.
<u>Polygonum bistortoides</u>	<u>Melica</u> spp.
<u>Taraxacum</u> spp.	<u>Phleum</u> spp.
<u>Trifolium longipes</u>	<u>Poa</u> spp.
<u>Trifolium repens</u>	<u>Scirpus</u> spp.

Investigations were conducted at 32 locations where bears were observed foraging. The most frequently recorded activities associated with feeding sites were grazing on clover (59%) and grazing on graminoids (38%). Other feeding activities recorded at foraging sites included preying on elk calves (16%), feeding on dandelion (16%),

feeding on thistle (16%), digging for small mammals (6%), digging yampa (*Perideridia gairdneri*, 3%), and scavenging bison carrion (3%, Table 10).

Predation--Adult elk had already arrived in Pelican Valley from the northern winter range when observations began each year. The earliest newborn calf sighting occurred 22 May 1987 and the latest on 24 June 1988.

In 944 grizzly bear sightings, 70 hunts, 26 of them successful, were observed on elk groups containing calves (Table 11). Of all grizzly bear sightings, 21% (6 of 28 sightings), 13% (43 of 323 sightings), and 4% (16 of 400 sightings) in May, June, and July, respectively, involved hunts on cow/calf groups. No hunts were observed in August or September. Hunts for elk calves ranged in time from 5 sec to 71 min ($\bar{x} = 11.7 \text{ min} \pm 2.3 \text{ SE}$) and covered distances from 5 m to 4,812 m ($\bar{x} = 812 \text{ m} \pm 128 \text{ SE}$). Bears tended to chase elk groups containing calves for longer time periods (Mann-Whitney U-test, $U = 98$, $P = 0.001$) and for greater distances ($U = 111$, $P = 0.002$) than elk groups without calves.

Excluding hunts of unknown outcome, grizzly bears were successful in 41% (26 of 64) of the observed hunts on cow/calf groups. Success (SUC) was positively correlated with the number of attempted hunts (ATT) and negatively correlated with the time of year (WEEK) ($\text{SUC} = -0.91 + (0.65 \times \text{ATT}) - (0.18 \times \text{WEEK})$, $df = 7$, $R = 0.96$, $P < 0.01$). Grizzly bears were successful in killing calves in 71%, 42%, and 7% of the observed hunts in May, June, and July, respectively. After the first week of July, grizzly bears were apparently unable to catch elk calves. By August, grizzly bears and elk were observed to graze within 50 m of each other.

Table 10. Activities recorded at grizzly bear feedsites in nonforested areas of Pelican Valley, Yellowstone National Park, May through August, 1987.

Feeding Activities Observed										
Month	Number of feedsites investigated	Bison carrion	Elk calves	Fish	Small mammals	Graminoids	Clover	Thistle	Dandelion	Yampa
May	4	0	3	0	0	1	1	0	1	0
June	12	0	2	1	0	3	6	1	2	0
July	9	1	0	0	0	2	5	2	0	1
August	7	0	0	0	2	6	7	2	2	0

Table 11. Weekly summary of grizzly bear predation on elk calves in the Pelican Valley area of Yellowstone National Park, 1984-1988.

Week (month/day)	Grizzly sightings	Total hunts	Successful hunts	Unsuccessful hunts	Outcome ^a unknown	Success Rate (%) ^b
5/15 - 5/21 ^c	8	0	0	0	0	0
5/22 - 5/30 ^c	20	7	5	2	0	71
6/01 - 6/07 ^c	16	3	2	1	0	67
6/08 - 6/14 ^d	72	16	9	6	1	60
6/15 - 6/21	85	11	4	6	1	40
6/22 - 6/30	150	17	5	10	2	33
7/01 - 7/07	124	5	1	2	2	33
7/08 - 7/14	114	2	0	2	0	0
7/15 - 7/21	83	7	0	7	0	0
7/22 - 7/31	79	2	0	2	0	0
8/01 - 9/21	193	0	0	0	0	0

^aTermination of hunt obscured by forest cover or topography.

^bCalculated as successful hunts (total hunts minus outcome unknown).

^cObservations for 1987 only.

^dObservations for 1985-1987.

The size of the elk group chased also influenced the success rate. Grizzly bears successfully killed calves in 38% of the hunts that involved cow/calf groups of greater than 25 elk, and successfully killed calves in only 14% of the hunts that involved cow/calf groups of less than 25 elk (Table 12).

Table 12. Number of chases, number of kills, and success rate of attempted grizzly bear predation on different size elk cow/calf groups in the Pelican Valley area of Yellowstone National Park, 1984-1988.

Elk group size	Number of chases ^a	Number of kills	Percent of total chases	Percent of total kills	Success rate (%)
1 - 25	7	1	13	5	14
26 - 50	18	7	33	37	39
> 50	30	11	54	58	37

^aDoes not include hunts of unknown outcome or hunts through calving/bedding areas which did not involve a chase.

Single bears accounted for 80% of the observed predatory attempts on cow/calf groups (Table 13). Since bears were not marked or collared for this study, single bears could not be identified by specific sex or age class. Breeding pairs, subadult pairs, females with cubs, and females with yearlings were also observed chasing elk calves.

Table 13. Characteristics of grizzly bears observed chasing elk in Pelican Valley, Yellowstone National Park, 1984-1988.

Category	Chases of elk calves			Chases of adult elk		
	No.	% of total	% success	No.	% of total	% success
Single bears	56	80	44	5	50	0
Breeding pairs	8	11	43	2	20	0
Subadult pairs	4	6	0	1	10	0
Females with cubs of the year	1	1	0	0	0	0
Females with yearlings	1	1	0	2	20	0
Females with two year olds	0	0	0	0	0	0

Grizzly bears used 3 techniques in hunting elk calves. In May and early June, when newborn calves are extremely immobile, bears were observed apparently locating newborn calves by scent in calving/bedding areas (9 of 70 hunts, 6 successes). Adult elk retreated as bears approached these areas. Bears then moved through the sagebrush in somewhat of a zigzag pattern, occasionally rising onto their hind legs. Calves that remained bedded and were detected by bears were killed. These hunts ranged in time from 5 sec to 71 min ($\bar{x} = 32.2 \text{ min} \pm 9.6 \text{ SE}$) and covered distances from 5 m to 1,625 m ($\bar{x} = 935 \text{ m} \pm 211 \text{ SE}$).

The primary hunting method observed (59 of 70 hunts, 18 successes) was similar to that described by Cole (1972). The bear approached cow/calf groups at a loping pace while in the open, apparently not using vegetation or topography for cover. Elk were aware of the bear's presence and reacted by bunching into tight groups while intently watching the bear. After the initial approach, the bear made a series of charges that tended to separate confused calves from the group. The chase then concentrated on these calves. Elk calves could generally outdistance the bear in a straight run but were often caught when the bear cut to the inside of calves as they changed direction in an effort to rejoin the herd. Once within reach, the bear used its forelegs to grasp and pull down running calves by the rump. This type of hunt ranged in time from 5 sec to 58 min ($\bar{x} = 8.7 \text{ min} \pm 2.0 \text{ SE}$) and covered distances from 27 to 4,812 m ($\bar{x} = 818 \text{ m} \pm 149 \text{ SE}$).

Chasing elk calves over long distances was not always futile. Bears were successful in 27% (4 of 15) of the hunts that covered distances greater than 805 m. On 1 occasion, a bear chased a group of elk for 14 min over a distance of approximately 2,346 m before killing a calf. The bear then spent 20 min more chasing the elk over a circuitous 1,372 m and killed 2 more calves. The bear was observed

feeding on 2 of the 3 calves and may have returned at night to feed on the remaining calf.

Bears were observed killing more than 1 calf on 2 other occasions. In 1 instance, a bear killed 2 calves in a bedding area and fed on both of them. On another occasion, a bear chased and killed 3 calves. This bear fed on 2 of the calves; a second, larger bear then chased the first bear away and fed on the third calf.

The third style of hunting observed (2 of 70 hunts, both successful) involved the use of cover. Bears used tree cover to approach elk grazing within 50 m of the forest edge. Each of these hunts lasted less than 20 sec and covered less than 137 m. In each incident, elk suddenly became alert and closely monitored the forest edge before a bear rushed from the trees and initiated chase. Due to the high efficiency (short chase, high success rate) of this type of hunt, it may occur more frequently than observed.

Bears spent from 9 to 76 min ($\bar{x} = 40 \text{ min} \pm 4 \text{ SE}$) feeding on calves immediately following the kill. Bears returned to 6 of 26 (23%) calf kills for a second feeding period. Second feedings episodes ranged from 4 min to 10 min ($\bar{x} = 7 \text{ min} \pm 1 \text{ SE}$). Bears may have returned at night to feed on diurnal kills. Coyotes (Canis latrans), ravens (Corvus corax), and bald eagles (Haliaeetus leucocephalus) were commonly observed feeding on the remains of calves killed by bears.

A cow elk was observed attempting to protect her calf during a chase. The bear was overtaking a calf that had become separated from the cow during the chase. The cow ran at the bear, approaching it from an angle, and succeeded in veering the bear away from the calf. The cow then attempted to lead the calf away from the area. The bear, however, quickly initiated a second chase; this time successfully taking the calf without further interference from the cow. In another

instance, 3 bears (1 adult and a mating pair) had successfully taken 3 calves in a calving area. As the bears fed upon the calves, a cow elk cautiously moved back into the calving area and led her calf, still hidden in the sagebrush, away from the bears. On another occasion, a group of cow elk left a calf bedding area as a grizzly bear approached. A lone cow remained and watched the bear catch and feed on a calf, presumably its own, from a distance of approximately 30 m. When the bear finished feeding 56 min later and moved away, the cow defended the carcass and chased off 2 coyotes that approached to scavenge.

Ten hunts (8 unsuccessful, 2 of unknown outcome) on adult elk were observed. These hunts ranged in time from 5 sec to 1 min ($\bar{x} = 0.2 \text{ min} \pm 0.09 \text{ SE}$) and covered distances from 27 m to 402 m ($\bar{x} = 107 \text{ m} \pm 35 \text{ SE}$). Grizzly bears hunted adult elk from May through July. No attempts at predation on adult elk by grizzly bears were observed in August or September. On 1 occasion, however, a black bear was observed unsuccessfully chasing a group of adult cow elk in August.

Bears were observed attempting to catch spawning fish on 3 occasions. The 3 instances of observed bear fishing activity occurred on 2 separate creeks. Bears were observed fishing in creek sonyew number (a system for numbering unnamed Yellowstone waters) 108513 on 2 occasions with 1 known success of at least 3 fish (either cutthroat trout or longnose suckers). The third instance of observed bear fishing activity occurred at a small water fall on Raven Creek (sonyew number 108512) and did not appear to be successful.

Grizzly bears were observed unsuccessfully chasing ducks (Anatidae) twice, Canada geese (Branta canadensis) twice, and sandhill cranes (Grus canadensis) 6 times. Numerous observations were made of bears digging both for small mammals (probably voles, Microtus spp.,

and pocket gophers, Thomomys talpoides) and vegetal foods but these could not always be accurately differentiated from the lookout.

Use of Carrion--During this study, 21 carcasses scavenged by grizzly bears were observed. The mean distance of carcasses from tree cover was $327 \text{ m} \pm 338 \text{ SD}$ with a range of 4.6 to 999 m. Of the 21 carcasses observed, 14 (67%) were fed upon by more than 1 grizzly bear. One carcass was used by at least 7 different grizzly bears. A dominance hierarchy formed when more than 1 bear was present at a carcass at one time. Only 1 bear (the most dominant present) generally fed on a carcass at one time. Less dominant bears grazed around the periphery of carcasses until the more dominant bears finished feeding and left. Bears observed feeding on carcasses usually also spent time foraging on vegetation as well.

Bear-Coyote Interactions

Bear-coyote interactions were commonly observed at carcasses. Interactions at carcasses typically involved bears defending carcasses from coyotes that were attempting to scavenge (Appendix E).

In 19 observations, bear-coyote interactions did not involve the presence of a carcass. Twelve (63%) of these observations were of coyotes following (trailing) bears as they traveled; 5 (26%) were of coyotes harassing bears; and 2 (11%) were of interactions between coyotes and female grizzly bears with COY.

In 12 instances, coyotes were observed following bears as they traveled. Six (50%) of these observations involved coyotes following bears that were involved in actual (3 observations) or attempted (3 observations) predation on elk calves. Coyotes scavenged on the remains of calf kills in all 3 instances where they trailed bears

involved in successful predation. The remaining 6 observations (50%) were of coyotes trailing bears as they traveled (5 observations) or foraged (1 observation).

Trailing was observed in 7% (2 of 28), 2% (7 of 323), and 1% (3 of 400) of the grizzly bear observations in May, June, and July, respectively. Trailing was not observed in August or September. The time period in which trailing was observed coincides with the period when grizzly bears are preying on elk calves. Coyotes may have been following bears in order to scavenge on the remains of calf kills.

In 5 observations, coyotes were observed harassing bears. These incidents typically involved coyotes nipping at a bears rump and heels as the bear traveled or foraged. During these incidents, bears often lunged and swatted at the coyotes but were never successful at catching or hitting them.

During 2 bear observations, coyotes approached female grizzly bears with COY. In both incidents bear cubs chased the approaching coyote. Whether the coyotes were playing with the bear cubs or attempting to prey on the cubs by luring them away from their mothers' safety is unknown. The fact that coyotes only chased cubs that were out of their mothers' view suggests that coyotes may have been attempting to prey on the cubs.

Bear-Bison Interactions

Twelve bear-bison interactions were observed (Appendix F). Four (33%) observations were of bears temporarily leaving carcasses (1 observation) or other foraging sites (3 observations) as lone, bull bison walked past within close distances; 3 (25%) were of bears leaving trails (2 observations) or changing their direction of travel (1 observation) to avoid bison or bison groups; 2 (17%) were of bears

and bison grazing within 40 m of each other and appearing to be mutually indifferent to one another's presence; 1 (8%) was of a bull bison charging a bear that appeared to have startled it; 1 (8%) was of a bison group forming a defensive line between their calves and an approaching bear; and 1 (8%) was of a lone bull bison that moved away from an approaching bear.

Bear-Moose Interactions

One bear-moose interaction was observed. An adult grizzly bear and a bull moose were observed grazing approximately 40 m from each other. The moose periodically stopped grazing and intently watched the bear; the bear paid little attention to the moose.

Visitor Impact On Grizzly Bear Activity

The closed, restricted day-use, and open regulations were in place in Pelican Valley for 44%, 33%, and 23% of the observation days, respectively. During the closed, restricted, and open periods, 481, 316, and 147 bear sightings, respectively, were recorded.

Bear-Human Interactions

During the 5 years of the study, 2,819 people and 1,771 stock animals were observed in the valley (Table 14). Backcountry use averaged 2 people and 2 stock per day during the closed periods, 12 people and 6 stock per day during the restricted periods, and 21 people and 15 stock per day during the open periods. The average horse group consisted of 3.4 people and 5.7 stock per party. Backpacker, day-hiker, and angler groups averaged 2.4, 2.4, and 2.6 people per party, respectively.

Table 14. Number and type of recreational use in Pelican Valley, Yellowstone National Park, 1984-1988.

Year	Observation days	People on horseback	Total stock ^a	Backpackers	Day hikers	Anglers	Total people
1984 ^b	60.0	300	507	226	127	191	844
1985 ^c	68.0	348	586	20	162	168	698
1986 ^d	81.0	226	361	9	67	125	427
1987	72.0	160	285	15	369	154	698
1988 ^e	28.5	24	32	13	54	61	152

^aIncludes pack stock.

^bAll campsites closed 1 August due to bear-caused human mortality.

^cAll backpacker campsites closed permanently.

^dPelican Valley closed to recreational use for 55 days due to a bear mauling and 3 bear-human confrontations.

^eObservations terminated 22 July due to forest fire.

There were 36 known encounters between bears and backcountry users in Pelican Valley from 1984 through 1988. Subadults and females with COY were involved in 67% of the encounters but represented only 31% of the bear sightings recorded. Grizzly bears reacted to encounters with backcountry users by fleeing (53%), showing no reaction (33%), or charging (14%).

In 18 of 19 incidents where bears fled, they ran to forest cover before stopping. Flight distances to forest cover ranged from 69 m to 1,207 m ($\bar{x} = 422 \text{ m} \pm 334 \text{ SD}$). However, full flight distance is unknown as bears could not be observed once they entered forested areas.

Four bears observed appeared to be habituated to people. These bears tolerated people at close distances and fled in only 3 of 15 encounters with people.

All 5 cases where bears charged during encounters with people involved females with COY and occurred within 7 ($\bar{x} = 3.6 \pm 2.2$ SD) days after the valley was opened to recreational use following a period of closure. Two of the 5 incidents involved off-trail hiking.

Hikers were significantly more likely to be charged (4 of 13) during an encounter with a grizzly bear than people on horseback (1 of 23) (Fishers exact test, $P = 0.047$). All incidents in which hikers were charged during encounters with bears involved groups of 1 or 2 people.

One case involved a single person traveling off the designated trail; this case was the only one which resulted in a human injury. The only incident in which a horse party was charged involved a single horse and rider traveling off trail.

One bear-caused human fatality occurred during the study. A backpacker camping alone was pulled from her tent and killed by a grizzly bear in late July 1984.

Distance From Cover

There was a strong trend (Kruskal-Wallis test, $U = 4.53$, $P = 0.104$) for bears to move farther from tree cover during the closed ($\bar{x} = 304$ m \pm 14 SE) and restricted ($\bar{x} = 293$ m \pm 21 SE) periods than during the open ($\bar{x} = 228$ m \pm 23 SE) periods (Table 15). Chi-square analysis indicated that the frequency at which bears made use of areas >500 m from forest cover was not independent of recreational activity in the valley. Bears made significantly more frequent use of areas farther than 500 m from tree cover during the closed and restricted periods than during the open periods ($\chi^2 = 8.87$, $df = 2$, $P = 0.014$). The difference between the closed and restricted periods was not significant ($\chi^2 = 0.5012$, $df = 1$, $P = 0.48$).

Table 15. Frequency of bear activity at different distances from tree cover during open, restricted, and closed periods of visitor use in Pelican Valley, Yellowstone National Park, 1984-1988.

Regulation	0 - 500 m		>500 m	
	N	%	N	%
Open	128	87	19	13
Restricted	246	78	70	22
Closed	364	76	117	24

Proximity of Bears to Backcountry Campsites

Significantly fewer bear sightings were recorded within 400 m of campsites when they were occupied than when they were unoccupied ($\chi^2 = 7.01$, $df = 1$, $P = 0.01$, Table 16). Campsite occupancy reduced the number of bear sightings within 400 m by approximately 67%.

Table 16. Comparison between the number of bear sightings within 400 m of occupied versus unoccupied campsites in Pelican Valley, Yellowstone National Park, 1984-1988.

Campsite occupancy	Bear sightings	Campsite nights	Percent
Occupied	4	85	4.7
Unoccupied	88	572	15.4

Activity Patterns

Activity patterns were similar among the open, restricted, and closed periods with 1 exception (Fig. 4). During the open periods, the morning peak in activity occurred later (0900 hours-1000 hours) than during the restricted (0600 hours-0700 hours) and closed (0600 hours) periods. This was due to the presence of a pair of subadult grizzly bears during the open period in 1984. The pair of subadults appeared to be habituated to humans and were more day-active than most other observed bears.

Visitor Compliance With Bear Safety Warnings And Regulations

The area closure regulation had a higher rate of compliance among hikers (99%) than the restricted day-use-only regulation (83%). Of 1,761 observed hikers in the valley, 18 (1%) entered the valley while it was closed. Of these hikers, 12 (67%) were day hikers, 4 (22%) were anglers, and 2 (11%) were backpackers. Of 843 hikers that entered the valley while the restricted day-use-only regulation (0900 hours-1900 hours) was in place, 140 (17%) violated the regulation. Of these, 91 (65%) were anglers, 45 (32%) were day hikers, and 4 (3%) were backpackers. The compliance rate of people on horseback was 100% (n = 1,136) with both the area closure and restricted day-use-only regulations.

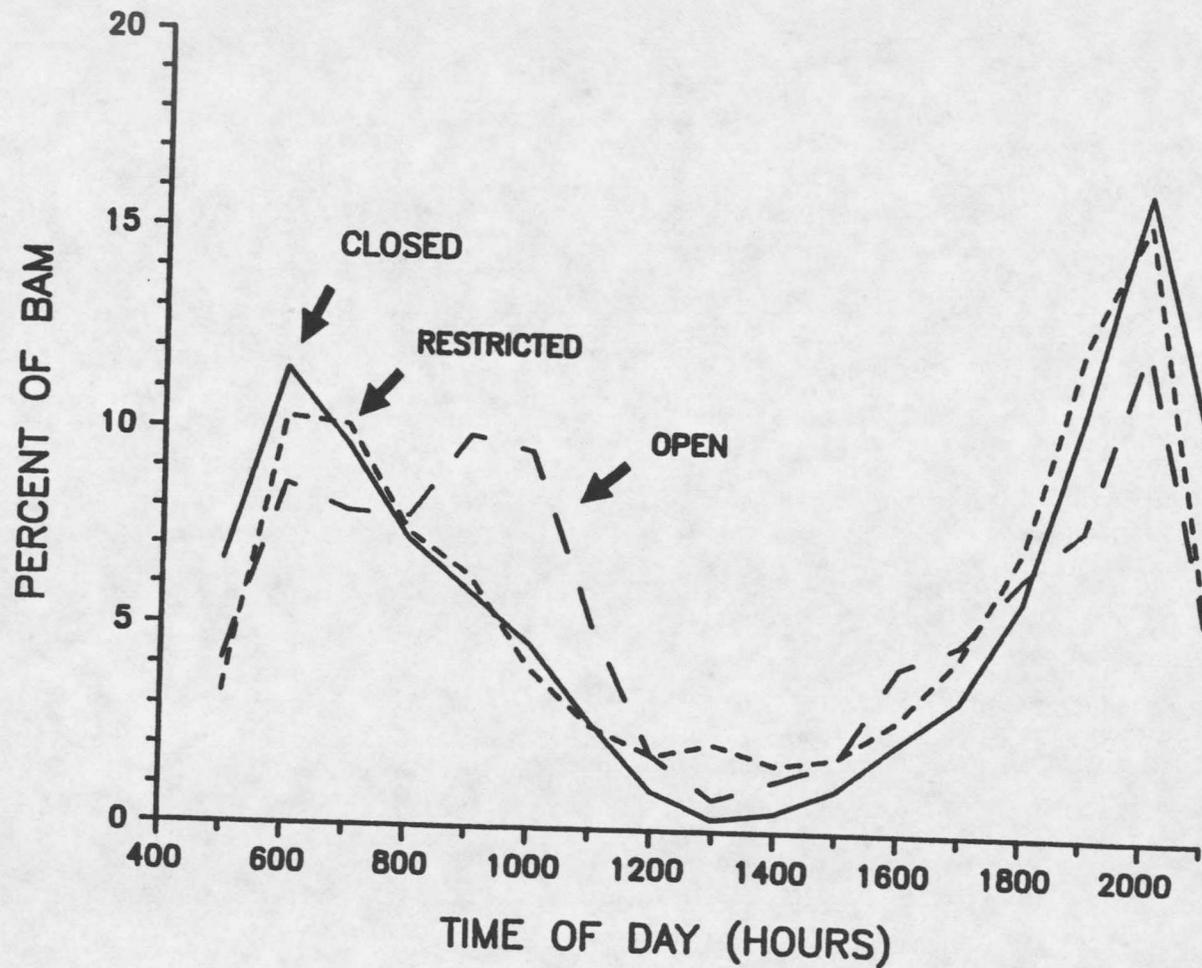


Fig. 4. Diurnal activity patterns of grizzly bears during closed, restricted, and open periods of recreational use in Pelican Valley, YNP, from May through September, 1984-88. Points indicate the percentage of total bear activity minutes (BAM) observed per 1-hour time block.

Signs posted at the Pelican Valley trailhead from 1986 through 1988 recommended hiking parties be of 4-or-more people and strongly recommended against hiking alone. Despite these warnings, 83% (279 of 337 parties) of the hikers entering Pelican Valley had group sizes of less than the recommended 4 people and 20% of the hikers hiked alone (67 of 337 parties). Observations in Pelican Valley suggest that bear safety recommendations are not effective at influencing visitor behavior.

DISCUSSION

Grizzly Bear Activity in Pelican Valley

Species Of Bear

The low percentage of black bear sightings in Pelican Valley may relate to several factors. This study was biased toward observations of grizzly bears. Black bears are primarily adapted to use forested habitat types and their edges and clearings (Herrero 1977). During this study, bears could not be observed in forested areas, and many small openings and edges in and along forested areas were blocked from view by the treeline.

Black bears may have avoided Pelican Valley's nonforested areas due to the amount of grizzly bear activity in those areas. According to several studies, black bears avoid areas of concentrated grizzly bear activity (Barnes and Bray 1967, Herrero 1972, Martinka 1976). Cases of grizzly bears killing black bears have been reported (Harting 1987).

Intraspecific Avoidance of Conspecifics

By Females With Cubs of the Year

Knight et al. (1986) suggested that, in spring, female grizzly bears with COY selected habitat for security from other grizzly bears over habitat productivity. A monthly comparison between sightings of female grizzly bears with COY to sightings of all other bears in Pelican Valley supports this theory. Females with COY were not observed in the valley during May and comprised only a small percentage

of the observed bears during June (6%). During July and August, female grizzly bears with COY comprised 25% and 36%, respectively, of all bear sightings. These results suggest that single adult bears may have displaced females with COY during May and June.

The number of observations of female grizzly bears with COY was highly variable between years and may be related to the whitebark pine cone production from the fall of the previous year. Whitebark pine nuts are the most important fall food of Yellowstone grizzly bears (Knight et al. 1986). Rogers (1976, 1987) found that reproductive success in black bears was correlated with the predenning weight of adult females and that very few females produced litters following a year of food scarcity. The number of female grizzly bears producing cubs in YNP may be lower following years of pine nut scarcity than following years of moderate to high pine nut production. This may account for some of the year-to-year variability in the number of female grizzly bears with COY observed in Pelican Valley.

Monthly Activity Patterns

The observed increase in mean bear activity minutes per sighting during July and August may reflect an increasing nutrient demand by bears. An increase in bear activity is expected as bears enter fall hyperphagia (Nelson et al. 1983). Bear behavior during hyperphagia is characterized by an intensive search for high-energy foods.

The observed decrease in mean BAM per sighting during September is not consistent with the findings of other studies. Schleyer (1983) and Knight et al. (1984) documented an increase in bear activity in YNP during fall. The September decrease in both the mean number of bear sightings per day and mean BAM per sighting may be due to a change in bear food habits at that time. By September, most of the graminoids

and forbs found in Pelican Valley, which were important to bears, were in the later stages of phenological development (Appendix Tables 18 and 19). Digestibility and protein content of plants are generally lowest when plants are in the post-flowering stage and either drying or desiccated (Mealey 1975, Graham 1978).

Graham (1978) reported that, between early August and early September, the moisture content and protein level were considerably higher in plants that were sheltered by forest canopy than in the same species on exposed sites. Vegetal bear foods found in forested areas may have been energetically more efficient in September and may have attracted bears to areas away from Pelican Valley's nonforested areas.

A notable increase of whitebark pine nuts in the diet of YNP grizzly bears occurs in September (Kendall 1981, Knight et al. 1984). Bears eat pine nuts from red squirrel (Tamiasciurus hudsonicus) caches in forested habitat types (Mattson and Reinhart 1987) where bears could not be observed during this study. The increase in the use of pine nuts by bears concurrent with the loss of succulence in the grazing resource of the valley may account for the large September decline in both bear sightings and mean bear activity min per sighting in the study area.

Diel Activity Patterns

The pattern of crepuscular activity peaks observed during this study using direct observations is consistent with the findings of radio telemetry studies by Schleyer (1983) and Harting (1985) for grizzly bears in YNP. Subadults and females with COY were more active during daylight hours than other observed bears. A higher level of diurnal activity by females with COY has also been reported for black bears in Sequoia National Park (Ayres et al. 1986).

In Pelican Valley, subadults and females with COY may have been using temporal spacing to increase security from other bears. Mattson et al. (1987) reported a spatial separation between the foraging areas of lone adult bears (high social status) and those of females with COY (security conscious) and subadults (low social status). Russell (1967) and Egbert and Stokes (1976) reported cases of subadult bears being killed by adults. Troyer and Hensel (1962) and McCullough (1981) described cases in which cubs were killed by adult bears. Knight et al. (1986) reported the occasional occurrence of grizzly bear cub remains in grizzly bear scats.

The higher level of diurnal activity observed in females with COY may also have been due to other factors. Females with COY may need increased foraging time to compensate for the energetic demands of lactation. Increased diurnal activity may also have been necessary for tending young, energetic cubs (Ayres et al. 1986).

The activity patterns of females with yearlings corresponded more closely to those of lone adult bears than to those of females with COY or subadults. These patterns suggest that the need for security from other bears is less of a concern for females once their cubs reach the yearling age class, or that less time is needed for tending yearlings.

Use of Nonforested Areas

Only 38% (357 of 944) of the bears observed during this study remained within 100 m of tree cover. Bears were commonly observed foraging across the valley from one side to the other, leaving them over 1,200 m from tree cover in any direction while in the middle of the valley. Previous studies using predominately sign (Graham 1978) and aerial observations (Blanchard 1980) found that 85% and 75%,

respectively, of the bear sign or bears observed in the open were within 100 m of forest cover.

Although the data collected during this study is biased toward observations of bears far from cover since they were easier to spot, the data suggests that grizzly bear use of areas >100 m from forest cover may have been previously underestimated. Studies that use bear sign (Graham 1978) as evidence of bear activity are biased toward locations where feeding behavior produces long-lasting evidence (Knight et al. 1987, 1988, 1989). Data collected strictly from aerial observations (Blanchard 1980) is probably biased toward observations of bears in or near forest cover. Most observation flights are made during midmorning. By midmorning, most bear cohorts are more likely to be bedded than feeding or traveling.

Food Habits

Food habits of grizzly bears in YNP have been described by Murie (1944), Craighead and Craighead (1972), Mealey (1975), Graham (1978), Craighead and Mitchell (1982), Craighead et al. (1982), and Knight et al. (1984, 1988). A notable exception to these earlier studies was the high amount of bear use of clover recorded during this study. Clover vegetation types were used by bears in greater proportion than availability during all months, especially during August and early September. Clover comprised a high proportion of observed bear activity minutes, a high proportion of activity observed at bear feeding sites, and a high percentage frequency and volume of scats collected. Extensive grizzly bear use of clover in Pelican Valley was also recorded by Graham (1978). Grizzly bears make more use of clover during years with above-average precipitation than during years with below-average precipitation (Gunther 1990). Above-average

precipitation was recorded in Pelican Valley during 4 of the 5 years of this study.

Predation on Elk Calves

Bear predation on elk calves in YNP has been documented by Howell (1921), Skinner (1925), Rush (1932), Thompson (1942), Murie (1944), Johnson (1951), Cole (1972), Craighead and Mitchell (1982), Craighead et al. (1982) and Houston (1982). These reports, however, gave little detail as to the frequency, chronology, techniques, or success rate of this bear behavior. Observations during this study indicate that for a short period each year, some bears are highly successful predators of elk calves.

Elk calving on the northern winter range takes place from about mid-May through late-June; thus, observed calves killed in Pelican Valley could have been from newborn to about 7 weeks old. Total body weights corresponding to these ages range from approximately 8.6 kg (Johnson 1951) to 58.9 kg (Murie 1951). At an estimated 4,600 kcal/kg, ungulates rank as the highest source of net digestible energy in the Yellowstone ecosystem (Mealey 1975).

Although elk calves are a good source of protein and high net digestible energy for bears (Mealey 1975), calves are available for only a short period of the year (mid-May through early-July). Elk calves in YNP are most vulnerable to predation during their first 30 days of life (Singer and Harting 1988). The importance of elk calves to the diet of YNP grizzly bears may be in extending the spring season of high-protein availability. Grizzly bears in YNP feed extensively on winter-killed carrion from March through May (Knight et al. 1984). Peak successful grizzly bear predation on elk calves occurs about the time (late-May through mid-June) winter-killed ungulates are no longer

readily available and may act to extend the spring season of high-protein consumption by 2 to 4 weeks for some bears.

The observed decrease in both hunting effort and success over time probably reflected a decrease in the cost/benefit of expending energy chasing elk calves as they became more mobile with age and as the proportion of catchable-age calves in the population declined over time. At that point, less nutritious but more readily available plant foods became more cost-efficient diet items.

From 1935 to 1967, the northern Yellowstone elk herd was reduced to an artificially low population of <5,000 elk (Houston 1982). Since 1967, elk numbers have increased to over 19,000 (Singer et al. 1988). Bear use of elk calves through predation could be expected to increase with this greater availability of elk. Documentation of grizzly bear predation on elk calves prior to termination of the elk herd reduction program (Thompson 1942, Murie 1944, Cole 1972, Craighead and Mitchell 1982, Craighead et al. 1982, Houston 1982) did not quantify to what extent bears made use of the elk resource through predation. Although rates of predatory attempts documented in this study cannot be compared to past levels, these results can be used for future comparison with predatory rates during any significant fluctuation in elk numbers as well as to evaluate the relative contribution of elk as carrion vs prey in grizzly bear food habits.

Predation on Spawning Fish

Several studies have documented grizzly bear use of spawning fish as a food source in YNP (Hoskins 1974, 1975; Mealey 1975; Graham 1978; Knight et al. 1984; Gunther 1984, 1985; Reinhart and Mattson 1987; Reinhart 1990). Knight et al. (1984) found cutthroat trout in grizzly bear scats from June through August with peak occurrence in July. At

4.1 digestible kcal/g, cutthroat trout rank as the second highest source of net energy for grizzly bears in the Yellowstone ecosystem (Mealey 1975, Knight et al. 1984).

Pelican Creek is the second largest tributary to Yellowstone Lake and supports an extensive spawning run of cutthroat trout as well as a smaller run of spawning longnose suckers (Jones et al. 1982). The mean number of spawning cutthroat trout and longnose suckers using the Pelican Creek system from 1980 to 1983 was 23,991 and 2,672, respectively (calculated from Jones et al. 1981, 1982, 1984). The mean weight of spawning cutthroat trout and longnose suckers using Pelican Creek from 1980 to 1983 was 473 g and 868 g, respectively (calculated from Jones et al. 1981, 1982, 1984). Therefore, the mean estimated biomass for the Pelican Creek system is 13,667 kg of spawning fish annually.

Despite the potential of spawning fish as a high protein food source for bears in Pelican Valley, only 3 of 944 grizzly bear sightings during this study involved bears fishing in the creek. Several factors may be responsible for the apparent lack of bear fishing activity in Pelican Valley. Hoskins (1975) found that grizzly bears in YNP were most successful fishing small shallow streams or shallow riffle areas in larger streams. Larger streams with little or no shallow riffles showed no evidence of bear fishing activity. Pelican Creek is a large stream with peak flow rates that can exceed $28 \text{ m}^3/\text{sec}$ (Jones et al. 1982) and may lack the shallow riffles (at least the parts visible from Pelican Cone) necessary for bears to fish it efficiently. Reinhart (1990) found that bear fishing success correlated more closely with fish density/ m^3 of water than fish density/linear stream distance. The low density of fish/ m^3 in Pelican Creek (Reinhart 1990) probably accounts for the low level of bear

fishing activity observed in Pelican Valley. The smaller tributary streams may be more fishable for bears, but most of these are not visible from Pelican Cone.

Another factor which may contribute to the lack of fishing by bears in Pelican Valley is the timing of the spawning migration. Pelican Creek has an early spawning run. In some years, almost 90% of the upstream migration and 80% of the downstream migration has been completed by 7 June and 3 July, respectively (Jones et al. 1981, 1982). Gunther (1984, 1985) and Reinhart and Mattson (1987) found that bear fishing activity peaked during the downstream migration of post-spawning cutthroat trout. Post spawners are generally fatigued from spawning activity (upstream migration and building redds) while at the same time stream depths have usually decreased, effectively increasing trout density and stream fishability (Reinhart and Mattson 1987). Although late summer flows in Pelican Creek are low ($1 \text{ m}^3/\text{sec}$) and may expose the shallow riffle areas necessary for bears to fish effectively, most of the downstream spawning migration may already be over by that time.

Use of Carrion

During some years, winter-killed ungulates are an important spring/summer source of protein for grizzly bears in Pelican Valley (Natl. Park Serv. 1982, 1984). Most carcasses, however, were probably already consumed by bears and other scavengers each year before the observer arrived at the Pelican Cone Lookout.

Sixteen carcasses used by grizzly bears were observed during this study. The mean distance from tree cover of carcasses used by grizzly bears during this study ($\bar{x} = 327 \text{ m}$) contrasts considerably from the observations of Schleyer (1983) who found that 7 of the 8 carcasses he

observed which were fed upon by bears were within the forest canopy. Data collected on carcass use during this study is biased toward observations of carrion far from tree cover. Carcasses used by bears within forested areas could not be seen by the observer. Bears may not feed on carcasses which are far from cover until after all carrion within or close to cover has been consumed. Most carrion close to cover may have already been consumed before the mid-May/June starting dates of this study. The carcass data from Pelican Valley does indicate that grizzly bears will make use of carrion that is quite far from tree cover during diurnal time periods if they are not disturbed by human activity.

Visitor Impact On Grizzly Bear Activity

In YNP, the importance of areas >100 m from forest cover to grizzly bears may have been previously underestimated. Results of this study suggest that grizzly bear use of nonforested habitat components was negatively affected by recreational activity in the valley. When the valley was open to camping and unrestricted day use, bear activity in nonforested areas was significantly reduced, and bears were displaced from areas near occupied campsites. Restricting use of the valley to time periods when grizzly bears were least active (0900 hours to 1900 hours) appears to have successfully prevented human-caused displacement of bears from productive nonforested habitats and, at the same time, allowed for recreational use of the area. Regulating human use so that it does not overlap with the primary diurnal foraging periods of grizzly bears also increases human safety by reducing the chance of bear-human encounters (Nat'l. Park Serv. 1986a). Closure of

campsites in Pelican Valley appears to have further reduced disturbance of bear foraging patterns while also reducing the potential for human injury.

Subadults and females with COY generally avoid other adult bears (Mattson et al. 1987). In Pelican Valley, subadults and females with COY were more day active than other observed bears. These activity patterns suggest that subadults and females with COY may have been using temporal spacing to increase security from other bears. However, by being more day active, these bear cohorts are more vulnerable to disturbance by backcountry recreational activity and/or habituation to people than other bears. Females of breeding age are the segment of the bear population most critical to the viability of the Yellowstone grizzly population (Knight and Eberhardt 1984, 1985). Relocation of trails in areas commonly frequented by females with COY may be necessary to reduce the impact of recreational activity on this segment of the population.

Not all bears observed during this study were displaced by recreational activity. Several bears were habituated to people and tolerated people at close distances in exchange for access to habitat during diurnal time periods. Although habituation may increase the efficiency of habitat use by bears in some instances by reducing displacement and minimizing the frequency of energy-demanding responses (Jope 1982), it often results in the bear being removed from the population due to concern for human safety (Meagher and Fowler 1989). Habituation even without food conditioning can be dangerous and has been associated with some bear-caused human fatalities (Herrero 1985). When a bear is habituated to people, hikers are more likely to inadvertently approach within its "individual distance" (Herrero 1970) and be charged (Jope 1983). In the fall of 1986, a photographer in YNP

approached and was killed by a habituated grizzly bear that had previously tolerated hundreds of onlookers within close distances throughout the summer (Natl. Park Serv. 1986b). Other findings, however, suggest that bears are less likely to charge hikers if they are habituated toward people. Jope (1985) found that, in Glacier National Park, habituation of grizzly bears to hikers reduced the rate of fear-induced charges and consequent injuries. Further studies are needed to determine under what conditions habituated bears become a threat to human safety.

All 5 incidents in which bears charged hikers during encounters occurred within 7 days after the valley was opened following a closure. Jope (1985) reported that, in Glacier National Park, most charges tended to occur in early summer before bears had habituated to the presence of hikers. Having rangers on horseback patrol the trails a few days prior to opening the valley may increase visitor safety during the transition period from closed to open regulations. Prohibiting or recommending against off-trail travel may increase visitor safety by making human use of the valley more predictable to bears.

Caution should be used when extrapolating the results of this study to other areas. Pelican Valley is a large, nonforested valley where bears commonly forage in areas >500 m from tree cover. The impact of recreational activity on grizzly bears may not be as pronounced in areas within closer proximity to forest cover.

MANAGEMENT IMPLICATIONS

Pelican Valley receives a high level of bear activity from May through August and appears to be especially important to females with COY during July and August. A minimum of 15 autonomous grizzly bears including 6 to 7 breeding-age females frequented Pelican Valley from 1984 through 1988. Cub production in the valley averaged 3.8 cubs per year. Pelican Valley is unique to most other areas within YNP in that bears commonly forage in areas that are quite far from forest cover. Gardners Hole, Hayden Valley, and Lamar Valley, the only other large nonforested areas within the park, all have primary roads running through them. Due to the high level of bear activity, the popularity of the area to recreational users, the impacts that recreational activity can have on bear activity, and the bear-human conflicts that have occurred in the past, Pelican Valley warrants the attention of resource managers.

The following management actions are recommended:

1. Reroute the Pelican Valley trail through the southern end of the valley.

Visitor safety could probably be improved by rerouting the hiking trail so that it enters Pelican Valley via the "fishermen's cut-off trail." The hiking trail is currently routed through a forested area interspersed with a series of small finger meadows; portions of this section of trail pass up and down small hills. The topography of the current trail does not allow hikers to see very far ahead, thus leaving them vulnerable to unexpected encounters with grizzly bears at close

range. By relocating the trail following the "fishermen's cut-off trail," hikers would enter the nonforested portion of the valley more quickly. In the open, hikers could better spot bears ahead, and bears could better spot approaching hikers. The chance of dangerous, sudden, close-range encounters between hikers and bears would be reduced.

2. Assign a ranger on horseback to patrol Pelican Valley a few days prior to opening the valley to visitor use.

All of the hiker-grizzly bear confrontations occurred within 7 days after the valley was opened to recreational use following a closure. Visitor safety could be improved by having rangers on horseback patrol the trails a few days prior to opening the valley. By having rangers patrol the trail before it is opened to recreational use, bears would become familiar with human presence in the valley prior to the day visitors are allowed in.

3. Retain the restricted day-use-only (0900-1900 hour) regulation.

The restricted day-use-only regulation allows most bear cohorts undisturbed use of Pelican Valley during time periods when they are most active, while allowing recreational use during time periods when people are most active. The day-use-only regulation also increases human safety by reducing the amount of temporal overlap between grizzly bear and hiker activity in Pelican Valley.

4. Increase ranger patrols along the southern end of Pelican Valley starting on 15 July (opening day of fishing season).

Anglers were the most common (65%) violators of the restricted day-use-only regulation. In Pelican Valley, most fishing is done along the southern end of the valley, south of the footbridge. Better

enforcement of the day-use-only regulation would reduce disturbance of bears as well as increase human safety by reducing temporal overlap between bears and recreational users.

5. Retain the 4 July recreational use opening date of Pelican Valley.

The highest level of bear activity was recorded during May and June. Keeping Pelican Valley closed until 4 July allows bears undisturbed use of the valley during the breeding season and during the elk-calf predation period. The closure also prevents disturbance of elk during the calving season.

6. Close campsite 5P1 (formerly designated 5C1).

The Final Environmental Impact Statement (FEIS), Development Concept Plan (DCP), for the Fishing Bridge developed area included 9 management actions designed to mitigate the impacts on grizzly bears from facilities remaining at Fishing Bridge and from replacement facilities elsewhere in the park. One of the required management actions included removing all backcountry campsites from "prime bear habitat" in Pelican Valley. One campsite, 5P1, which is in "prime bear habitat" remains open. In order to comply with the FEIS which was approved by the National Park Service in 1988, campsite 5P1 should be closed.

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APPENDICES

APPENDIX A

BEAR OBSERVATION FIELD FORM

BEAR OBSERVATION FIELD FORM

Date: _____ Time: _____ Observer(s): _____

Bear Sighting Number: _____ Scan Number: _____

UTM's: _____ E, _____ N Location: _____

Distance from Lookout: _____ Number of Bears: _____

Species of Bear: Grizzly _____ Black _____ Unknown _____

Age Class: Single Adult _____ Breeding Pair _____ Subadult _____

Female/COY _____ Female/Yearlings _____ Female/Two-Year-Olds _____

Unknown _____ Other _____/_____

Radio Bear # _____ Radio Verified: Yes _____ No _____

Description/Weight: _____

Distance from Cover: _____ Est. _____ Map Meas. _____

Habitat Type: ARCA/FEID _____ DECE/Carex-Carex _____ Carex spp. _____

DECE/Carex _____ Trifolium spp. _____ FEID/AGCA-GEVI _____

Thermal Area _____

Activity: Grazing _____ Digging _____ Fishing _____ Walking _____

Running _____ Playing _____ Scavenging _____/on _____

Predation _____/on _____ Other _____/_____

Weather: Temp. _____ oC _____ % Cloud Cover Wind Dir. _____

Wind Speed _____ mph Raining _____ Snowing _____ Hailing _____

Thunder _____ Lightning _____ Other _____/_____

Proximity To Backcountry Campsites:

5P1:	1/4 mile _____	1/2 mile _____	Occupied _____	Unoccupied _____
5P2:	1/4 mile _____	1/2 mile _____	Occupied _____	Unoccupied _____
5P3:	1/4 mile _____	1/2 mile _____	Occupied _____	Unoccupied _____
5P4:	1/4 mile _____	1/2 mile _____	Occupied _____	Unoccupied _____
5R1:	1/4 mile _____	1/2 mile _____	Occupied _____	Unoccupied _____

APPENDIX B

BEAR PREDATION FIELD FORM

BEAR PREDATION FIELD FORM

Date: _____ Time: _____ Observer(s): _____

Bear Sighting Number: _____ Scan Number: _____

UTM's: _____ E, _____ N Number of Bears: _____

Species of Bear: Grizzly _____ Black _____ Unknown _____

Classification: Single Adult _____ Breeding Pair _____ Subadult _____

Female/COY _____ Females/Yearlings _____ Female/Two-Year-Olds _____

Unknown _____ Other _____/_____

Distance from Forest Cover: _____ Est. _____ Map Meas. _____

Prey Species: Elk _____ Other _____/_____

Cow/Calf Group: _____ Number of Cows _____ Est. _____ Map Meas. _____

Number of Calves _____ Est. _____ Map Meas. _____

Adult Group : _____ Bulls Only _____ Cows Only _____ Bulls/Cows _____

Number of Adults: _____ Est. _____ Map Meas. _____

Hunt Successful _____ Unsuccessful _____ Outcome Unknown _____

Number Killed: Calves _____ Adults _____

Length of Chase: Time: _____ Est. _____ Timed _____

Distance: _____ Est. _____ Map Meas. _____

Type of Hunt: Search _____ Chase _____ Use Of Cover _____

Other _____/_____

Feeding Time: 1st Feeding Episode

From: _____ To: _____

From: _____ To: _____

From: _____ To: _____ Total Feeding Time: _____

Feeding Time: 2nd Feeding Episode Date: _____

From: _____ To: _____

From: _____ To: _____

From: _____ To: _____ Total Feeding Time: _____

APPENDIX C

BEAR-HUMAN ENCOUNTER FIELD FORM

BEAR-HUMAN ENCOUNTER FIELD FORM

Date: _____ Time: _____ Observer(s): _____

Bear Sighting Number: _____ Scan Number: _____

UTM's: _____ E, _____ N Number of Bears: _____

Species of Bear: Grizzly _____ Black _____ Unknown _____

Classification: Single Adult _____ Breeding Pair _____ Subadult _____

Female/COY _____ Female/Yearlings _____ Female/Two-Year-Olds _____

Unknown _____ Other _____/_____

Distance from Cover: _____ Est. _____ Map Meas. _____

Bear's Reaction:

Flee _____ Flight Distance _____ Est. _____ Map Meas. _____

Flee To: Forest Cover _____ Stopped in Open _____ No Reaction _____

Charge _____ Distance Charged _____ Est. _____ Map Meas. _____

Description of Party: Number of People _____ Number of Stock _____

On Trail _____ Off Trail _____

Distance from Bear _____ Est. _____ Map Meas. _____

People's Reaction:

Stop _____ Climb Tree _____ Move Past _____

Move Away _____ Distance Moved _____ Est. _____ Map Meas. _____

Move Toward _____ Distance Moved _____ Est. _____ Map Meas. _____

How Close to Bear _____ Est. _____ Map Meas. _____

APPENDIX D
INDIVIDUAL BEARS

Table 17. Individual bears observed in Pelican Valley, Yellowstone National Park, 1984-1988.

Year	Number of bears	Description
1984	3	Female grizzly bear and 2 cubs of the year.
	2	Female grizzly bear and 1 cub of the year.
	2	Female grizzly bear and 1 yearling.
	2	Pair of subadult grizzly bears, both light brown.
	1	Subadult grizzly bear, dark brown, observed same day as pair of subadult grizzly bears.
	1	Adult grizzly bear, blonde.
	3	Mating pair of grizzly bears and an adult grizzly bear observed concurrently, all dark brown.
	1	Adult black bear, black, with injured leg, walked using only 3 legs.
	1	Adult black bear, black, healthy.
Total	16	14 grizzly bears and 2 black bears.
1985	3	Female grizzly bear and 2 cubs of the year.
	3	Female grizzly bear and 2 two year olds.
	2	Female grizzly bear and 1 two year old, both blonde.
	2	Female grizzly bear and 1 two year old, both dark brown.
	1	Radio grizzly bear #114, three-year-old female.
	1	Radio grizzly bear #118, subadult female.
	5	5 single adult grizzly bears observed concurrently.
	1	Subadult grizzly bear.
1	Adult black bear, black.	

Table 17. Continued.

Year	Number of bears	Description
1985	1	Adult black bear, brown.
Total	20	18 grizzly bears and 2 black bears.
1986	6	2 sets of female grizzly bears, each with 2 cubs of the year, observed concurrently.
	4	Radio grizzly bear #116, female and 3 cubs of the year.
	3	Radio grizzly bear #83, female and 2 cubs of the year.
	6	6 single adult grizzly bears observed concurrently.
	1	Radio grizzly bear #118, subadult female.
	2	Pair of subadult grizzly bears, both light brown.
	1	Subadult grizzly bear, dark brown.
	1	Subadult black bear, black.
Total	24	23 grizzly bears and 1 black bear.
1987	3	Female grizzly bear and 2 cubs of the year.
	3	Female grizzly bear and 2 yearlings, sow light brown, both yearlings blonde.
	3	Female grizzly bear and 2 yearlings, all dark brown.
	2	Radio grizzly bear #83, female and 1 yearling.
	4	4 single adult grizzly bears observed concurrently.
	1	Radio grizzly bear #118, adult female.
	1	Radio grizzly bear #134, adult female.
	1	Radio grizzly bear #138, adult male.
	1	Subadult grizzly bear.
	1	Adult grizzly bear with distinguishing light patch on right side of rump.

Table 17. Concluded.

Year	Number of bears	Description
1987	1	Adult black bear, black.
	1	Adult black bear, brown.
Total	22	20 grizzly bears and 2 black bears.
1988	4	4 single adult grizzly bears observed concurrently.
	3	Radio grizzly bear #118, female and 2 cubs of the year.
	2	Female grizzly bear and 1 cub of the year.
	2	Female grizzly bear and 1 yearling.
	2	Female grizzly bear and 1 two year old.
	1	Radio grizzly bear #134, adult female.
	1	Radio grizzly bear #138, adult male.
	1	Radio grizzly bear #141, two-year-old male.
	1	Adult black bear, black.
	1	Adult black bear, brown.
Total	18	16 grizzly bears and 2 black bears.

APPENDIX E
BEAR-COYOTE INTERACTIONS

BEAR-COYOTE INTERACTIONS

Bear-coyote interactions were commonly observed at carcasses. The following summarized notes recorded in my field journal provide a representative example of these interactions:

On 2 July 1984, at 1703 hours, an adult grizzly bear was observed feeding on a bison carcass approximately 800 m from cover. Seven ravens and 1 coyote were within 10 m of the carcass. The coyote slowly circled the carcass, occasionally making short rushes in toward it. Each time the coyote got close to the carcass, the bear lunged at the coyote; the coyote jumped back and then began circling the carcass again. At times the coyote lay down and watched the bear feed. Between 1703 hours and 1731 hours (28 min), the coyote made 5 rushes toward the carcass. At 1731 hours, the bear walked between 5 m and 10 m from the carcass. The coyote slowly moved toward the carcass, then dashed in, and picked up a piece of meat or hide. The bear ran back to the carcass; the coyote ran 30-40 m from the carcass and began feeding on what it had taken.

Harassment

Coyotes were observed harassing bears on 5 occasions. The following summarized notes from my field journal provide a representative example of this behavior:

On 6 June 1987, at 1446 hours, a subadult grizzly bear was observed being harassed by a coyote. The bear continually pivoted as it grazed, apparently trying to face the coyote at all times. The coyote kept circling the bear and occasionally ran in and nipped at the bear's heels and rump. Each time this happened, the bear lunged out at the coyote then ran after it for a few steps but was unsuccessful in catching it. On 2 occasions the bear ran away from the coyote. The coyote followed closely behind nipping at the bear's heels. This episode continued for 29 min until the bear and coyote moved into the trees and out of view.

During 1 observation, a bear apparently tried to lure 3 coyotes that were harassing it to within striking distance:

On 22 June 1986, at 1944 hours, a subadult grizzly bear was observed being harassed by a coyote. The coyote kept running up from behind the bear and nipping at the bear's heels. The bear would spin around and swat at the coyote, but the coyote was always able to jump out of the way. Two more coyotes came running out of the trees and began harassing the bear. The 3 coyotes circled the bear which kept turning from side to side trying to keep all 3 coyotes in view. When a coyote was able to circle in behind the bear, it ran in and nipped at the bear. The bear would spin around and lunge at the coyote, then another coyote would run in from behind the bear. On a few occasions, the bear sat down on its rump and turned its head from side to side, watching the coyotes. Each time the bear got up and tried to

walk away, the whole process would start again. The bear finally sat down on its rump, rolled onto its back, and lay down with all four legs sticking straight up into the air. When the bear did this, the coyotes appeared curious and slowly walked toward it. When the coyotes were within striking distance, the bear suddenly lunged and swatted at the coyotes. Storer and Tevis (1978) described incidents in which the California grizzly bear (*Ursus arctos californicus*) used similar behavior to lure cattle and horses within striking distance. The coyotes jumped back then lay down in a circle around the bear. Each time the bear got up and began walking, the coyotes started harassing it; the bear would again lay down on its back with its legs in the air, and the process would be repeated. Finally, the bear ran for the trees with the coyotes in pursuit. As the bear ran, it was spinning left and right swatting at the coyotes as they ran in to nip at it. The bear and coyotes then entered the trees and were lost from view.

Interactions With Female Grizzly Bears With Coy

During 2 bear observations, coyotes approached female grizzly bears with COY:

On 4 July 1984, at 1117 hours, a coyote approached a female grizzly bear with 1 COY that were foraging. The adult bear was aware of the coyote but continued grazing. The cub made several short charges at the coyote but stopped and ran back to the adult bear each time it got between 5 m and 10 m

from it. The coyote left but returned 20 min later, and the procedure was repeated 3 more times.

On 6 July 1988, at 0948 hours, a female grizzly bear with 1 COY that were grazing were approached by a coyote. The cub chased the coyote up and over a small hill where they were blocked from view. A few seconds later, they came back over the top of the hill with the coyote chasing the cub. The adult bear immediately ran at the coyote, chased it back over the top of the hill, then returned and resumed grazing. The coyote approached again; the cub chased it, and the entire process was repeated.

Whether coyotes were playing with bear cubs or attempting to prey on the cubs by luring them away from their mothers' safety is unknown. The fact that coyotes only chased cubs that were out of their mothers' view suggests that coyotes may have been attempting to prey on the cubs.

APPENDIX F

BEAR-BISON INTERACTIONS

BEAR-BISON INTERACTIONS

The following summarized notes from my field journal provide representative examples of bear-bison interactions:

On 3 July 1985, at 0555 hours, an adult grizzly bear was observed feeding on an elk calf it had killed. A lone bull bison was walking in a northly direction which would take it directly past the bear and carcass. The bear stopped feeding, looked up at the approaching bison, then ran approximately 25 m west of the carcass. The bison paused momentarily then continued walking north past the carcass. After the bison had passed, the bear returned to the carcass and continued grazing.

On 30 July 1984, at 1728 hours, a subadult grizzly bear was observed grazing within 25 m of a hiking trail. A group of 3 backpackers came down the trail from the north. The bear stopped grazing, looked at the hikers, but did not run. The hikers left the trail, detoured approximately 400 m in a half circle around the bear, then continued south. A group of 4 backpackers came down the trail approximately 30 min later. The bear stopped grazing, looked at the hikers, but again did not run. The hikers reacted the same way as the previous group. Approximately 10 min later, a bison walked south down the trail. The bear stopped foraging, ran approximately 35 m west, and let the bison pass. The bear then returned to its original location and resumed grazing.

On 8 August 1985, at 1911 hours, an adult grizzly bear was observed grazing on clover. A lone bull bison was walking south down the trail toward the bear. The bear's view of the approaching bison was blocked by a small hill. The bison walked up over the top of the hill and down toward the bear. The bear stopped grazing, looked up, then ran approximately 20 m east of the trail. After the bison passed, the bear returned to the clover patch and resumed grazing.

On 10 June 1985, at 1949 hours, a subadult grizzly bear was observed walking northeast on a trail. Two bull bison were grazing next to the trail. The bear left the trail, detoured in a half circle around the bison, then returned to the trail and continued northeast.

On 28 August 1986, at 1738 hours, a female grizzly bear and 3 COY were observed walking on a hiking trail. As the bears walked north up the trail, a large lone bull bison was walking south down the trail. When the bears were between 30 m and 40 m from the bison, they stopped; the bison stopped; then, the bears left the trail and walked west. The bison continued down the trail.

On 23 June 1987, at 2013 hours, an adult grizzly bear was observed walking west through the valley. A group of 5 bull bison was grazing west of the bear. A finger of trees was blocking the bison's view of the bear. As the bear walked around the tip of the trees, the bison appeared startled. Four of the bison turned and ran a short distance. One of the bison charged the bear, chasing it for 20 m to 30 m. The bear ran from the bison; when the bison terminated

the charge, the bear stopped running and continued walking west.

On 27 August 1986, at 2008 hours, an adult grizzly bear was observed walking south along upper Raven Creek. A group of 19 bison with 5 calves was grazing south of the bear. When the bear approached to within 30 m of the bison, a cow and calf bison, which were closer to the bear than the rest of the herd, ran 25 m back to the herd. The adult bison stood facing the bear; the 5 calves in the group stood behind the adults. The bear stopped, sat down, looked at the bison, then turned and walked east into the trees.

On 30 July 1985, at 1731 hours, an adult grizzly bear was observed approximately 300 m west of a lone bull bison that was lying down with its back toward the bear. As the bear foraged, it was slowly moving toward the bison. When the bear's foraging took it to within 30 m of the bison, the bison stood up, faced the bear, then turned and walked away to the east. When the bison stood up, the bear stopped grazing and watched the bison. After the bison walked away, the bear resumed grazing.

APPENDIX G
VEGETATION PHENOLOGY

Table 18. Phenological changes of vegetal bear foods from June through August in Pelican Valley, Yellowstone National Park, 1986.

Species	Stage of phenological development ^a										
	Week (month/day)										
	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24	8/31
Forbs											
<u>Cirsium scariosum</u>	1	1	1	1	1	3	3	3	4	4	4
<u>Epilobium</u> spp.		1	1			2	2	2	3		4
<u>Equisetum arvense</u>	1	1	1								
<u>Fragaria</u> spp.	1	1	1	1	3	3	3	3	4	4	4
<u>Perideridia gairdneri</u>		1	2	2	2	2	2	2	3	3	3
<u>Polygonum bistortoides</u>				2	3	2	3	3	4	4	4
<u>Taraxacum</u> spp.	2	1	3	4	3	4	4	4	4	4	4
<u>Trifolium longipes</u>	1	2	3	2	2	3	3	4	4	4	4
<u>Trifolium repens</u>					2					3	

Table 18. Concluded.

Species	Stage of phenological development										
	Week (month/day)										
	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24	8/31
Graminoids											
<u>Agropyron</u> spp.	1	1	2	2	2	2	3	3	3	3	4
<u>Bromus</u> spp.	2	1	2	2	2	3	3	3	3	3	3
<u>Calamagrostis</u> spp.				2		3	3	3	3	3	3
<u>Carex</u> spp.	2	2	2	3	3	3	3	4	4	3	4
<u>Deschampsia</u> spp.	1		2	2	3	3	3	3	3	3	4
<u>Festuca</u> spp.	1	1	2	2	2	3	3	4	3	3	4
<u>Melica</u> spp.	2	2	2	3	3	3	4	4	4	4	4
<u>Phleum</u> spp.		2	2	2	3	3	3	3	4	3	4
<u>Poa</u> spp.		2	1	3	3	3	3	3	3	3	4
<u>Scirpus</u> spp.	1	2	1	2		3		3	4	4	4

- 1 = Succulent - no flowers evident.
 2 = Succulent - flowers developing or developed.
 3 = Curing - flowers mature or degenerating.
 4 = In or beginning to seed.

Table 19. Phenological changes of vegetal bear foods from May through August in Pelican Valley, Yellowstone National Park, 1987.

Species	Stage of phenological development ^a									
	Week (month/day)									
	5/25	6/8	6/15	6/25	7/9	7/16	7/23	8/3	8/19	8/22
Forbs										
<u>Cirsium scariosum</u>	1	1	1	1	3	3	3	4	4	4
<u>Fragaria</u> spp.	1	2	3	4	4	4	4	4	4	
<u>Perideridia gairdneri</u>	1	1	1	1	2	2	2	3	4	3
<u>Taraxacum</u> spp.	2	2	2	3	4	4	4	4	4	
<u>Trifolium longipes</u>	1	1	2	3	4	4	4	4	4	
<u>Trifolium repens</u>										4
Graminoids										
<u>Agropyron</u> spp.	1	1	1	1	3	3	3		4	3
<u>Bromus</u> spp.	1	1	2	2	3	3	3	3	4	3
<u>Carex</u> spp.	1	1	2	3	3	4	3	3		4

Table 19. Concluded.

Species	Stage of phenological development									
	Week (month/day)									
	5/25	6/8	6/15	6/25	7/9	7/16	7/23	8/3	8/19	8/22
Graminoids										
<u>Deschampsia</u> spp.		1	1	2	3	3	3	4	4	4
<u>Festuca</u> spp.	1	1	1	2	3	3	3	3	4	
<u>Melica</u> spp.		1	2	2	3	4	3	4	4	
<u>Phleum</u> spp.		1	2	2	3	4	3	3	4	3
<u>Poa</u> spp.	1	1	1	2	3	3	3	3	4	4
<u>Scirpus</u> spp.		1		1						

- 1 = Succulent - no flowers evident.
- 2 = Succulent - flowers developing or developed.
- 3 = Curing - flowers mature or degenerating.
- 4 = In or beginning to seed.

APPENDIX H
REPRODUCTIVE BEHAVIOR

REPRODUCTIVE BEHAVIOR

Male bears have been observed locating females in estrous by following their scent trails (Rogers 1987). On one occasion during this study a female bear apparently located a male by following the male's scent trail. On 24 June 1984, a female (as determined by subsequent behavior) grizzly bear was observed traveling south down upper Pelican Valley following the route a male (as determined by subsequent behavior) grizzly bear had taken earlier. The female bear was walking at a fast pace with its head down and was not stopping to forage. Occasionally, the female bear stopped, moved back and forth in a zigzag pattern as if searching for a scent trail, then resumed traveling at a fast walk, at times breaking into a loping gait. The female followed the travel route of the male bear for 1.6 km before reaching the male. As the female bear approached, the male stopped foraging, moved behind the female, sniffed the female's genital area, and attempted to mount her. The female then sat down on her rump. The male attempted to mount the female 2 more times before it became too dark for further observations. The female sat down both times.

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