VISITOR IMPACT ON GRIZZLY BEAR ACTIVITY IN PELICAN VALLEY, YELLOWSTONE NATIONAL PARK

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Abstract: Visual observations were used to determine if human recreational activity affected grizzly bear (*Ursus arctos horribilis*) use of open meadow areas in Pelican Valley, Yellowstone National Park. Visitor compliance with bear management regulations and safety warnings were also evaluated. From May - September 1984-88, 944 bear observations were recorded. During this period, the study area was managed for 3 levels of backcountry use: open (both day use and overnight camping allowed), restricted use (day use 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. Foot parties were more likely to be charged during an encounter with a grizzly bear than people on horseback. All incidents in which hikers were charged by bears involved groups of 1 or 2 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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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 - 1982 (45% increase from 1973). As use of YNP's backcountry increased, park managers became concerned over the potential impact high levels of recreational use might have 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. The park began restricting recreational use in specific areas of prime bear habitat in 1983. The goals of these restrictions were to: (1) minimize bear/people interactions; (2) prevent human-caused displacement of bears from prime food sources, and (3) decrease the risk of human injury in areas with high levels of bear activity (National Park Service 1982).

In 1984, I began a study to evaluate the effectiveness of restricting human activities in the Pelican Valley area. The objectives of the study were to: (1) determine if backcountry recreational activity displaced bears from productive open meadow habitats, (2) determine if backcountry recreational activity disrupted grizzly bear diurnal activity patterns, and (3) evaluate visitor compliance with bear management regulations and safety warnings.

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STUDY AREA

The study area encompassed approximately 4,850 ha (12,000 acres) of nonforested habitat in the Pelican Valley area of YNP (Fig. 1).

The vegetation of Pelican Valley is a mosaic of community types dominated by silver sagebrush/Idaho fes-

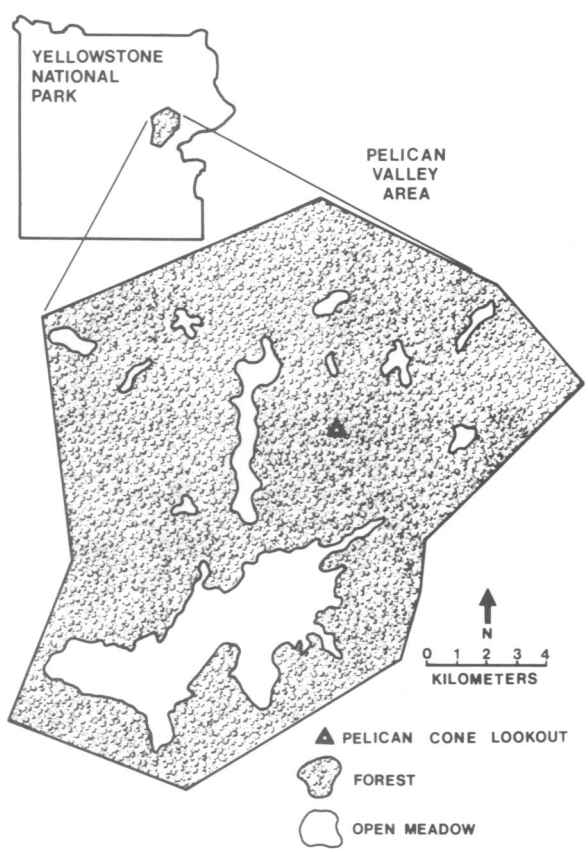

Fig. 1. Open meadow areas in Pelican Valley visible from Pelican Cone Lookout, Yellowstone National Park.

cue (*Artemisia cana/Festuca idahoensis*) with riparian habitats of tufted hairgrass (*Deschampsia cespitosa*) and sedges (*Carex* spp.) (Graham 1978). 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).

Riparian bottoms, vegetation community type diversity, high interspersion of open meadows and forest cover, winter-killed bison (*Bison bison*), and elk (*Cervus elaphus*) calving areas combine to make Pelican Valley an area with a high level of grizzly bear activity (National Park Service 1982). Grizzlies are active in the area from March through November (S. J. Fowler, Natl. Park Serv., pers. commun.).

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 (41 miles) of hiking trails. The campsites had a combined total capacity of 228 people and 285 stock (horses and mules) per night. Overnight use in the valley averaged 1,632 visitor use nights per year from 1973 - 1983 (National Park Service 1984). Records of day use in the valley were not available for the years prior to 1981. From 1981 - 1983 combined overnight and day use averaged 84 people and 11 stock per day during the peak season (July - August). Human use restrictions were implemented in the valley in 1984.

METHODS

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 allowed viewing of most of the nonforested areas in the surrounding drainages. Binoculars (11 x 80) were used for scanning. A 2,000-mm telescope with a useable magnification of 44 to 77 power allowed detailed observations.

Since grizzly bears in YNP are generally most active during nocturnal and crepuscular hours (Schleyer 1983, Harting 1985), the meadows and open areas were scanned once every half hour from 0500 - 1100 hours and from 1800 - 2145 hours. Between 1100 and 1800 hours the valley was scanned once every hour. Fog, low lying clouds, haze, heat waves, and heavy precipitation limited observations on some days. Although bears could only be observed during daylight hours, most bears using the area are probably included since bears exhibiting nocturnal activity patterns generally have crepuscular activity peaks (Schleyer 1983, Harting 1985).

Each bear or group of bears observed was recorded as 1 bear sighting. Bears observed together, such as females with young, breeding pairs, or pairs of subadults were recorded as 1 bear sighting. Recording data in this way eliminated bias toward behavior of females with young, the behavior of the dominate bear of breeding pairs or pairs of subadults. Data recorded for each bear sighting included time period active, interactions with people, proximity to backcountry campsites, and maximum distance the bear moved from forest cover.

All bears observed were classified as grizzly bears, black bears (*Ursus americanus*), or unknown. Eighty-three percent (N = 961) of the bears observed were identified to species. Of these, 98% were classified as grizzly bears. Data from bears classified as grizzly bears and species unknown were pooled for analysis. Black bear observations were omitted.

Bear observations were divided further according to backcountry use: open (both day use and overnight camping), restricted (day use between 0900 and 1900 hours only, no overnight camping), and closed (no recreational use). A set schedule for testing each regulation could not be followed. The study area was closed each spring through 3 July to prevent displacement of bears (National Park Service 1986*a*). The valley opened 4 July but was reclosed following confrontations between bears and recreational users, concentrated bear activity along trails, or the presence of carcasses near trails. After 1985, all campsites in Pelican Valley were closed and day use after 4 July was limited to the hours between 0900 and 1900 hours in an effort to further reduce human disturbance and to increase visitor safety (National Park Service 1986*a*).

Five of 13 campsites in the study area in 1984 were visible from Pelican Cone. Two of the 5 were closed in 1985; all were closed thereafter. 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 silver sagebrush/Idaho fescue habitat. A heterogeneity test justified pooling the data from the 5 campsites.

Bear activity minutes (BAM) were recorded for each minute bears were observed and divided into 1-hour time blocks for analysis. Activity pattern comparisons were made among the 4 categories of bears that could be distinguished from Pelican Cone: (1) females with cubs of the year (COY), (2) females with yearlings, (3) subadults (2 1/2-through 3 1/2-year-olds), and (4) all other bears.

Human use was monitored at the same time as bear use. Data collected included number of people in each party, number of stock (pack and saddle horses and mules), campsite number, type of use (day or overnight use), current visitor use regulation, and compliance with regulations and safety warnings. Any incident in which bears reacted to the presence of people or people reacted to the presence of bears was recorded as a bear/human encounter.

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

RESULTS

In 309.5 observation days, 944 bear sightings were recorded. The closed, restricted, 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. Fourteen to 23 grizzly bears frequented Pelican Valley each summer of the study.

Human Use in Pelican Valley

During the 5 years of the study, 2,819 people and 1,771 stock animals were observed in the valley. 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.

Bear/Human Encounters

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 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 m ± 334 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 (Herrero 1985) 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 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 was the only case that 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 of 1984.

Distance from Cover

The average distance bears moved from forest cover while being observed during this study was 290 m ± 323 SD. Previous studies in YNP using predominantly 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 tree cover. Only 38% (357 of 944) of the bears observed during this study remained within 100 m of tree 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 ± 14 SE) and restricted ($\bar{x}$ = 293 m ± 21 SE) periods than during the open ($\bar{x}$ = 228 m ± 23 SE) periods. 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 ($X^2 = 8.87$, df = 2, $P = 0.0135$). The difference between the closed and restricted periods was not significant ($X^2 = 0.5012$, df = 1, $P = 0.479$).

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 ($X^2 = 7.01$, df = 1, $P = 0.0081$). Campsite occupancy reduced the number of bear sightings within 400 m by approximately 67%.

Activity Patterns

Major peaks in diurnal activity occurred at 0600 and 2000 hours (Fig. 2). Only 6% ($N = 56{,}480$ BAM) of the observed activity occurred between 1200 and 1600 hours. This observed pattern of crepuscular activity peaks sup-

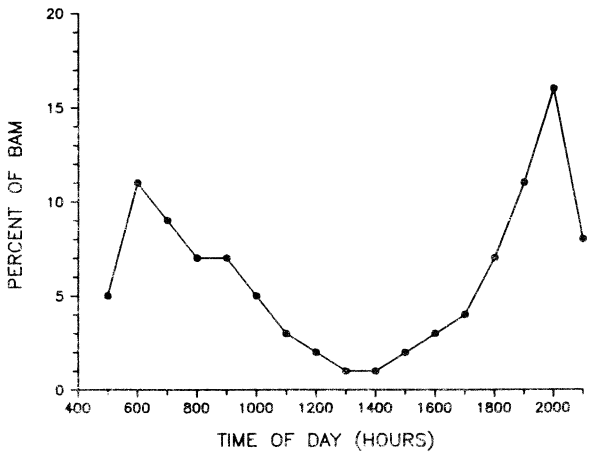

Fig. 2. Diurnal activity profile of grizzly bears in Pelican Valley, YNP, from May through September, 1984-88. Points indicate the percentage of total bear activity minutes (BAM) observed per 1-hour time block.

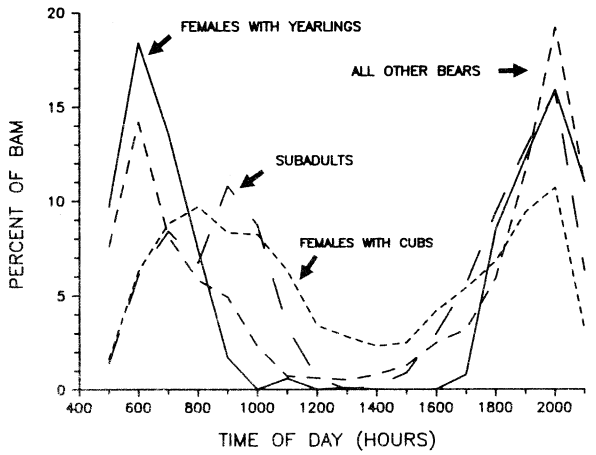

Fig. 3. Diurnal activity patterns of grizzly bear cohorts in Pelican Valley, YNP, from May through September, 1984-88. Points indicate the percentage of total bear activity minutes (BAM) observed per 1-hour time block.

ports the findings of radio telemetry studies by Schleyer (1983) and Harting (1985) for grizzly bears in YNP.

Activity patterns of subadults and females with COY differed from those of all other bears (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 bears observed (0600 hours). The percentage of observed activity minutes during the late morning and afternoon hours (1000 - 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).

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 - 1000 hours) than during the restricted (0600 - 0700 hours) and closed (0600 hours) periods. This was due to the presence of a pair of subadult grizzlies during the open period in 1984. The pair of subadults appeared to be habituated to humans and were more day active than most other bears observed.

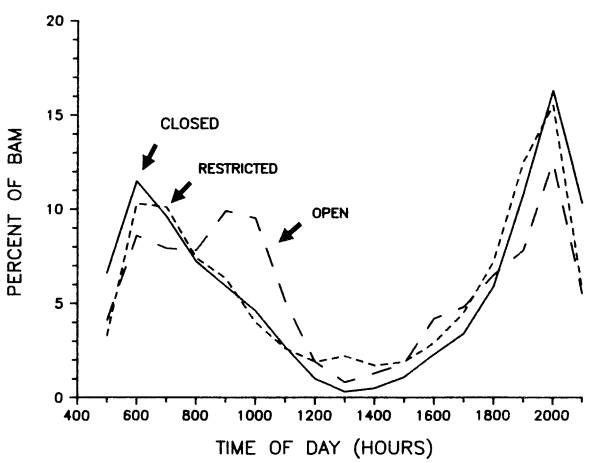

Fig. 4. Diurnal activity patterns of grizzly bears during closed, restricted, and open periods of recreational use in Pelican Valley, YNP, from May through September, 1984-88. Points indicate the percentage of total bear activity minutes (BAM) observed per 1-hour time block.

Visitor Compliance with Bear Safety Warnings and Regulations

The area closure regulation had a higher rate of compliance among hikers (99%, $N = 1,683$) than the day use only regulation (83%, $N = 843$). The compliance rate of people on horseback was 100% ($N = 1,136$) with both regulations.

Signs posted at the Pelican Valley trailhead from 1986 through 1988 recommended hiking parties 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). My observations in Pelican Valley suggest that bear safety recommendations are not very effective at influencing visitor behavior.

DISCUSSION

The importance to grizzly bears in YNP of areas >100 m from forest cover may have been previously underestimated. These results 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 open areas was significantly reduced and bears were displaced from areas near occupied campsites. Restricting use of the valley to time periods when grizzlies were least active (0900 - 1900 hours) appears to have successfully prevented human-caused displacement of bears from productive open 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 grizzlies also increases human safety by reducing the chance of bear/human encounters (National Park Service 1986*a*). 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 cubs were more day active than other bears observed. This suggests that subadults and females with COY may have been using temporal spacing to increase security from other bears. By being more day active, these cohorts of bears 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 from nonforested habitat 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 bear habitat use 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. Habituation even without food conditioning can be dangerous and has been associated with some bear-caused human fatalities (Herrero 1985). Hikers may inadvertently approach within a bear's "individual distance" (Herrero 1970) and be charged when the bear is habituated to people (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 proximity throughout the summer (National Park Service 1986*b*). Other findings, however, suggest that bears are less likely to charge hikers if they are habituated towards 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 period of being closed. 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 patrol the trails a few days before 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 where security cover is more readily accessible.

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