EFFECT OF YOSEMITE BACKCOUNTRY USE LEVELS ON INCIDENTS WITH BLACK BEARS

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Abstract: Black bear (*Ursus americanus*) incidents, defined as property damage or personal injury by bears, increased dramatically in recent years in the backcountry of Yosemite National Park, California. Since all backcountry zones do not receive the same level of visitor use, incidents could be compared between zones of various use levels. Data collected from 1976 through 1979 showed that as visitor density increased, reported bear incidents increased linearly. In order to reduce or maintain bear incidents at acceptable levels, managers of backcountry areas may have to reduce nonaversive bear/human encounters and the availability of human food items.

Int. Conf. Bear Res. and Manage. 5:307–311

Black bears in Yosemite National Park have used food provided intentionally and unintentionally by humans since the 1920's. This relationship between bears and humans over a period of 60 years has led to serious conflicts including personal injury and property damage. It has also led to alterations in the natural behavior, foraging habits, distribution, and population levels of bears in the Park (Harms 1977).

In 1975 an intensive management program was initiated by the National Park Service in Yosemite to restore the natural integrity of the black bear population. This program included public information and education, removal of artificial food sources, enforcement of regulations, control of problem bears, and research and monitoring (Human/bear management plan, Yosemite Natl. Park, Natl. Park Serv., U.S. Dep. Inter., 1979). Since most of the property damage occurred in frontcountry (as opposed to backcountry) campgrounds, the program concentrated on the frontcountry with considerable success. In 1975, reported incidents with black bears in the frontcountry totaled 879 with an estimated value of property damage over $100,000. These figures were reduced to 161 incidents and an estimated $13,000 worth of property damage in 1979.

In the Yosemite backcountry, however, reported bear incidents increased from 100 in 1975 to 225 in 1979 with a high of 371 in 1977 (Table 1). Part of this increase might be attributed to the success of the frontcountry effort, with bears being forced into the backcountry. Also the proportion of incidents that were reported increased in 1976 and remained stable through 1979.

Since visitor use was not evenly distributed over the areas of the backcountry, it was possible to compare the number of incidents with bears in an area to the visitor density in that same area. This study was an attempt to determine the relationship between incidents and use levels and to evaluate some of the factors which influence that relationship.

We wish to extend our appreciation to Peggy Endicott and Joe Coho for their efforts in compiling visitor use data. We gratefully acknowledge Joan Brenchley, Debbie Bird, and Beth Harrison for assistance in compiling bear incident data, and Teri Grosse for preparing the figures.

STUDY AREA

Yosemite National Park encompasses 308,000 ha on the west slope of the Sierra Nevada in central California. Elevations vary from 600 m on the western boundary to 4,000 m on the crest. The climate is Mediterranean with hot, dry summers and cool, moist winters. The unroaded backcountry of the Park covers 277,000 ha.

The vegetation of Yosemite can be described by 4 major types (Barbour and Major 1977). A limited amount of chaparral (7,000 ha), consisting of oaks (*Quercus* spp.), manzanita (*Arctostaphylos* spp.), and ceanothus (*Ceanothus* spp.), exists at the lower elevations. The mixed conifer type occupies 65,000 ha between 1,300 m and 2,000 m. The most prevalent species in this type are ponderosa pine (*Pinus ponderosa*), incense-cedar (*Calocedrus decurrens*), white fir (*Abies concolor*), and California black oak (*Quercus*

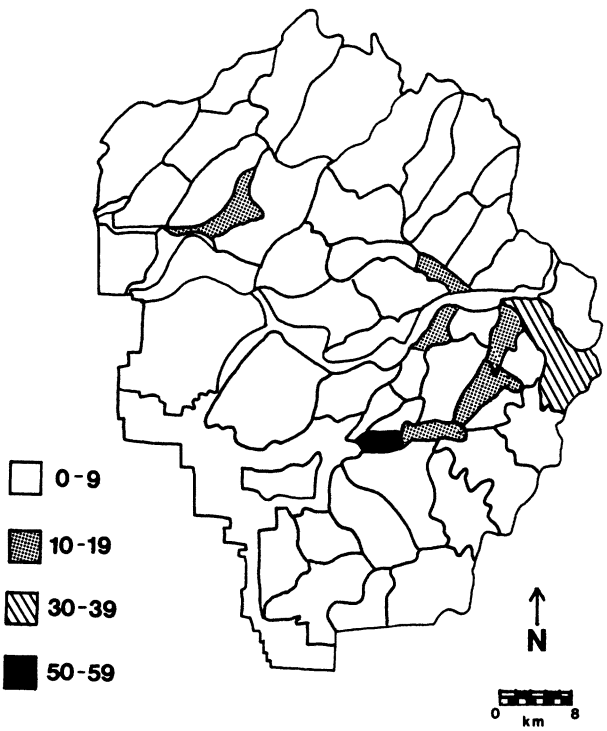

Fig. 1. Average annual reported bear incidents for travel zones in Yosemite National Park, 1976–1979. (No zones had incidents averaging 20–29 or 40–49.)

kelloggii). Between the mixed conifer type and 2,700 m elevation the 70,000-ha red fir (*Abies magnifica*) type is found. The lodgepole pine (*Pinus contorta*) subalpine type extends to 3,300 m and covers 122,000 ha of the Park. The remaining 44,000 ha are above timberline.

Four habitat classes based upon the relative abundance and availability of known bear food items have been delineated by Graber and White (1983). Class 1 areas (16% of the backcountry) were considered prime habitat and contained either oaks or manzanita. Class 2 areas (19% of the backcountry) were considered good bear habitat. They occur primarily in the mixed conifer zone and are typically concentrated at the periphery of meadows and mast-producing areas. Logs provide a source of insect food. Class 3 areas (42% of the backcountry) had lodgepole pine and red fir as the major constituents, and are not snow free until June. There, food items consist primarily of grasses, forbs, and unnatural food stuffs. Class 4 areas (22% of the backcountry) were either barren, alpine, or subalpine types with little or no available food.

Table 1. Visitor use, reported bear incidents, and property damage estimates for the backcountry, Yosemite National Park, 1976–1979.

Year	Visitors	Visitor nights	Bear incidents	Dollar damage
1976	71,066	186,526	165	4,758
1977	74,537	194,243	371	9,397
1978	70,909	172,472	277	9,398
1979	66,053	181,775	225	8,553
Mean	70,641	183,754	260	8,027

The black bear was historically an animal of the chaparral and mixed conifer types and was only rarely seen above 2500 m during the early part of this century (Grinnell and Storer 1924). In recent years, however, they are commonly sighted at 3100 m in the subalpine type, and bear incidents occur throughout the Park (Fig. 1).

Yosemite National Park is within 4–6 hours driving time from Los Angeles and San Francisco. The park has averaged over 2.4 million visitors for the past 10 years. Backcountry use averaged 70,600 visitors per year since 1976. These visitors spent an average of slightly less than 3 nights in the backcountry for a total of nearly 184,000 visitor nights per year. The 100-day summer season between Memorial Day and Labor Day accounted for 68% of the use, with August being the peak month (van Wagtendonk 1981).

The backcountry is divided into 53 areas or travel zones for Park management purposes. Use was concentrated in zones which are within 1 day's travel of the trailheads (Fig. 2). Over 40% of the use for the period from 1972 through 1979 occurred in only 10 of the zones (van Wagtendonk 1981).

METHODS

Bear incidents, defined as property damage or personal injury caused by bears, were recorded by Park Service personnel on special forms. Information included date, time, location by zone and camp area, description of the bear, type of incident (injury or damage), type of property damaged, estimated value, reason for the incident,

and the name and address of the persons involved. Incident reports were taken at ranger stations, information centers, and backcountry permit issuing points and also by frontcountry and backcountry rangers. All data were stored on the National Park Service Bear Information Management System (Cella and Kapler 1979). Output from the system included listing of incidents by backcountry travel zones.

Backcountry use information was collected from backcountry permits. The permit has been mandatory for overnight backcountry users since 1972. The permits provided information about the number of people in each party, their entering and exiting dates and locations, the zones the party planned to travel through, and where they expected to spend their nights. Since 1976, travel zone information has been recorded only during August. The permits were analyzed to determine the average number of people per night for each zone for the peak use period.

A survey conducted by van Wagtendonk and Benedict (1980) allowed corrections to be applied to the data for changing itineraries and failure to obtain permits. Zones in the interior of the backcountry received less use than indicated on the permits while zones close to trailheads received more than the indicated use.

The average and total number of incidents per year for the years 1976 through 1979 were analyzed by comparing them to the average visitor density per night which occurred in the same zone during the peak use period for the same years. Since zone data were only recorded during single weeks in August, it was not possible to analyze total use per year. Other independent variables included in the model were habitat class, the number of management kills of problem bears in a zone, the distance and number of days hike from trailhead to trail zone, the number of trail segments in a zone, the length of trails in a zone, and the number of camp areas per zone. Many of these factors are different measures of visitor use but approach visitor distribution in a zone from different perspectives so were included in the model.

Statistical analyses were accomplished using stepwise regression and nonlinear regression programs from the SAS package (Helwig and Council 1979). All tests for significance were at $\alpha = 0.05$.

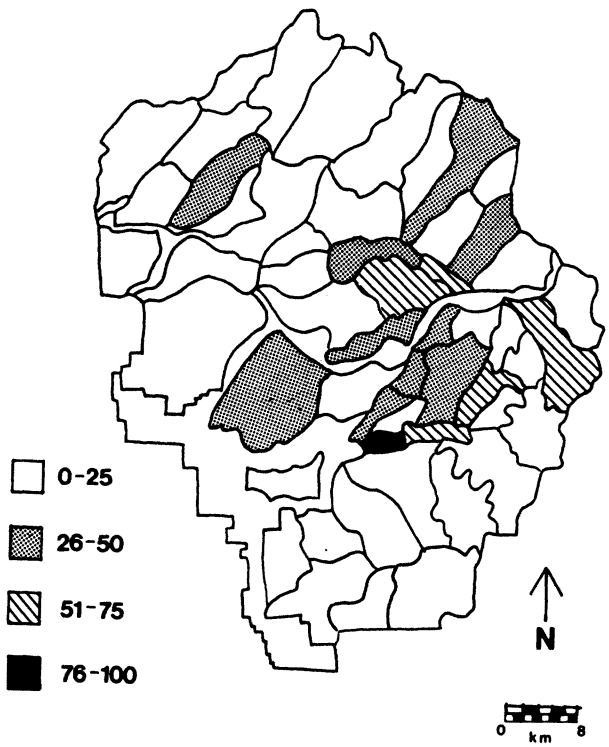

Fig. 2. Average number of visitors/night during August for travel zones in Yosemite National Park, 1976–1979.

RESULTS AND DISCUSSION

A total of 1,038 bear incidents in the backcountry travel zones was recorded from 1976 through 1979. Data collected in 1979 (Hastings, B.C., Dep. Wildl. Sci., Utah State Univ., unpublished data) and in 1975–1978 (van Wagtendonk, unpublished data) suggested that only 8–11% of the actual bear incidents that occurred were reported. Factors affecting the rate of reporting included ease of reporting and the value of property damaged. Due to the location of Park Service facilities and personnel relative to backcountry trailheads, reporting levels were higher in some travel zones than others. Attempts to account for potential reporting biases in the data did not produce significant relationships with either visitor use or habitat class. This may be due to insufficient data to accurately reflect the level of bias Parkwide. Visitor use in a few travel zones may be underestimated for similar reasons. As the value of property damage increased, the reporting rate also increased (Hastings, unpublished data). The data presented in

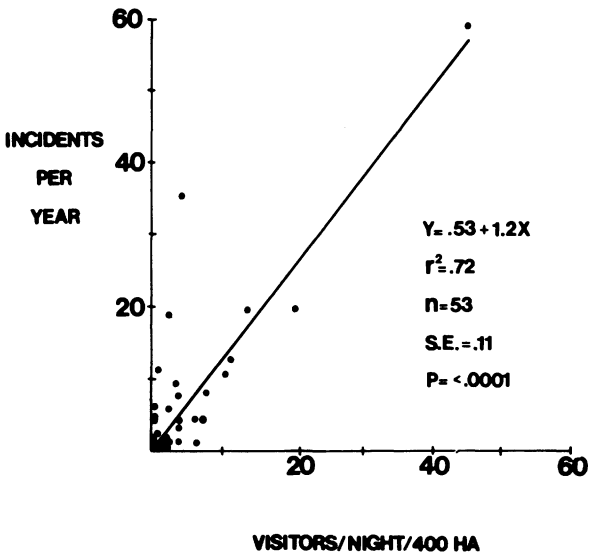

Fig. 3. Linear equation correlating bear incidents with visitor use/night/400 ha in each travel zone during August, Yosemite National Park, 1976–1979.

this study may more accurately reflect the relationship between visitor use and relatively high-cost property damage.

Since an incident can occur only when a bear and a visitor encounter each other, there was a positive linear relationship between incidents and visitor density (Fig. 3). Merrill (1978) showed a significant relationship between bear incidents and concentrated use in Glacier National Park.

Visitor density, as used in this paper, is a measure of 2 related factors affecting the bear/human conflict. One factor would include both chance encounters in a natural setting and intentional encounters resulting from a bear's attraction to a human resource such as food. If nonaversive, both types of encounters could contribute to perpetuating the bear/human conflict by promoting bear habituation to humans (McArthur, 1979).

Secondly, visitor density reflects a level of food availability. The relationship between visitor density and food availability will vary with different food storage techniques and the varying ability of bears to obtain food. The visitor density/food availability relationship in Yosemite was felt to have remained constant throughout the study period. A very low level of food reward may be sufficient to perpetuate food-seeking behavior in bears (Stokes 1970). Reduction of the level of nonaversive bear/human interactions and/or the availability of human food items appears necessary to reduce incidents to an acceptable level.

There is a point on the line of increasing use where bear behavior might be suspected of changing. After a certain level of bear/human interaction and/or food availability is reached, bears might more likely be drawn into a camp area and cause incidents than in sparsely used zones. Increased local human use may also coincide with a disproportionate increase in bear/human interactions even in the absence of any change in bear behavior (Stuart 1978). These factors could interact to provide an exponential relationship between visitor density and bear incidents.

In order to detect if such a relationship existed, the data were evaluated using an exponential relationship. The regression equation was $Y = 0.0002e^{0.2056X}$ ($r^2 = 0.24$, $N = 53$, $P = 0.0001$), where Y is the number of incidents per year for a zone and X is the number of visitors per night during the peak use period for the same zone. The low r^2 value is felt to be a result of too few observations at the higher use levels. The level of significance should caution land managers that such a relationship might exist.

No significant relationships were found between the area of each of the habitat classes in a travel zone and the occurrence of bear incidents. Merrill (1978) found significant differences in incident levels between vegetation types in Glacier National park. Amstrup and Beecham (1976) reported distribution of black bears in Idaho to be influenced by food availability. Increased backcountry visitor use in Yosemite in recent years may have increased food availability in previously marginal habitat, which could result in increased bear density, with bears in marginal natural habitat more dependent on visitor foods than bears in prime natural habitat.

No significant relationships were detected between the occurrence of bear incidents and the other independent variables tested. The greatest r^2 was achieved when incidents were compared with the average visitor density over the entire study period as opposed to incidents and visitor density for each year. This is due to greater variability in annual data probably resulting from factors such as fluctuations in weather and natural food availability, and the sex, age, and previous experiences of bears. For example, a camp area

might be visited regularly by a solitary female 1 year, the same female with 2 cubs the following year, and a solitary female and 2 independent yearlings the 3rd year. Breeding condition of females might also serve to attract males to an area which may contribute to incidents. Different family structures have different capabilities for obtaining food and elicit different levels of anxiety in Park visitors. Also, previous learning experiences of an individual bear would carry over from year to year, thus tending to stabilize bear incident levels in spite of fluctuations in visitor use.

CONCLUSIONS

The data suggested a definite correlation between visitor density and the occurrence of bear incidents. In order to reduce bear incidents to an acceptable level, managers of backcountry areas must address the level and nature of backcountry visitor use. Bear/human encounters that could promote habituation of bears to humans should be reduced, and food should be stored so it is not available for consumption by bears. These may be accomplished by means of increased public information–education efforts to teach visitors proper ways of behaving when a bear is encountered and proper food storage procedures. The use of food storage devices, either permanent or portable, may be necessary to approach a low enough level of food availability to discourage food seeking behavior in bears. A reduction in visitor density, both on an annual and per-night basis, may also be necessary and would contribute to reducing both bear/human interactions and food availability. In addition to these management actions, research needs to be done to more fully understand alterations in bear behavior due to human encounters.

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