Final Report:
Bear Element Assessment Focused on Human-Bear Conflicts in Yosemite National Park

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Table of Contents

List of Tables

List of Figures

Black Bear Element
Executive Summary

Overview of Three-Year Effort. Our research efforts were focused on the bear element of the Human-Black Bear Interaction Assessment for Yosemite National Park. We conducted field research during the high use recreational seasons of 2001 and 2002. Our research involved an examination of historical trends in reported conflicts between humans and black bears. We used radio collars and radio telemetry to assess black bear behavior and use of Yosemite Valley compared to human use. We also collected bear scat to describe the food habits of bears in Yosemite Valley. We assessed areas and reasons why trash and recycling were available to bears for consumption. We also determined the functionality and "user-friendliness" of "bear-proof" food storage lockers in use in Yosemite National Park.

Findings. Key findings from the bear component of the Human Black Bear Interaction Assessment indicate that there has been a recent decline in reported incidents in Yosemite National Park (YNP). To achieve YNP's goals of continued reductions in incident numbers and a restoration of natural behavior patterns of black bears, Park management must continue to improve because human-bear incidents remained a significant concern and continued to alter bear behavior in YNP. The annual number of human-bear incidents documented in YNP between 1989 and 2002 ranged between 230 and 1,584. Corresponding annual property damage estimates ranged between $32,303 and $659,569. However, a decreasing trend in the number of incidents in YNP between 1998 and 2002 corresponded to efforts outlined by the Human-Bear Management Program. This Program was made possible by an annual congressional appropriation of $500,000, initially available in 1999. The appropriation provided for increased staffing levels, improved communication efforts, the installation of "bear-proof" food storage lockers, and the implementation and enforcement of food storage regulations.

Yosemite Valley (YV) was an area of particular concern between 1989 and 2002, with 62% of annual incidents occurring in an area that comprises only 0.6% of the Park. A significant majority (97%) of human-bear incidents documented in YV occurred in campgrounds and parking lots. Visitor and employee failure to follow food storage regulations despite successful dissemination of information about human-bear conflicts also continued to result in problems. Human error was responsible for a majority (65%) of human-bear incidents in YV. Additionally, the number of incidents attributed to human error increased between 1989 and 2002. These trends were particularly alarming when juxtaposed with the finding that 93% of victims involved in incidents received information about human-bear incidents and food storage regulations prior to the incidents. Failures in enforcement of regulations were also of concern. Park personnel implemented no corrective action in 64% and issued citations in only 3% of the incidents that occurred in YV between 1989 and 2002. The frequency that citations were issued did not differ prior to and following the implementation of food storage regulations in campgrounds and parking lots. Finally, adult male (55%) and adult female (41%) bears were involved in the majority of incidents in YV between 1989 and 2002.

During the 2001 and 2002 seasons, 22 bears were captured and 19 were fitted with radio collars. Bears were found to be smaller in size compared to bears captured in YNP during the 1970's and consistent in size with bears captured in less developed areas of California. Thus, bears in YV have returned to a more natural physical condition, following reductions in the availability of human-provided food and garbage to bears. The home-range sizes of bears captured in YV were also consistent with those estimated for bears throughout North America. Despite YV having one of the highest concentrations of human food, garbage, and optimal, natural bear habitat in YNP, only two collared bears were consistently located in YV. This finding demonstrated the connectivity between the bears found in YV, other developed areas of YNP, and backcountry areas.

Human activity and use of developed areas in YV, including food resource enrichment and harassment, resulted in deviations from natural, diurnal behavioral patterns exhibited by bears in areas with less human impact. Adult male bears regularly used developed areas during monitoring efforts and were significantly more active during nocturnal periods. Adult and subadult female bears tended to be diurnal when they used only natural areas, but tended to be nocturnal when they used developed areas. Bears were also found to use developed areas more frequently than some natural habitats and tended to be located closer to developed areas than expected by chance.

Black bear diets were composed of vegetative matter (80%), animal matter (4%), debris (10%), and human food and garbage (6%). Common food items in the spring included grasses, sedges, and rushes, which made up over 85% of the spring diet. Apples, berries, and acorns comprised a majority of the summer and fall diet of bears in YV. The use of apples (59.5% and 38.5% of the summer and fall diet, respectively) was of particular concern because of their nonnative status and proximity to developed areas of YV. Human food use was most prevalent during the summer season, corresponding with high visitor use of YV. Efforts of the 1975 YNP Human-Bear Management Plan to reduce the availability of human food and garbage to bears have proven successful. We found bears consumed one third the amount of human food and garbage as they did in the mid 1970's.

Edible garbage has been documented as an important food source for bears and has served as an attractant to developed areas. Edible garbage was found to be available to bears on every survey of trash and recycling units in Curry Village Tent Camp. Recycling units in Curry Village Tent Camp and in Yosemite Concession Services (YCS) residential areas, and dumpsters in NPS residential areas were also sources of edible garbage. Fifty-five percent of the documented problems were units that were overflowing or had trash placed around base. The most common areas for this type of problem were in Curry Village Tent Camp, Housekeeping Tent Camp, Upper Pines Campground, YCS village residential/administrative areas, and Swinging Bridge picnic area. Forty-one percent of the documented problems were improperly secured containers. The majority of improperly secured containers were unclipped dumpsters found at the back dock of service areas. Other common areas for unclipped or unlatched containers were at NPS campgrounds and Housekeeping Tent Camp.

"Bear-proof," food-storage containers in use in YNP were satisfactory tools to use to help reduce the availability of human-intended food and garbage to bears, provided they were used correctly. However, any incremental improvements in the placement and design of the containers which make them easier or more pleasant to use will improve compliance. The new BearSaver models with their slam-to-latch doors and larger capacity were an improvement in many ways upon the older models. However, the value of simple and robust construction cannot be overemphasized. Longevity can ultimately only be proven by field-testing, and the older Herrick models were testimony to the effectiveness of "over-building."

Recommendations. Efforts outlined by the Yosemite National Park Human-Bear Management Plan have resulted in declines in the number of human-bear incidents documented in the Park since the annual congressional appropriation of $500,000 became available in 1999. The continued management of human-black bear interactions in YNP is a challenging, multi-dimensional program, requiring the cooperation of numerous Park personnel and Park partners. Based on the findings of our research effort we offer the following recommendations to improve bear management in YNP:

- Continue to address the multiple dimensions of the human-bear system in YNP, including interpretive messaging, food storage and trash disposal, regulation implementation and enforcement, and aversive conditioning of bears.
- Increase efforts in determining the number and circumstances surrounding human-bear incidents in the backcountry areas of YNP. Collection of these data will yield a better understanding of human-bear conflict throughout the Park and better enable Park managers to focus limited resources in areas of concern.
- Work to provide more consistent, motivating messaging regarding human-bear issues. Since 93% of human-bear incident victims reported receiving bear-related information prior to being involved in an incident, the failure in the Park's communication system does not appear to be in information dissemination, but rather in how the messages motivate visitors to follow Park regulations.
- Implement stronger law enforcement efforts in YV campgrounds and parking lots, especially the use of citations. Regulations requiring proper food storage have been made for these locations, but have not been supported by increases in law enforcement actions. Establish stronger Title 36 language for improper food storage violations (36 CFR section 2). Improper food storage violations are a primary concern, but a related concern is enforcement of campground site capacity regulations in the Park.
- Consider campground size and edge in infrastructure development and changes proposed by the Yosemite Valley Plan. The smaller Park Service campgrounds, the larger concessionaire campgrounds, and campgrounds with less edge had fewer documented human-bear incidents.
- Strongly consider the destruction of bears habituated to the level of breaking into vehicles without any detectable food or other attractants inside.
- Conduct research into the patterns of the habituation behavior in the bear population of YNP, particularly the passage of the behavior from sow to cub. The passage of the habituation behavior from sow to cub has been identified in other areas. This finding has warranted more prompt destruction of habituated bears. These removals avoid the destruction of more bears that would have occurred if individuals identified as habituated would have been allowed to persist as a reproductive member of the population.
- Conduct research on the activity patterns of bears that use both YV and backcountry areas. This research will lead to a more comprehensive understanding of bear activity Park-wide. The activity patterns of habituated bears are of particular concern, particularly if they are found to be involved in human-bear conflicts in YV and in backcountry areas.
- Continue research efforts into the effectiveness of current and proposed aversive conditioning techniques.
- Concentrate additional aversive conditioning efforts on subadult male bears beginning to exhibit habituated behavior. Males appear to be habituating as subadults, likely contributing to the documented pattern of adult males involved in a majority of the human-bear incidents.
- Remove the historic Curry Orchard and gradually remove Lamons and Hutchings Orchards, followed by increased enforcement of food storage regulations and aversive conditioning. If

Lamons and Hutchings Orchards remain, continue current orchard management practices of mechanical removal of mature fruit from the orchards.

- Continue periodic investigations of bear food habits in YV to quantify the success of reducing the amount of human food and garbage available to bears.
- Increase the frequency of pickup and/or provide additional trash and recycling containers in areas where edible garbage was consistently available to bears. Continue monitoring efforts used to identify problem areas.
- Provide stronger education and enforcement of regulations to employees of back-dock areas where dumpsters were consistently unsecured.
- Implement a consistent and standardized monitoring program of all Park Service and concessionaire trash and recycling units to continue to identify problem areas and provide opportunities for corrections to be made.
- Assure that the "bear-proof" food storage containers are easy to use, accessible, and convenient for visitors. In some cases it is not convenient. For example, for many visitors the storage lockers at Curry Village are located quite a distance from the overnight lodging units.
- Incorporate more ventilation and a double-top design into "bear-proof" food storage containers, and install in shady locations whenever possible to reduce heat issues. Provide a light-colored interior to make contents more visible.

Introduction

Interactions between humans and wildlife have become common place in areas where anthropogenic development (e.g., agricultural, residential, and recreational) occur in close proximity to wildlife habitat. Conflicts between humans and many of the world's large carnivorous mammals have required extensive efforts to manage for human-wildlife co-existence (e.g., gray wolves in North America, jaguars in South America, brown bears in Scandinavia, and tigers in India). Recreational pressures on the ecosystems and wildlife of the United States National Park system have required addressing anthropogenic impacts and the development of programs to manage human-wildlife interactions.

Interactions between humans and bears are a significant management concern throughout the National Park system. Conflicts between humans and black bears (*Ursus americanus*) are commonly centered on the availability of human-provided food and garbage to bears. Similar to other regions, the relationship between bears and humans in Yosemite National Park (hereafter YNP) has led to alterations in the natural behavior, foraging habits, reproductive rates, physical size, distribution, and population levels of black bears in the Park.

Due to recent increases in human visitation and bear incidents in YNP, the need arose for a comprehensive assessment to examine the problem further. The assessment adopted a systems approach to the interaction between humans and bears and was broken into two parts: the Human Element and the Bear Element. The Bear Element of this research effort was conducted by the Hornocker Wildlife Institute/Wildlife Conservation Society. This report includes the components of the Bear Element research efforts conducted between June 2001 and December 2003. It provides a series of five reports presenting the research efforts conducted.

The first report, **Human-black bear incidents in Yosemite National Park, CA 1989-2002**, was an evaluation of the effectiveness of the Human-Bear Management Program. We analyzed trends in human-bear incidents documented in the heavily impacted Yosemite Valley (hereafter YV) of YNP between 1989 and 2002. We evaluated the effectiveness of food storage lockers and parking lot food storage regulations to reduce human-bear conflicts. We also evaluated the effectiveness of the bear-related information used by the Park to inform visitors about human-bear conflicts, proper food storage, trash disposal, and the regulations in place to reduce the frequency of human-bear conflicts. Our objectives were to assess the success of bear management in YV and develop recommendations for its improvement.

The second report, **Impacts of recreational-use pressures on the ecology of black bears in Yosemite Valley, Yosemite National Park, CA 2001 – 2002**, was an evaluation of the effectiveness of efforts to re-establish and maintain elements of the natural ecology of black bears in YV during 2001 and 2002. We assessed morphological measurements, home range size, activity patterns, habitat use, and distances bears were located from developed areas in YV, and compared these data to results reported on bear populations in less impacted areas.

The third report, **Black bear food habits in Yosemite Valley, Yosemite National Park, California 2001-2002**, provided Park managers with a current description of black bear seasonal food habits and an indication of the extent to which bears continue to obtain human-provided food and garbage. Our results were compared to those of Graber and White (1983) to assess the effectiveness of Park managers' efforts to reduce the amount of human-provided food available to bears since the mid 1970's. We also quantified bear use of non-native foods, particularly apples found in the historic orchards in and around YV.

The fourth report, entitled **Sources of edible garbage available to wildlife from trash and recycling units in Yosemite Valley, Yosemite National Park, CA 2001**, identified areas of consistent availability edible garbage from trash and recycling units as well as the sources of human error resulting in this availability. Identification of these areas and sources of human error assisted YNP managers in targeting areas to increase collection efforts and/or provide additional containers. We also provided recommendations on methods to reduce human errors resulting in the availability of garbage to bears from trash and recycling containers. Our recommendations will become part of the ongoing efforts to reduce the attractiveness of developed areas to bears and the number of human-bear conflicts in YNP.

The fifth report, **Evaluation of "bear-proof" food-storage containers in Yosemite National Park**, was an assessment of the functionality and "user-friendliness" of "bear-proof", food-storage containers in use in YNP. Each type of container in YNP was located and inspected to assess functionality and "user-friendliness" and to make recommendations for improvements.

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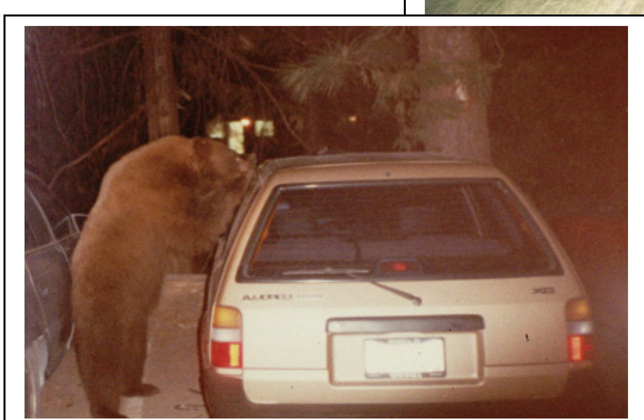
Human-Black Bear Incidents in Yosemite Valley, Yosemite National Park, CA 1989-2002

DNC Security, Fire, and Safety

National Park Service



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Interactions between humans and wildlife have become common place in areas where anthropogenic development (e.g.: agricultural, residential, recreational) occur in close proximity to wildlife habitat. Conflicts between humans and many of the worlds large carnivorous mammals have required extensive efforts to manage for human-wildlife co-existence (e.g.: gray wolves in North America, jaguars in South America, brown bears in Scandinavia, tigers in India). Recreational pressures on the ecosystems and wildlife of the National Park system of the United States have required addressing anthropogenic impacts and the development of programs to manage human-wildlife interactions.

Since the 1920's anthropogenic influences have led to alterations in natural black bear (*Ursus americanus*) behavior (Hastings et al. 1981), food habits (Graber and White 1983), reproductive rates, physical size, distribution, and population levels in Yosemite National Park (Harms 1977, Graber 1981, Keay 1995) and led to increased interaction between humans and bears resulting in personal injury and property damage (Harms 1977, Hastings and Gilbert 1987, Keay and Webb 1989). In an effort to reduce the number of conflicts, the National Park Service initiated the Human-Bear Management Program in Yosemite in 1975 (Harms 1977, Keay and Webb 1989). Goals of the program included restoring and maintaining the natural distribution, abundance, and behavior of the black bear population; providing for the safety of visitors and their property; and providing opportunities for visitors to understand, observe, and appreciate black bears in their natural habitat.

Keay and Webb (1989) reviewed the history and assessed the effectiveness of the program from its inception until 1986. They analyzed data on human-bear incidents (defined as personal injuries or property damage) maintained by the Resources Management Division and found the program had mixed success in different areas of the Park. They concluded more aggressive public education, continued efforts to reduce the amount of human food available to bears, and strict law enforcement might increase the effectiveness of the program.

Since the assessment by Keay and Webb (1989), Yosemite National Park personnel have continued efforts to minimize the number of human-bear conflicts. Intensive efforts have been concentrated within the 1,800 ha of Yosemite Valley (hereafter YV), which receives 90% of the nearly 3.5 million people who visit the park annually (Keay and Webb 1989, National Park Service Public Use Statistics Office www.aqd.nps.gov/stats) and accounted for 62% of the human-black bear conflicts documented in the Park between 1989 and 2002.

In an effort to reduce the number of conflicts in YV campgrounds, Park personnel began installing and requiring the use of “bear-proof” food storage lockers in 1991, with each YV campsite having a locker installed by 1994. In a similar effort to reduce the number of conflicts in YV parking lots, food storage regulations were implemented in 1999, which prohibited the overnight storage of food in vehicles. Park personnel continued efforts to inform visitors about bears, human-bear conflicts, and proper food storage. Methods included the use of brochures, signs, videos, interpretive programs, and personal contact by Park personnel with Park residents and the public.

Park personnel also used law enforcement actions in response to human-bear incidents where food storage regulations were violated. Law enforcement and other park personnel issued verbal warnings, written warnings, and citations to incident victims. Yosemite personnel also impounded property, including food, food containers, and vehicles, found in violation of food storage regulations. Either a verbal warning, written warning, or citation was issued to an employee or visitor when their impounded property was claimed.

Significant advances in the Yosemite Human-Bear Management Program were made following a congressional appropriation in 1999. Funds were used to staff additional bear-related positions, purchase additional food storage lockers, improve public information, and conduct research. The Yosemite Bear Council, a collaborative organization with representatives from each Park division and Park cooperators, was also formed to coordinate the Human-Bear Management Program.

We evaluated the effectiveness of the Human-Bear Management Program by analyzing trends in human-bear incidents documented in the heavily visitor-impacted YV of YNP between 1989 and 2002. We evaluated the effectiveness of food storage lockers and parking lot food storage regulations to reduce human-bear conflicts. We also evaluated the effectiveness of the bear-related information used by YNP personnel to inform visitors about human-bear conflicts, proper food storage, trash disposal, and the regulations in place to reduce the frequency of human-bear conflicts. Our objectives were to assess the success and develop recommendations for improvement of bear management in YV.

Methods

We analyzed data from YNP's human-black bear incident database for incidents which occurred in YV between 1989 and 2002. YNP managers define a bear incident as a bluff charge or other aggressive behavior, personal injury, property damage, bear trapped in or released from a dumpster, and cases of bears obtaining human food (National Park Service 2002). We calculated the percentage of park-wide incidents and tested for trends in the number of incidents which occurred in YV and more specifically in developed areas within YV. Developed areas were categorized as on or near (< 0.4 km) trails; in picnic areas; in businesses or residences; in campgrounds; or in parking lots or along roadsides. We assessed if the number of incidents recorded in these developed areas differed. We tested for trends in the numbers and proportions of incidents which occurred in these developed areas over time. We determined if a relationship existed between campground size (number of sites) and the number of human-bear incidents.

Food storage lockers and parking lot food storage regulations

We evaluated if the installation of food storage lockers in campgrounds and food storage regulations in parking lots resulted in changes in the number of human-bear conflicts in these areas of YV. We assessed whether the annual number of human-bear conflicts which occurred in the campgrounds prior to and following the complete installation of food storage lockers in 1994 differed. We also determined if the annual number of conflicts which occurred in parking lots prior to and following the 1999 food storage regulations prohibiting the storage of food in vehicles overnight differed.

Causes of human-bear incidents

We quantified the proportions and trends of the causes of human-bear incidents. Yosemite National Park personnel coded each human-bear incident based on the apparent reason it occurred. Reasons included unknown; feeding, baiting, or harassing bears; food left unguarded; improperly disposed garbage; improperly stored food; improper storage of a bear attractant; accidental encounter; conditioned bear behavior; and other. For our analyses, reasons were grouped into human error, conditioned bear behavior, and accidental encounters. We determined if the number of incidents caused by each of these factors was significantly different. We tested for trends in the numbers and proportions of incidents which were caused by each factor.

Education

Park personnel used interpretive messages to distribute bear-related information as a proactive means to educate visitors about human-bear conflicts, proper food storage, trash disposal, and the regulations in place to reduce the frequency of human-bear conflicts. To test whether these efforts were effective, we calculated the percentage of victims involved in human-bear conflicts who reported they had not received information related to bears and proper food storage prior to the incident. We tested for a trend over time in the proportion of victims who reported they had not received bear information prior to an incident. We calculated the same proportion following incidents where human error was determined to be the cause.

Corrective actions

We determined the proportion and trends of the use of verbal warnings, written warnings, and citations and how frequently no corrective action was taken following human-bear incidents. We quantified the frequency of each of these outcomes following all human-bear incidents, incidents where human error was determined to be the cause, and incidents where human error was determined to be the cause and the people involved in the incident reported that they had received information related to bears and food storage prior to the incident. We also assessed if there were changes in the proportions of incidents that resulted no corrective action and citations prior to and following regulations requiring the use of food storage lockers and prohibiting overnight storage of food in vehicles.

Bear demographic

We identified what age and sex classes of bears were involved in human-bear incidents. Age classes were based on age at first reproduction. Bears greater than 4 years of age were classified as adults and those under four years of age were classified as subadults (Keay 1995).

Data analyses

Wilcoxon Rank-Sum or Kruskal-Wallis with Fisher's LSD tests were used to test for significant differences. Simple linear regression was used to test for trends and relationships in the number or proportion of incidents over time. All statistical tests were run in NCSS 2001 (NCSS 2001). Significance was determined using $\alpha = 0.10$.

Results

A total of 9,333 human-bear incidents were recorded in Yosemite National Park between 1989 and 2002. An average of 667 incidents occurred during each of the 14 years, with a maximum of 1,584 in 1998 and a minimum of 230 in 2001.

We detected no increasing or decreasing trend in the number of human-bear incidents recorded Park-wide between 1989 and 2002 ($b = 15.9$, $p = 0.488$, $n = 14$). However, since the recorded high of 1,584 incidents in 1998, the number of annual incidents has been on a decline ($b = -258.8$, $p = 0.094$, $n = 14$, Figure 1).

Park-wide, 62% of incidents occurred in YV. We detected no trend in the number of recorded human-bear incidents recorded in YV between 1989 and 2002 ($b = 31.8$, $p = 0.176$, $n = 14$) or since the recorded high of 1,369 incidents in 1998 ($b = -236.6$, $p = 0.108$, $n = 5$, Figure 1).

Location of human-bear incidents

Most incidents in YV occurred in campgrounds (53%) and parking lots (44%). Only 3% of incidents occurred in businesses or residences and less than 1% occurred on or near trails and in picnic areas. A significantly larger proportion of incidents occurred in campgrounds and parking lots, than near businesses or residences, on or near trails, or in picnic areas ($H_{c\ 4,0.05} = 58.14$, $p < 0.001$). However, the proportion of incidents documented in campgrounds and in parking lots were not significantly different. We detected no trend in the number of recorded

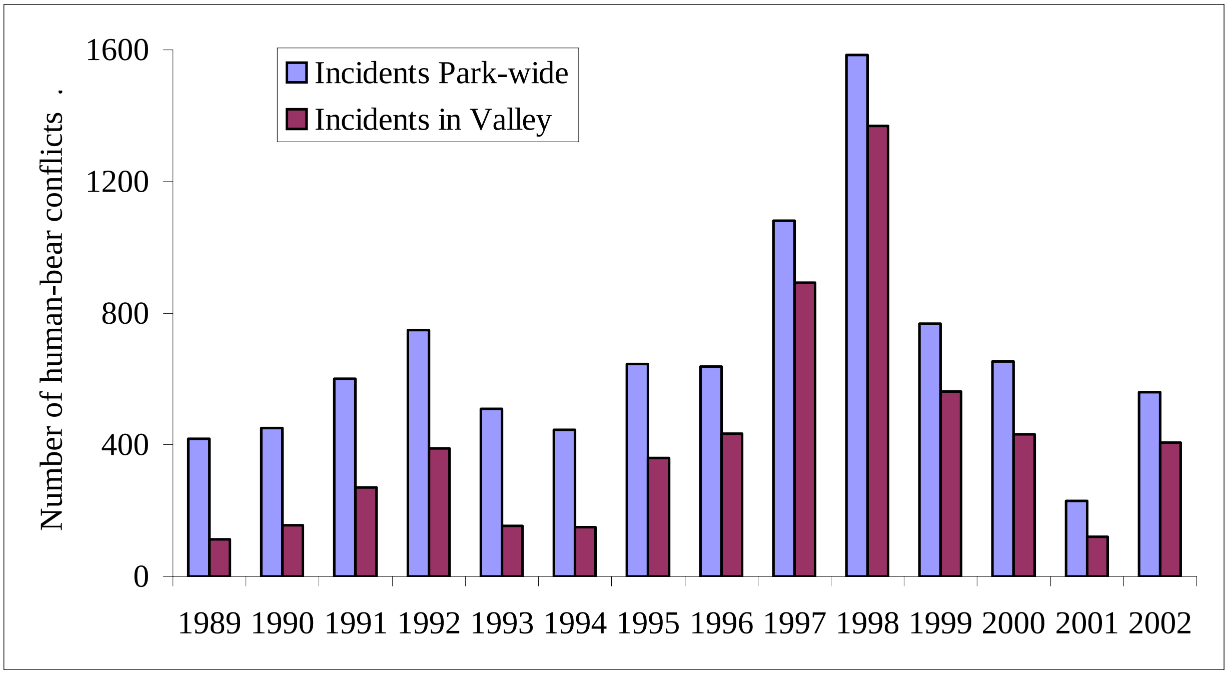

Figure 1. The number of annual human-bear incidents documented in Yosemite Valley and Yosemite National Park, Calif. between 1989 and 2002.

human-bear incidents in campgrounds (b = 6.2, p = 0.266, n = 14) or parking lots (b = 26.8, p = 0.189, n = 14). However, we detected a decreasing trend in the proportion of incidents that occurred in campgrounds (b = -3.1, p = 0.012, n = 14) and an increasing trend in parking lots (b = 3.3, p = 0.011, n = 14).

We did not detect a relationship between campground size and mean annual number of incidents ($y = 0.01 \times size + 16.67$, r = 0.05, p = 0.891). However, we did detect a positive relationship between campground size and the mean annual number of incidents when we removed the 2 YV, concessionaire administered tent-cabin camps and considered only Park Service administered campgrounds ($y = 0.22 \times size + 0.54$, r = 0.78, p = 0.021).

Food storage lockers and parking lot food storage regulations

Mean annual incidents occurring in YV campgrounds did not differ prior to ($\bar{x}$ = 135, SE = 23) and following ($\bar{x}$ = 189, SE = 31) a food storage locker being installed in each YV campsite in 1994 (Z = -1.33, df = 12, p = 0.182). Mean annual incidents occurring in YV parking lots did not differ prior to ($\bar{x}$ = 243, SE = 113) and following ($\bar{x}$ = 183, SE = 43) regulations prohibiting the overnight storage of food in vehicles (Z = 0.921, df = 12, p = 0.357).

Causes of human-bear incidents

Conditioned bear behavior, human error, and accidental encounters were documented as the cause of 35, 65, and < 1% of the human-bear incidents, respectively. Because accidental encounters were relatively infrequent, they were not considered further in the analyses. A significantly larger proportion of incidents were caused by human error than conditioned bear behavior (Z = -3.96, df = 12, p < 0.001). We detected no trend in the number of incidents that were caused by conditioned bear behavior (b = 2.3, p = 0.808, n = 14) and an increasing trend in the number caused by human error (b = 23.4, p = 0.046, n = 14). We detected a decrease in the proportion of incidents due to conditioned bear behavior ($b = -2.9$, $p = 0.002$, $n = 14$) and an increase in the proportion of incidents due to human error ($b = 1.8$, $p = 0.014$, $n = 14$).

Education

We found that 7% of victims involved in a human-bear incident reported they had not received bear-related information. We did not detect an increasing or decreasing trend in the proportion of victims who reported not receiving bear information prior to an incident ($b = 0.6$, $p = 0.315$, $n = 13$). Of those incidents resulting from human error, we also found that 7% of victims reported that they did not receive some form of bear-related information prior to the incident.

Corrective actions

Park personnel implemented no corrective action in 64% of the 5,110 incidents that occurred in YV between 1989 and 2002 in which an outcome was reported. In other cases, Park personnel gave verbal warnings (26%), written warnings (8%), and citations (3%) (Table 1). We detected a decreasing trend in the proportion of incidents where no corrective action was taken ($b = -2.37$, $p = 0.022$, $n = 14$). We did not detect an increasing or decreasing trend in the proportion of incidents where verbal warnings ($b = 0.64$, $p = 0.618$, $n = 14$), written warnings ($b = -0.45$, $p = 0.438$, $n = 14$), or citations ($b = 0.12$, $p = 0.481$, $n = 14$) were used.

The proportion of annual incidents occurring in YV campgrounds followed by no corrective action was larger prior to ($\bar{x} = 0.69$, SE = 0.06) than following ($\bar{x} = 0.43$, SE = 0.06) the implementation of regulations requiring the use of food storage lockers ($Z = 2.14$, df = 12, $p = 0.032$). However, the proportion of annual incidents occurring in YV campgrounds that resulted in a citation did not differ prior to ($\bar{x} = 0.01$, SE = 0.004) and following ($\bar{x} = 0.02$, SE =

Table 1. The use of each corrective action in Yosemite Valley, Yosemite National Park, California between 1989 and 2002 following all incidents (n=5,110), incidents where human error was determined to be the cause (n=2,637), and incidents where human error was determined to be the cause and bear-related information was received prior to the incident (n=1,316).

Corrective Action	All Incidents (%)	Human Error Incidents (%)	Human Error Incidents and Bear Information Received (%)
None	64	54	36
Verbal Warning	26	30	45
Written Warning	8	12	15
Citation	3	4	4

0.007) the implementation of regulations requiring the use of food storage lockers ($Z = 0.352$, df $= 12$, $p = 0.725$).

Similarly, the proportion of annual incidents occurring in YV parking lots followed by no corrective actions was larger prior to ($\bar{x} = 0.70$, SE = 0.05) than following ($\bar{x} = 0.53$, SE = 0.06) regulations prohibiting the overnight storage of food in vehicles ($Z = -1.913$, df = 12, $p = 0.056$). However, the proportion of annual incidents occurring in YV parking lots that resulted in a citation did not differ prior to ($\bar{x} = 0.05$, SE = 0.01) and following ($\bar{x} = 0.03$, SE = 0.01) regulations prohibiting the overnight storage of food in vehicles ($Z = -0.857$, df = 12, $p = 0.391$).

Compared to the outcome of all recorded incidents, larger percentages of verbal and written warnings were given following incidents where human error was identified as the cause and following incidents where human error was identified as the cause and the visitors involved reported they had received bear-related information prior to the incident (Table 1). However, the percentage of citations given remained nearly equal in each incident situation (Table 1).

Bear demographic

Adult male (55%) and adult female (41%) bears were involved in the majority of incidents where the bear involved was identified (n=346). Subadult male and subadult female bears were involved in 3 and 1% of the incidents, respectively.

Discussion

Human-black bear incidents remain a significant concern in YNP. Considerably larger numbers of incidents have been documented in YNP in the recent past (9,333 between 1989 and 2002) compared to other national parks with black bear populations. By means of comparison, Sequoia and Kings Canyon National Parks personnel jointly documented 4,843 human-bear incidents between 1989 and 2002 (National Park Service unpublished data). Great Smoky

Mountains National Park personnel documented 2,170 between 1990 and 2002 (National Park Service unpublished data). Redwood National and State Parks personnel documented 205 between 1989 and 2002 (National Park Service unpublished data).

Despite comparatively larger numbers of human-bear incidents and the lack of significant declines between 1989 and 2002, the efforts directed by Human-Bear Management Program in YNP appear to have achieved some levels of success. Although Keay and Webb (1989) did not address trends in incidents in YV specifically, they did detect a significant decline in the number of incidents which occurred in front-country areas of YNP between the initiation of the Human/Bear Management Program in 1975 and 1986. However, they found no increasing or decreasing trend when they excluded data from the first two years of the program. And despite the lack of a decreasing trend in the number of human-bear incidents between 1989 and 2002, an encouraging downward trend was detected from the recorded high number of incidents in 1998 until 2002 Park-wide. These recent decreases have been attributed to efforts made possible by a 1999 congressional appropriation of funds. The appropriation allowed for increased staffing levels, improved communication efforts directed at informing visitors about human-bear incidents, the installation of additional food storage lockers, and the implementation of additional food storage regulations and enforcement.

YV remained an area of particular concern for Park personnel, given 62% of the annual incidents that occurred in this small area equal to only 0.6% of the Park. This high concentration of incidents may be related to high levels of human use. Approximately 90% of the nearly 3.5 million annual park visitors visit YV (Keay and Webb 1989, National Park Service Public Use Statistics Office www.aqd.nps.gov/stats). Additionally, Graber (1981) identified the presence of high levels of human use in optimal, natural bear habitat as contributing factors to human-bear conflicts in YV. It was also believed that the number of reported incidents in backcountry areas were low and unrepresentative (Harms 1980, Hastings and Gilbert 1987). This was thought to be a result of limited Park personnel stationed in the backcountry to document backcountry incidents and the unwillingness of visitors to report incidents generated by a fear of receiving a citation.

Within YV, campgrounds and parking lots continued to have high concentrations of human-bear incidents. Keay and Webb (1989) found incidents in front-country areas occurred primarily in campgrounds (67%) and parking lots (25%) between 1975 and 1986. Similarly, we found the largest percentages of incidents were documented in campgrounds (53%) and parking lots (44%). However, we found a decreasing trend in the proportion of incidents that occurred in campgrounds and in increasing trend in the proportion of incidents that occurred in parking lots. These trends could be attributed to the timing of management actions. Efforts to reduce human food availability in YV campgrounds began with the installation of food storage lockers, beginning in 1991, with each YV site having a locker by 1994. However, efforts to reduce human food availability in YV parking lots did not begin until 1994, with the current regulations prohibiting the storage of food in vehicles overnight not being implemented until 1999.

The size and design of campgrounds in YV may have contributed to the number of incidents. Significant, positive relationships have been found between bear incidents and concentrated human use in the backcountry of Yosemite (Keay and van Wagtendonk 1983) and Glacier National Parks (Merrill 1978). Among the Park Service campgrounds, the number of incidents appeared to increase with the size of the campground. This may have been a function of larger campgrounds accommodating more overnight visitors, and thus a greater likelihood for human-bear interactions as bears sought out human-provided food and garbage. However, the number of incidents did not appear relative to size for the 2 concessionaire campgrounds, which were much larger than Park Service campgrounds (447 sites on average, compared to 90 in Park Service campgrounds). The concessionaire campgrounds may have had such high concentrations of human use that they were not as attractive to bears because of a potentially greater probability of being harassed by people. Additionally, the two concessionaire campgrounds also had a limited amount of edge (4 meters per site on average) compared to Park Service campgrounds (12 meters per site on average), which may influence attractiveness to bears in terms of access to escape cover throughout the campground. Thus, size and edge should be considered in campground infrastructure development and changes.

Several factors may have contributed to the apparent lack of success of food storage containers in campgrounds. Park personnel identified design flaws in some models of food storage containers which allowed bears to gain access to food stored in even properly secured containers. Additionally, visitors found some of the earlier models difficult to close and secure properly. Finally, visitors have also reported that containers were not large enough to store all of their food. Park personnel should continue in efforts to design and install effective, easy-to-use containers in cooperation with manufactures. Efforts should also continue in informing visitors of human-bear issues, the dimensions of the food storage containers, and regulations requiring their use prior to or immediately upon arrival.

Factors which may have contributed to the apparent lack of success of the 1999 regulation prohibiting the overnight storage of food in vehicles were visitors failing to follow the regulation and conditioned bear behavior. Given its relative novelty, Park personnel need to make continued efforts to educate visitors of this regulation. Additionally, conditioned bears have been documented breaking into vehicles without any detectable food or other attractant inside. Greater consider should be taken in destroying bears exhibiting this level of habituation, as called for in the Human-Bear Management Plan (National Park Service 2002).

Visitor failure to follow food storage regulations continued to be a significant concern in YV. Trends in both the number and proportion of incidents attributed to human error significantly increased between 1989 and 2002. Similarly, Keay and Webb (1989) found 38 and 59% of the human-bear incidents which occurred in front-country areas were the result of conditioned bear behavior and human error, respectively. They also identified a decrease in the proportion of incidents due to conditioned bear behavior and an increase due to human error between 1975 and 1986. Park personnel relied on communication and enforcement methods to promote proper food storage. Improvements in each of these approaches should be made in order to increase their effectiveness.

Yosemite managers have been successful in distributing bear-related information, with only a small proportion of victims (7%) reported not to have received bear-related information. Similarly, Keay and Webb (1989) determined 11% of front-country victims did not receive bear-related information. Keay and Webb (1989) concluded that visitors must be motivated through communication efforts and provided simple techniques to make food inaccessible to bears. While messaging regarding human-bear issues was received by a majority of YV visitors, continued efforts should be made to make messaging and its delivery more motivating.

Regulations requiring the use of food storage lockers and prohibiting the overnight storage of food in vehicles have not been supported by strong law enforcement actions (e.g. citations) in either the campgrounds or parking lots of YV. A more aggressive law enforcement campaign including larger financial penalties would be an alternative motivating factor for non-compliers. More aggressive law enforcement was also recommended as an alternative by Keay and Webb (1989) and was proven successful in reducing the availability of human foods in Yellowstone National Park (Meagher and Phillips 1983). Yosemite managers should establish stronger Title 36 language for improper food storage violations (36 CFR section 2). This would enable law enforcement rangers greater ability to issue citations for food storage violations and provide financial incentive for visitors to follow food storage regulations.

Researchers in other areas have found that adult male bears were disproportionately represented among bears near developed areas (Piekielek and Burton 1975, Beeman and Pelton 1976, Alt et al. 1977, Rogers 1987). Mattson (1990) attributed this disproportion to the greater probability of males encountering developed areas as a result of larger range sizes, seasonal exclusion of adult females, and active selection by males. Similarly, we found adult males were involved in a majority (55%) of the human-bear incidents in YV. Additionally, adult males represented 40% of the bears killed for management reasons between 1989 and 2002 in YV. Adult females, subadult males, and subadult females represented 35, 15, and 10% of the bears killed in management related actions.

In considering the management goal of reducing the number of human-bear conflicts and the involvement of adult female bears in human-bear conflicts, Yosemite managers should consider more prompt destruction of conditioned bears. Meagher and Fowler (1989) found that efforts to protect and preserve grizzly bears, particularly adult females, led to the destruction of more bears than would have occurred if individuals were removed once they were identified as a conditioned bear. Meagher and Phillips (1983) reported Yellowstone National Park bear managers appeared to have attained their objective of restoring bear populations to subsistence on natural forage within the Park. Bear management in Yellowstone initially involved the translocation and destruction of conditioned bears. These removals were followed by efforts to educate people, increased law enforcement, intensified sanitation, refinement of management techniques, and development of a monitoring system to provide management information. These efforts were followed by developing an awareness that preventative bear management must be a consistent part of Park operations.

Bear management in Yosemite has also included the removal of some conditioned bears, education, law enforcement, intensified sanitation efforts, refinement of management techniques, development of a monitoring system to provide management information, and the installation of “bear-proof” food storage and trash receptacles. However, Yosemite managers have not made extensive efforts, as in Yellowstone, to remove conditioned bears from the population. As Meagher and Fowler (1989) recommended to Yellowstone managers, although we acknowledge public and political pressures to retain individual bears, we suggest the prompt destruction of habitual nuisance bears may enhance population welfare through the recruitment of naïve individuals.

Successful management of human-bear interactions involves the combination of a variety of elements; including visitor education, law enforcement, sanitation, “bear-proof” food storage and waste containers, monitoring, and research. Although single elements did not appear successful in reducing the number of human-bear incidents, their combined use has probably contributed to the decline park-wide incidents. In order to achieve further declines, we recommend Yosemite managers implement more motivating educational efforts, a stronger law enforcement program, and the prompt destruction of habitual nuisance bears to further reduce the number of human-bear incidents in YV.

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Impacts of Recreational-Use Pressures on the Ecology of Black Bears in Yosemite Valley, Yosemite National Park, CA 2001 – 2002

All photos Wildlife Conservation Society

Interactions between humans and bears are significant management concerns throughout the National Park system (Harms 1980, Tate and Pelton 1983, Gniadek and Kendall 1998, Gunther and Hoekstra 1998, Schirokauer and Boyd 1998). Conflicts between humans and black bears are commonly centered around the availability of human-provided food and garbage to bears (Graber 1981, Tate and Pelton 1983, Hastings et al. 1989, Mattson 1990, Peine 2001). Similar to other regions (Beeman and Pelton 1980, Blanchard and Knight 1991, Beckmann and Berger 2003) the relationship between bears and humans in Yosemite National Park (hereafter YNP) has led to alterations in the natural behavior (Hastings et al. 1981), foraging habits (Graber 1981, Graber and White 1983), reproductive rates, physical size, distribution, and population levels of black bears in YNP (Harms 1977, Graber 1981, Keay 1995).

The documented history of conflicts dates back to the first arrival of non-Indians in Yosemite Valley (hereafter YV) in 1851 (National Park Service 2003). Tourism quickly began to impact the ecosystems and wildlife of YV during the late 1800's. Limitations in transportation restricted the removal of garbage and food waste from YV, forcing YNP managers and hotel operators to use open pit dumps.

By the 1930's, as many as 60 bears were observed during the summer season in the 18 km^2 of YV (National Park Service 2003). Artificial feeding areas were established in 1937 in the west end of YV in order to draw bears away from developed areas in the east end of YV. These feeding areas also provided the visiting public with a unique opportunity to see bears. As much as 60 tons of human-food scraps were fed to bears annually (National Park Service 2003).

By the 1940's, it was recognized that continued feeding of bears and lethal control of bears demonstrating threatening behavior toward people had altered the natural ecology of the bear population in YNP (Beatty 1943, National Park Service 2003). This recognition led to closures of artificial feeding areas in the 1940's. Additionally, the introduction of dumpster-style trash containers and the ability to transport their contents to landfills outside of YNP allowed for the closure of the dumps in YNP. The last garbage dump in YV was closed in 1963 and the last in YNP in 1971. However, removal of these artificial food sources was followed by increases in human-bear conflicts as bears turned to raiding campsites and breaking into vehicles to obtain food.

The National Park Service initiated the Human-Bear Management Program in YNP in 1975 to address continuing negative human and black bear interaction issues (National Park Service 1975). Goals of the program included restoring and maintaining the natural distribution, abundance, and behavior of the black bear population; providing for the safety of visitors and their property; and providing opportunities for visitors to understand, observe, and appreciate black bears in their natural habitat. The objectives of the program included providing public information and education; eliminating the availability of artificial food sources to bears by providing "bear-proof" food storage devices and garbage receptacles; enforcement of regulations regarding proper food storage and feeding of YNP wildlife; relocation or destruction of problem bears; and research and monitoring.

The goal of our research was to ascertain the effectiveness of efforts to reestablish and maintain elements of the natural ecology of black bears in YV during 2001 and 2002. We assessed and compared morphological measurements, home range size, activity patterns, habitat use, and distances bears were located from developed areas in YV to results reported on bear populations in less impacted areas.

Study Area

YNP encompasses approximately 308,000 ha on the west slope of the Sierra Nevada range in central California. Our research was conducted in the approximately 1,800 ha of YV. The vegetation of YV is composed primarily of mixed conifer, with prevalent species being ponderosa pine (*Pinus ponderosa*), incense cedar (*Calocedrus decurrens*), and California black oak (*Quercus kelloggii*) (Barbour and Major 1977).

YV receives 90% of the nearly 3.5 million people who visit YNP annually (Keay and Webb 1989, National Park Service Public Use Statistics Office www.aqd.nps.gov/stats). Approximately 45% of YNP's 1,948 campsites and most of the 1,600 lodging units for YNP visitors and employees are located in YV. Additionally, 62% of human-bear conflicts documented in YNP between 1989 and 2002 occurred in YV (Matthews unpublished data).

Methods

We trapped bears in YV between 3 July and 17 November 2001 and 25 April and 18 August 2002. Culvert traps, Aldrich foot snares, and free range darting were used in 69 locations for a total of 1316 trap nights (Figure 2,Table 2). Trap locations were selected based on reported bear activity, effective coverage of YV, and road availability and access. Bears were immobilized using 4.3 mg/kg Ketamine and 2.1 mg/kg Xylazine. Each bear was marked with colored and uniquely numbered Allflex (Allflex International, Palmerton North, New Zealand) and Dalton Jumbo Tag (Dalton Supplies, New South Wales, Australia) ear tags. A subcutaneous, uniquely numbered microchip was implanted into each bear for future capture identification, particularly following ear tag loss (HomeAgain Microchip Identification System, Barrington, IL). Bears were equipped with a motion-sensitive radio-transmitter (Model 405 or 505, Telonics, Mesa, AZ). Standard morphological measurements were taken for each bear.

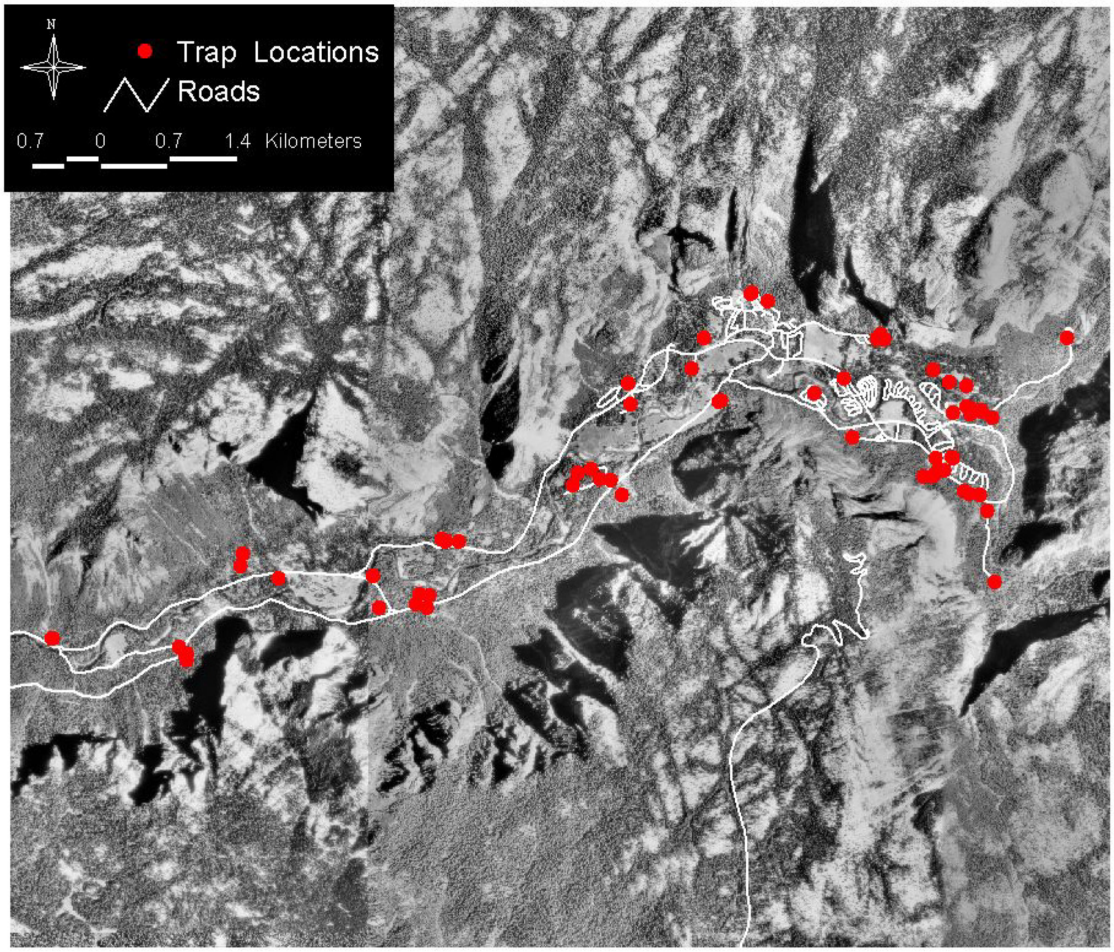

Figure 2. The 69 trap locations used to capture black bears in Yosemite Valley, Yosemite National Park, California, 3 July - 17 November 2001 and 25 April - 18 August 2002.

Table 2. Black bear trapping results in Yosemite Valley, Yosemite National Park, California, 3 July - 17 November 2001 and 25 April - 18 August 2002.

Trap Type	Number of Locations	Trap Nights	Number of Captures	Trap Success (%)
Culvert	42	718	37	5.2
Aldrich foot snare	26	597	12	2.0
Free range darting	1	1	1	100.0
All trap types	69	1316	50	3.8

Morphological measurements and sex ratios

We compared current weights and total lengths of adult male and adult female bears to results presented by Graber (1981) for bears captured in YNP between 1974 and 1978 and by Sitton (1982) for bears captured in Placer, Trinity, and Tulare counties of California between 1978 and 1980. Wilcoxon signed-rank tests were used to determine significance at $\alpha = 0.05$. We also compared current sex ratios in Yosemite to the expected 50:50 ratio and to ratios reported by Graber (1981) and Sitton (1982) using χ^2 goodness of fit tests at $\alpha = 0.05$.

Telemetry effort

We used ground-based and aerial telemetry techniques to collect locations on radio-collared bears. Ground based telemetry locations were collected using the loudest-signal method (Springer 1979) using either a TR5 (Telonics, Mesa, Ariz.) or R1000 (Communications Specialists, Inc., Orange, Calif.) handheld receiver and a 4-element RA-14 antenna (Telonics, Mesa, Ariz.). Ground based telemetry locations were collected between 9 July and 15 November 2001 and 3 April and 12 December 2002. We used a Cessna 182, model 1000 receiver (Advanced Telemetry Systems, Inc., Isanti, Minn.), and 4-element YAGI antennas (Advanced Telemetry Systems, Inc., Isanti, Minn.) for aerial telemetry. Seventeen aerial telemetry flights occurred every 10-20 days between 20 April and 12 December 2002.

Home-range estimation and use of Yosemite Valley

Ground-based and aerial telemetry locations were used to calculate home range estimates using the minimum convex polygon (MCP) procedure for all bears with at least 15 locations (Mohr 1947). Aerial telemetry data were also used to estimate the proportion of time each radio-collared bear spent in YV.

Activity patterns and movements

Bear activity patterns and movements in YV were assessed using twenty-four hour monitoring events. A monitoring event was conducted each week between 7 August and 29 October 2001 and between 15 May and 15 October 2002. One radio-collared bear was tracked during each monitoring event. We used a randomized systematic protocol to select the individual bear to be tracked each week. We made an effort to conduct an equal number of monitoring events for each age-sex class on as many radio-collared bears as possible. We were limited by the number of radio-collared bears in each class and variations in the length and timing of the presence of individual bears in YV.

The sampling method we used to describe bear activity patterns involved listening to the audible radio-telemetry signal for 30 seconds approximately every 15 minutes. Some of the radio collars were equipped with a reset switch, which activated a motion sensor in the transmitter when the collared animal was active, causing an increase in pulse rate. We also used signal modulation (changes in the tone or strength of the radio signal) to determine bear activity. Bear activity was classified as either active or inactive. The “active” classification was dependent on the bear changing physical location and not simply activity mode (Ayres et al. 1986). Locations of the monitored bear also were recorded at 1-hour intervals during each 24-hour period using triangulation methods.

We calculated the proportion of time different age-sex classes were active for each hour of a 24-hour period. Hourly activity was calculated by dividing the number of active readings by the total number of readings. Proportions of hourly activity were plotted to identify patterns in activity throughout a 24-hour period.

We also determined black bear activity levels during diurnal and nocturnal periods. Diurnal and nocturnal periods were based on civil twilight (United States Naval Observatory, Astronomical Applications Department, http://aa.usno.navy.mil). The 15-minute activity readings were pooled into 1-hour intervals. Bear activity for each 1-hour interval was characterized as either active or inactive. The proportion of activity during diurnal and nocturnal periods was calculated by dividing the number of hourly active readings by the total number of readings. Diurnal and nocturnal activity patterns were determined for each age-sex class. *G*-tests were used to test the null hypothesis that bears were equally active during diurnal and nocturnal periods.

We also quantified black bear activity patterns during periods of use of developed areas (e.g. campgrounds, parking lots) in YV. Each 24-hour monitoring event was classified based on whether or not the monitored bear used a developed area We defined use as a bear being located in or within 132 m of a developed area. The 132 m criteria was based on our radio-telemetry error determined using the location error method (Zimmerman and Powell 1995). The radius of the error circles was the average location error plus two standard deviations. We determined proportions of activity when bears used developed areas and when they used only natural areas. *G*-tests were used to test the null hypothesis that bears were equally active during diurnal and nocturnal periods when they used developed areas and when they used only natural areas.

Bear movement patterns were determined by measuring the distance traveled between two successive locations collected at approximately 1-hour intervals during a monitoring event. Movements were calculated in meters moved per hour. A GLM ANOVA was used to test the null hypothesis that bears of each age-sex class traveled equal distances during diurnal and nocturnal periods. Significance for all tests was determined using $\alpha = 0.05$.

Habitat use

We quantified black bear habitat use within YV to determine if bear selection of natural and developed habitats were in proportion to their availability. The development of vegetation polygons for geographic information system (GIS) applications was based on vegetation interpretation of 1:15,840 1997 aerial photography (NatureServe In Press). For our analyses, the vegetation polygons were classed into five groups: hardwood forest and chaparral, coniferous forest, barren, riparian and grasslands, and urban (Figure 3).

We compared utilized to available habitat within YV using compositional analysis at two levels: home range composition within YV vs. all of YV (Johnson's second-order selection), and proportional habitat use based on radio locations vs. home range composition (Johnson's third-order selection) (Johnson 1980, Aebischer et al. 1993). Boundaries of YV were defined following the 1,800 m elevation criteria outlined by Graber and White (1983) on the north and south boundaries (Figure 3). The eastern and western boundaries were based on more arbitrary criteria following generally accepted boundaries of YV by YNP managers. The eastern and western boundaries were 2.25 km northeast of Mirror Lake and 0.5 km west of Pohono Bridge (Figure 3). We used MCP home range estimates to describe the outer limits of the movements of each bear (Mohr 1947, Aebischer et al. 1993). We calculated habitat compositions in YV (Figure 3) and the area of each bear's MCP which overlapped YV (Figure 3) using a GIS (ArcView 3.2, Environmental Systems Research Institute, Inc., Redlands, Calif.).

We determined proportional habitat use within YV for each radio-collared bear using ground-based radio-telemetry efforts conducted between 9 July and 15 November 2001 and 3 April and 12 December 2002. Bear movements depend on past experience (Powell 1987, White and Garrott 1990). Therefore, no 2 telemetry locations can be considered independent.

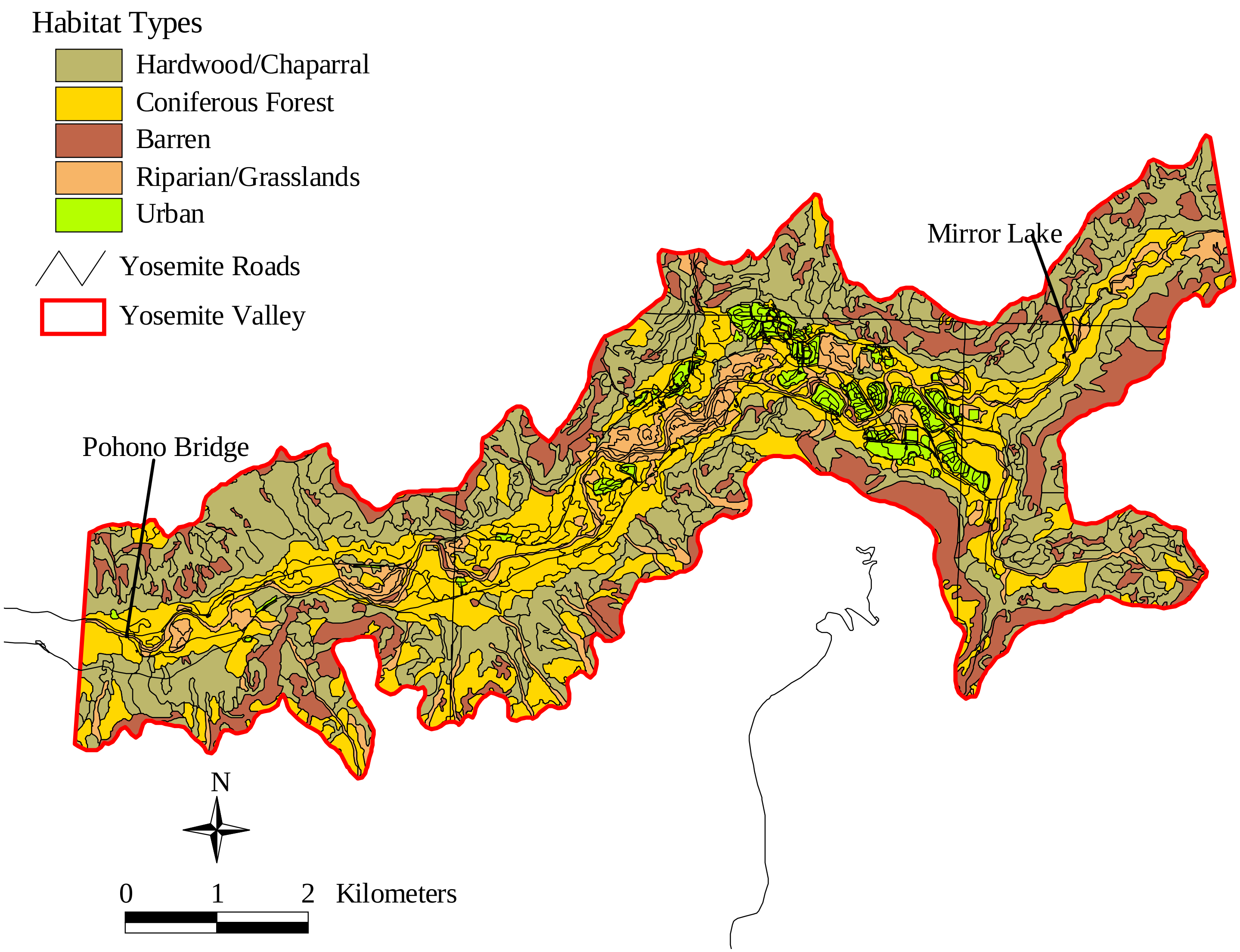

Figure 3. Habitat types within the defined boundaries of Yosemite Valley, Yosemite National Park, California.

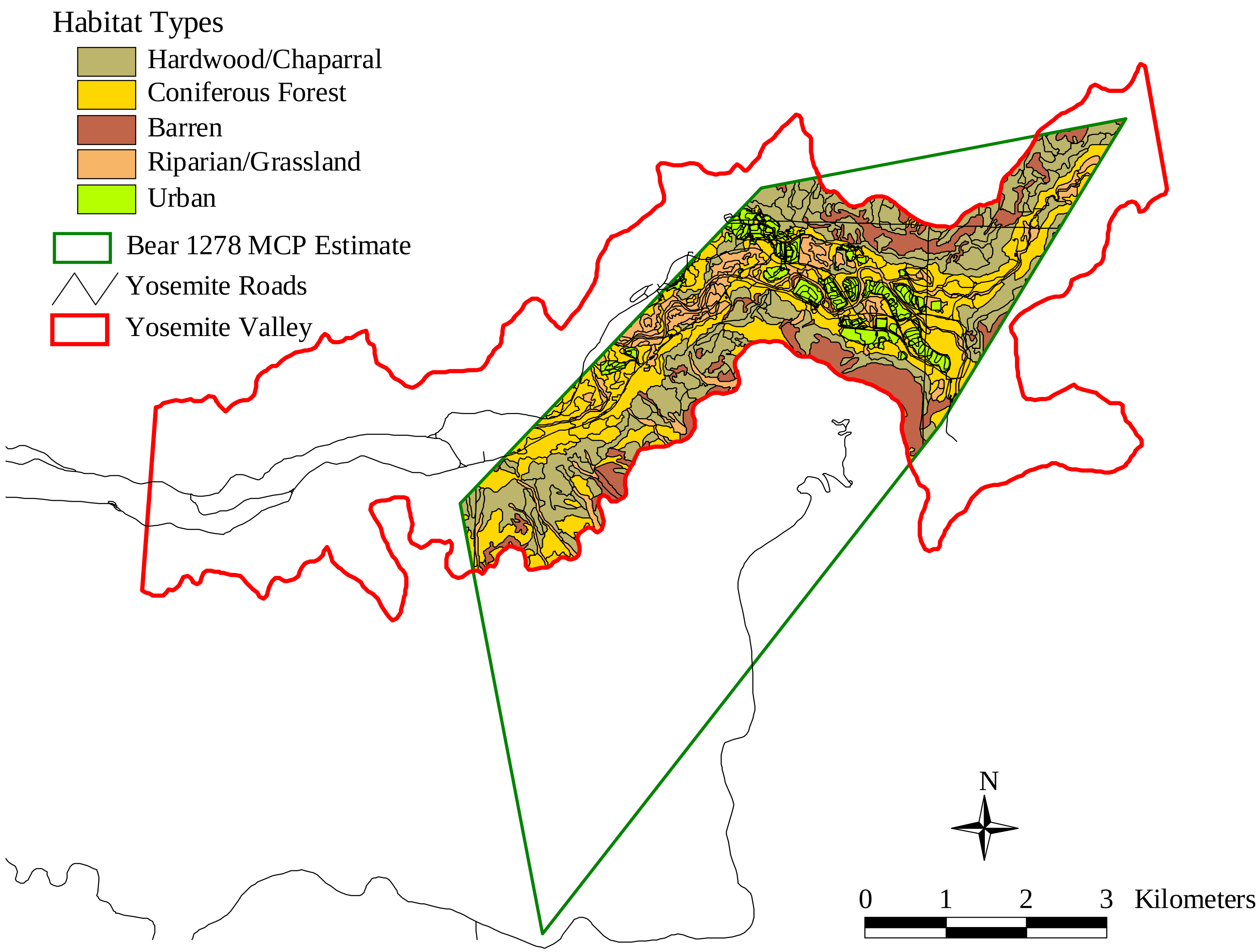

Figure 4. Habitat types within the area of the MCP home range estimate of bear 1278 which overlapped with Yosemite Valley, Yosemite National Park, California.

Garshelis (1978) found a bear can usually move between any 2 points in its home range within 6 hours. Thus, only locations recorded >6 hours apart were used in the habitat use analysis. We buffered each bear location by a telemetry-error circle with a radius of 132 m (Figure 5). We used the habitat compositions of each error circle to determine the proportional habitat use of each radio-collared bear (Figure 5).

We replaced a value of 0% corresponding to a non-utilized but available habitat type with 0.1% (Aebischer et al. 1993). We used Resource Selection Analysis Software (RSW) for compositional analyses. Significance was determined using $\alpha = 0.10$.

Distances from development

Distances bears were located from developed areas of YV were calculated. Developed areas included any anthropogenic feature in YV which was in use during 2001 and 2002, excluding roads and trails. These included, but were not limited to, parking lots, campgrounds, lodging facilities, picnic areas, visitor center areas, and roadside turnouts with trash cans. Locations collected for each individual bear at least 6 hours apart within YV were used for distance analyses (Garshelis 1978). Distances each age-sex class were located from developed areas were tested for significant differences using an ANOVA and Fischer’s least significant difference multiple comparison procedure (LSD MCP). Distances bears were located from developed areas during diurnal and nocturnal periods and active and inactive periods were tested for significant differences using Mann-Whitney U tests. Bear locations were also compared to random locations generated from the uniform random distribution using an ANOVA and Fischer’s LSD MCP. Significance for all test was determined using $\alpha = 0.05$.

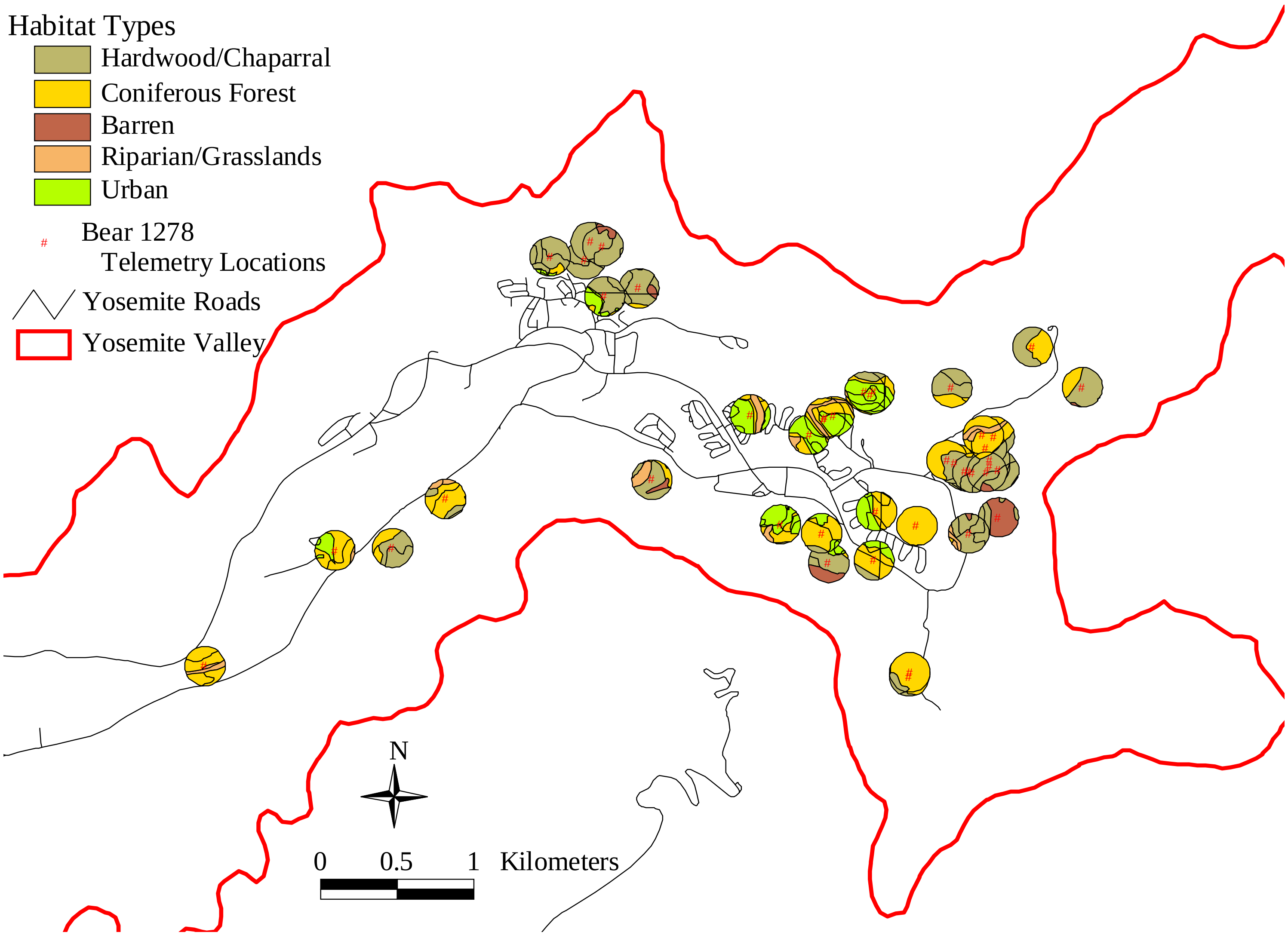

Figure 5. An example of determining habitat use of an individual radio-collared bear in Yosemite Valley, Yosemite National Park, California. These were the locations collected using radio-telemetry on bear 1278 and the corresponding 132 m radius error circles. The proportion of each WHR habitat type within the error circles were used in the compositional analysis to quantify black bear habitat use.

Results

Twenty-two bears were captured a total of 50 times between 2001 and 2002. The 22 captured bears included 10 adult males, 6 adult females, 3 subadult males, and 3 subadult females. Of these captured individuals, 9 adult males, 6 adult females, 2 subadult males, and 2 subadult females were fitted with radio collars. One adult male was not collared because he was euthanized as a result of a capture related injury. One subadult female and one subadult male were not radio collared due to their small size. Two adult males dropped their collars approximately 4 and 6 weeks after capture. One radio-collared subadult male was killed by California Department of Fish and Game personnel outside YNP for management reasons in the spring of 2002.

Morphological measurements and sex ratios

The weights of adult male bears we captured in YV were significantly smaller ($Z = 2.14$, $n = 10$, $p = 0.032$) than the mean weight of adult male bears captured between 1974 and 1978 by Graber (1981) throughout YNP (Table 3 and Table 4). However, lengths of adult male bears ($Z = 0.31$, $n = 10$, $p = 0.760$) and weights ($Z = 0.84$, $n = 6$, $p = 0.402$) and lengths ($Z = 1.26$, $n = 6$, $p = 0.208$) of adult female bears were not significantly different from those reported by Graber (1981) (Table 3 and Table 4). Our results were also not significantly different ($Z < 1.68$, $p > 0.05$) from those reported by Sitton (1982) on bear populations in Placer, Trinity, and Tulare counties of California (Table 3 and Table 4).

Sex ratio

The sex ratio of bears captured in YV was 59:41 male to female and was not significantly different from 50:50 ($\chi^2_{0.05,1} = 3.24$, $p = 0.072$). The sex ratio of bears captured Park-wide between 1974 and 1978 by Graber (1981) was 52:48 male to female and was not significantly

Table 3. Mean , standard error (SE), and range of weights and total lengths for bears captured 3 July - 17 November 2001 and 25 April - 18 August 2002 in Yosemite Valley, Yosemite National Park, California.

Age Class	Sex	n	Mean ± SE Weight (kg)	Range of Weight (kg)	Mean ± SE Total Length (cm)	Range of Length (cm)
Adult	Male	10	117.0 ± 9.8	54 - 155	174.7 ± 4.9	140 - 192
Adult	Female	6	78.7 ± 6.4	55 - 94	149.1 ± 2.5	136 - 156
Subadult	Male	2	47.5 ± 16.5	31 - 64	142.5 ± 11.5	131 - 154
Subadult	Female	3	40.0 ± 2.5	37 - 45	139.7 ± 6.1	130 - 151

Table 4. Mean weights and total lengths for bears captured between 1974 and 1978 in Yosemite National Park, California (Graber 1982) and between 1978 and 1980 in Trinity, Placer, and Tulare counties, California (Sitton 1982).

Study	Age Class	Sex	Mean Weight (kg)	Mean Length (cm)
Graber (1982)	Adult	Male	142.0	175.0
Graber (1982)	Adult	Female	87.0	153.0
Sitton (1982)	Adult	Male	111.0	179.2
Sitton (1982)	Adult	Female	63.8	151.3

different from the current ratio ($\chi^2_{0.05,1}$ = 1.922, p = 0.166). Sitton (1982) reported a 64:36 male to female sex ratio of captured bears, which was not significantly different from the ratio we detected in YV ($\chi^2_{0.05,1}$ = 1.085, p = 0.298).

Home-range estimates

Locations were collected on radio-collared adult male (n = 492), adult female (n = 497), subadult male (n = 202), and subadult female (n = 274) bears. Adult males had the largest home ranges, with an average of 84.7 km^2 (Table 5 and Figure 6). They were followed in descending order by adult females (38.9 km^2), subadult females (23.1 km^2), and subadult males (18.7 km^2) (Table 5, Figure 7, and Figure 8). We found two adult males (bears 2251 and 3047) to have comparatively larger home ranges (204.0 and 193.9 km^2) than the other seven adult male bears (range 21.0 – 77.7 km^2). We also found one female (bear 3811) to have a comparatively larger home range (113.4 km^2) than the other five adult female bears (range 7.5 - 52.4 km^2).

Proportional use of Yosemite Valley

Only 2 of the 16 radio-collared bears (bear 3568, a subadult male, and bear 2391, an adult female) were located in YV during each aerial telemetry flight (Table 6). Locations were collected on only one subadult male (bear 3568), which was found within the boundaries of YV on each flight. Subadult females (n = 2) were found in YV on 69% of the flights, adult females (n = 6) on 64%, and adult males (n = 7) on 53%.

Activity patterns and movement

Twenty-eight 24-hour monitoring events were completed on 13 bears during the 2001 and 2002 seasons (Table 7). Adult males exhibited an apparent unimodal pattern of activity (Figure 9). Adult male activity usually started around 1700 and remained high until 0500, when activity levels declined throughout the morning. Hourly activity patterns of adult female,

Table 5. Minimum convex polygon (MCP) home range estimates for each radio-collared black bear in Yosemite National Park, California generated from location data collected 9 July - 15 November 2001 and 3 April - 12 December 2002.

Age Class	Sex	Bear ID	Home Range Area (km^2)	Number of Points
Adult	Male	1278	34.5	112
		2251	204.0	65
		2255	77.7	169
		2297	35.7	72
		3047	193.9	16
		3254	21.0	48
		3805	26.2	17
Adult	Female	2283	15.7	101
		2391	7.5	48
		2394	22.2	185
		3558	22.3	110
		3811	113.4	40
		3820	52.4	28
Subadult	Male	3568	19.3	120
		3810	18.1	86
Subadult	Female	3032	26.1	226
		3825	20.0	45

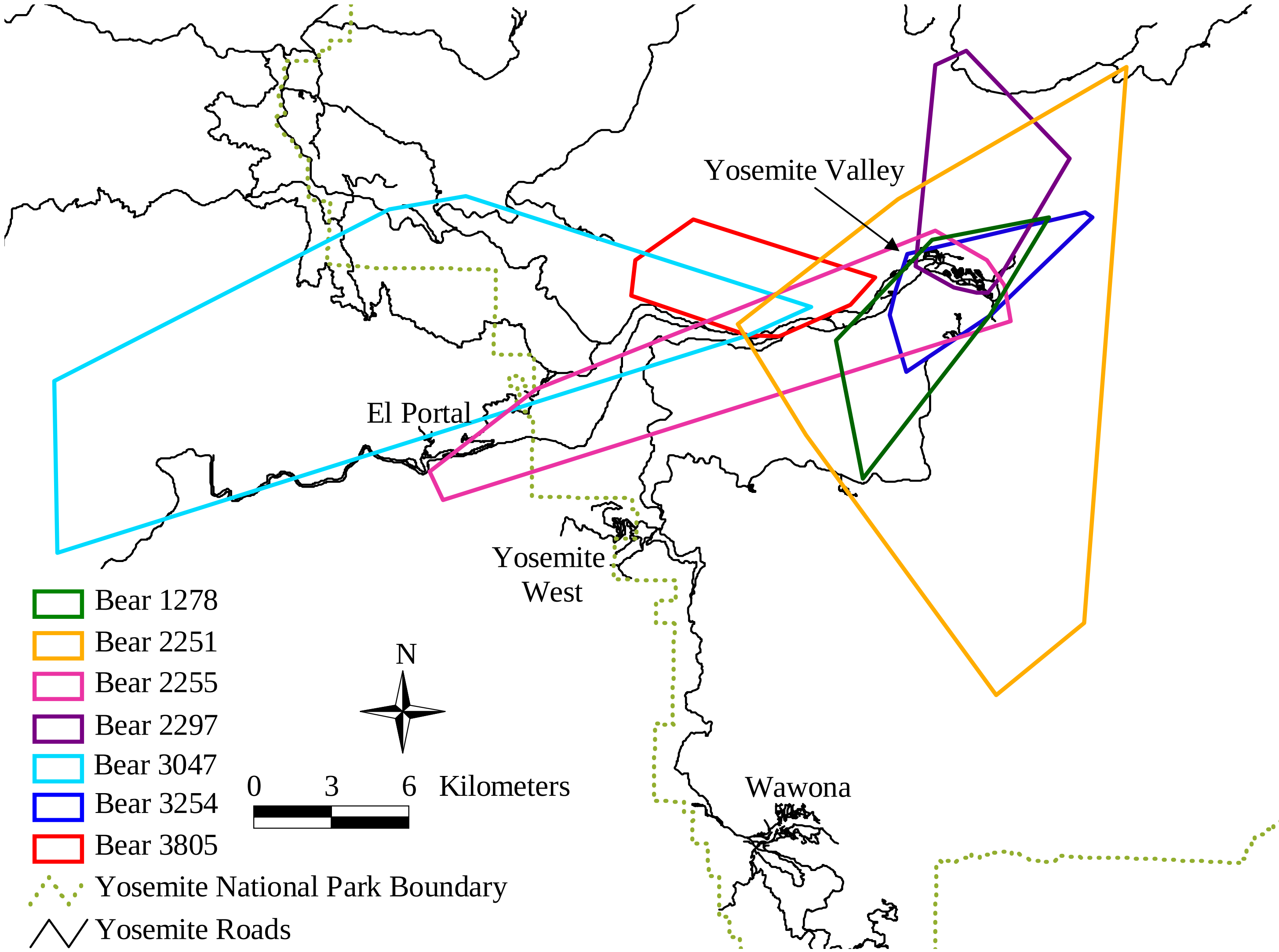

Figure 6. Minimum convex polygon (MCP) home ranges estimates of six radio-collared adult male black bears in Yosemite National Park, California. Location data were collected 9 July - 15 November 2001 and 3 April - 12 December 2002.

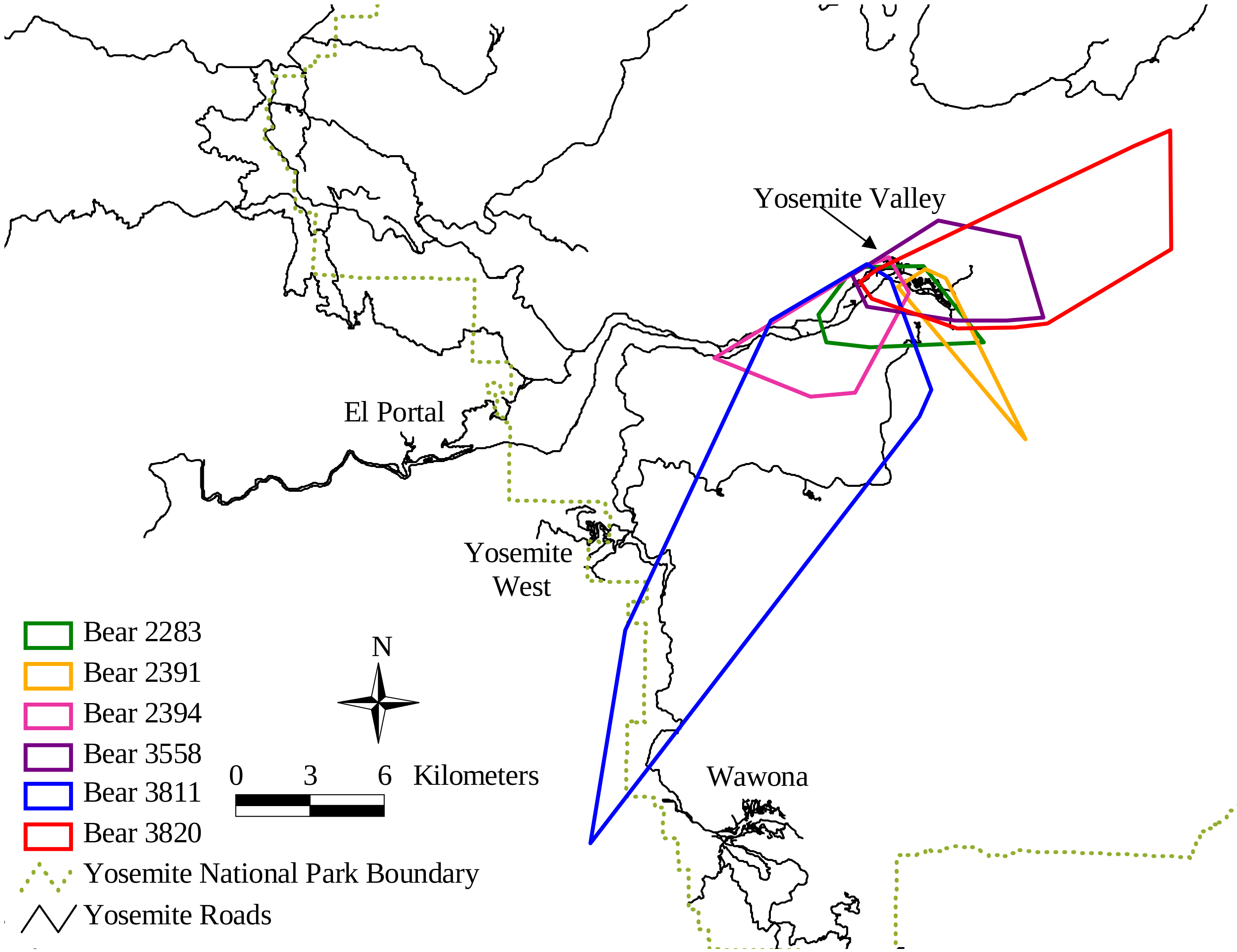

Figure 7. Minimum convex polygon (MCP) home ranges estimates of six radio-collared adult female black bears in Yosemite National Park, California. Location data were collected 9 July - 15 November 2001 and 3 April - 12 December 2002.

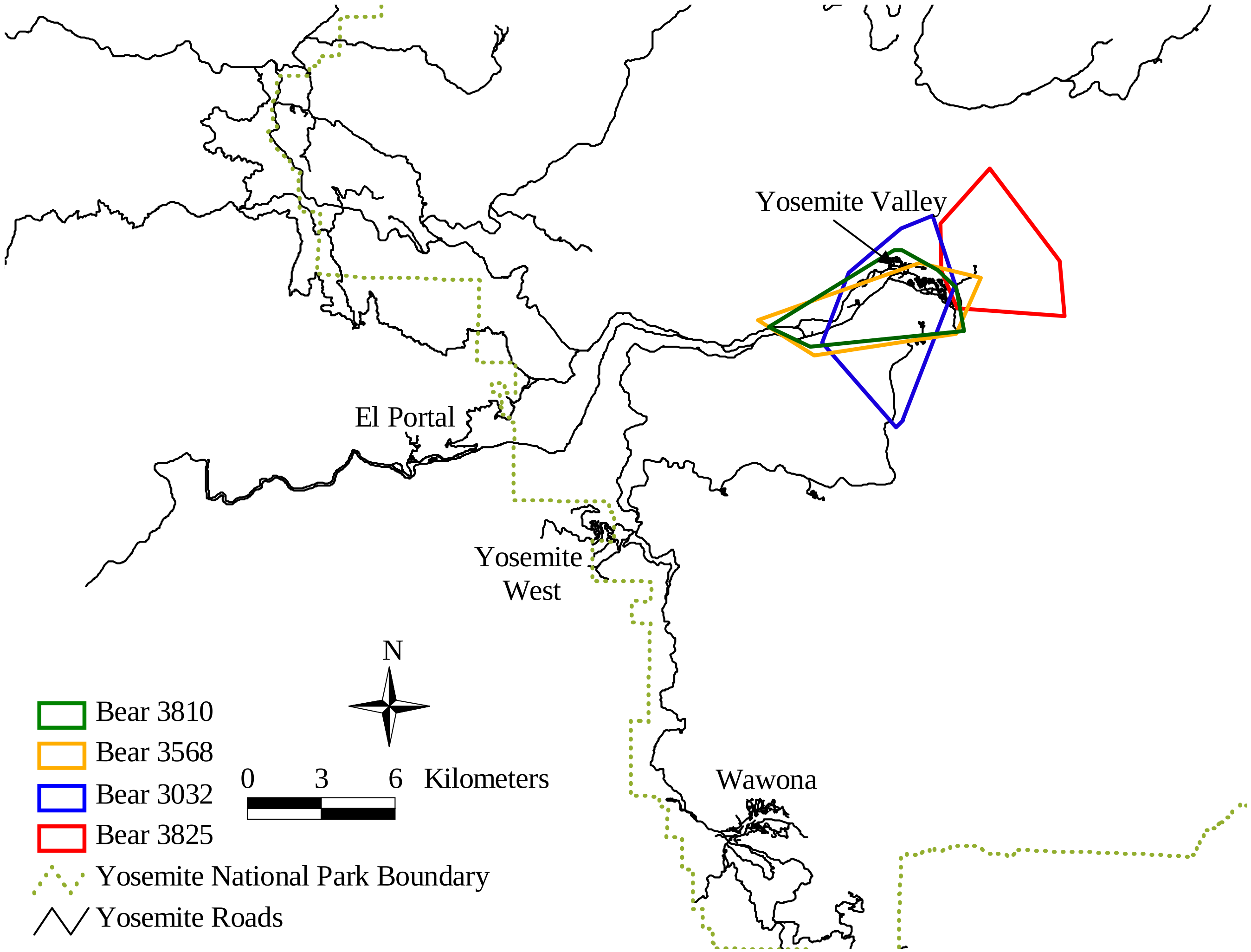

Figure 8. Minimum convex polygon (MCP) home ranges estimates of two radio-collared subadult male black bears (bears 3810 and 3568) and two radio-collared subadult female black bears (bears 3032 and 3825) in Yosemite National Park, California. Location data were collected 9 July - 15 November 2001 and 3 April - 12 December 2002.

Table 6. Percentage of black bear telemetry locations within the boundaries of Yosemite Valley, Yosemite National Park, California, April - December 2002. Bears with fewer than 17 location attempts were radio collared later in the season.

Age Class	Sex	Bear ID	Number Location Attempts	Percent of Locations in Valley
Adult	Male	1278	17	82
		2251	17	53
		2255	17	71
		2297	16	63
		3047	14	0
		3254	8	88
		3805	15	13
Adult	Female	2283	16	88
		2391	7	100
		2394	15	80
		3558	17	71
		3811	17	29
		3820	17	18
Subadult	Female	3032	17	88
		3825	14	50
Subadult	Male	3568	10	100

Table 7. Diurnal and nocturnal activity of radio-collared black bears documented during 24-hour monitoring events in Yosemite Valley, Yosemite National Park, California, 7 August - 29 October 2001 and 15 May - 15 October 2002.

				Hourly Activity Readings		Percent Activity	
Age Class	Sex	Radio-Collared Bears	24-hour Monitoring Periods	Diurnal	Nocturnal	Diurnal	Nocturnal
Adult	Male	5	8	117	85	21	61
	Female	4	8	125	74	49	62
Subadult	Male	2	5	71	52	51	58
	Female	2	7	104	65	63	65

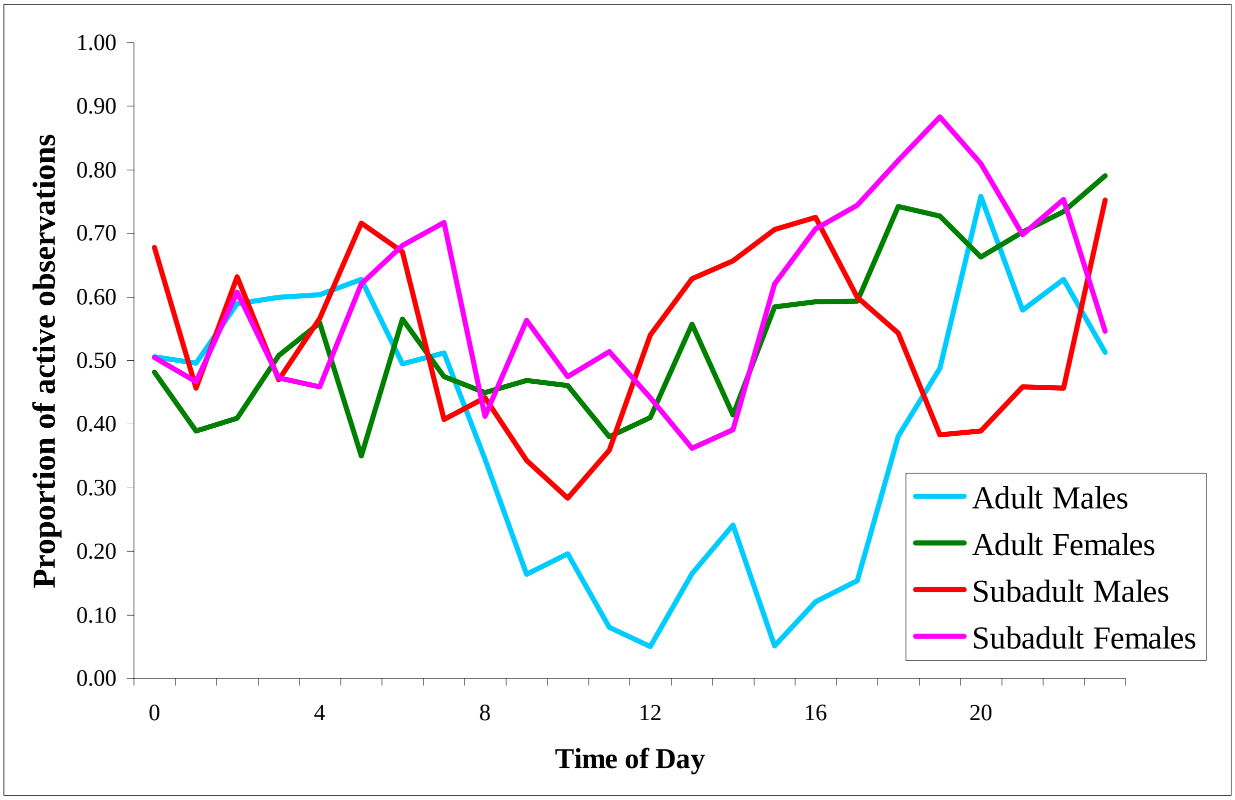

Figure 9. Hourly activity patterns of adult male (n=8), adult female (n=8), subadult male (n=5), and subadult female (n=7) black bears during 24-hour monitoring events in Yosemite Valley, Yosemite National Park, California, 7 August - 29 October 2001 and 15 May - 15 October 2002.

subadult female, and subadult male bears were similar. Each of these classes exhibited periods of activity and inactivity throughout a 24-hour period.

Adult male bears were significantly more active during nocturnal than diurnal periods ($\chi^2 = 20.3$, d.f. = 1, $p < 0.001$, Table 7). The activity patterns of adult female, subadult male, and subadult female bears were not significantly different between diurnal and nocturnal periods (all $\chi^2 \leq 1.3$, d.f. = 1, $p \geq 0.249$, Table 7). The proportion of activity for each age and sex class ranged from 21 to 63% and from 58 to 65% during diurnal and nocturnal periods, respectively (Table 7).

Monitored adult and subadult males used developed areas of YV during each of the 24-hour monitoring events. Thus we were unable to determine activity patterns of adult and subadult males when they used only natural areas. Monitored adult females were located in developed areas during 5 monitoring events and used only natural areas during 3 monitoring events (Table 8). We found when adult females used only natural areas they were significantly more active during diurnal than during nocturnal periods ($\chi^2 = 7.1$, d.f. = 1, $p = 0.008$, Table 8). Alternatively, when adult females used developed areas they were significantly more active during nocturnal periods than during diurnal periods ($\chi^2 = 8.8$, d.f. = 1, $p = 0.003$). Monitored subadult females were located in developed areas during 2 monitoring events and used only natural areas during 5 monitoring events (Table 8). We found when subadult females used only natural areas there was a trend toward being more diurnal and when they used developed areas they were generally more nocturnal; however, these results were not significant ($\chi^2 < 1.7$, d.f. = 1, $p > 0.198$).

Seven hundred and eight hourly movement distances were collected on 13 bears over 28 24-hour monitoring events (Table 9). No significant differences were found in the hourly

Table 8. Diurnal and nocturnal activity of radio-collared black bears during 24-hour monitoring events in natural and developed areas in Yosemite Valley, Yosemite National Park, California, 7 August - 29 October 2001 and 15 May - 15 October 2002. Monitored adult and subadult males used developed areas of YV during each of the 24-hour monitoring events. Thus we were unable to determine activity patterns of adult and subadult males when they used only natural areas.

					Hourly Activity Readings		Percent Activity	
Age Class	Sex	Location	Radio Collared Bears	24-hour Monitoring Periods	Diurnal	Nocturnal	Diurnal	Nocturnal
Adult	Male	Developed	5	8	117	85	21	61
	Female	Natural	2	3	43	24	79	29
		Developed	4	5	82	50	34	72
Subadult	Male	Developed	2	5	71	52	51	58
	Female	Natural	2	5	74	46	66	57
		Developed	1	2	30	19	53	84

Table 9. Diurnal and nocturnal movements of radio-collared black bears during 24-hour monitoring events in Yosemite Valley, Yosemite National Park, California, 7 August - 29 October 2001 and 15 May - 15 October 2002.

				Hourly Movement Observations		Movement Distances (meters/hour) ± SE	
Age Class	Sex	Radio Collared Bears	24-hour Monitoring Periods	Diurnal	Nocturnal	Diurnal	Nocturnal
Adult	Male	5	8	131	90	181 ± 29	365 ± 35
	Female	4	8	137	70	272 ± 29	410 ± 40
Subadult	Male	2	5	66	52	265 ± 41	237 ± 47
	Female	2	7	97	65	305 ± 34	295 ± 42

movement distances between each of the four sex-age classes (F = 2.15, df = 3, p = 0.093). Bears were found to move greater distances during nocturnal periods than during diurnal periods (F = 7.09, df = 1, p = 0.008).

Habitat use

Five hundred and sixty-six habitat telemetry locations were collected and used to determine habitat use of black bears in YV during the 2001 and 2002 seasons. The overall comparison of habitat use from MCP ranges compared to habitat availability in YV resulted in $\Lambda = 0.1663$ ($\chi^2_4 = 23.32$, $P < 0.001$, Table 10). Thus, bears did not establish home range areas within YV at random. A ranking matrix ordered habitat types in order of use in the following sequence: urban > riparian and grasslands > coniferous forest > barren > hardwood forest and chaparral (Table 11). There was no detectable difference in use of the two top-ranking habitats, but each were used significantly more than the remaining habitat types. Coniferous forest was used significantly less than the two top-ranking habitats and significantly more than the two bottom-ranking habitats. There was no detectable difference in use of the bottom-ranking habitats.

Overall, use of the five habitat types based on radio location compositions differed significantly from the habitat compositions within the MCPs ($\Lambda = 0.2317$, $\chi^2_4 = 19.01$, $P < 0.001$, Table 10). A ranking matrix ordered the habitat types in order of use in the following sequence: urban > coniferous forest > hardwood forest and chaparral > riparian and grasslands > barren (Table 12). Urban habitat was not used significantly more than coniferous forest, hardwood forest and chaparral, or riparian and grasslands. Barren habitat was used significantly less than the four top-ranking habitats.

Table 10. Proportional habitat availability within Yosemite Valley and average proportional habitat use based on minimum convex polygon (MCP) home range estimates and radio telemetry locations of black bears in Yosemite Valley, Yosemite National Park, California.

Habitat Types	Proportion of Yosemite Valley	Average proportional habitat use based on MCP home range estimates	Average proportional habitat use based on radio telemetry locations
Hardwood/Chaparral	44.2	35.7	37.4
Coniferous Forest	27.3	31.4	34.0
Riparian/Grasslands	8.5	11.2	10.2
Barren	16.1	13.9	5.6
Urban	3.9	7.7	11.6

Table 11. Ranking matrix for bears generated by comparing proportional habitat use within minimum convex polygon (MCP) home range estimates with proportions of habitat availability in Yosemite Valley, Yosemite National Park, California. A triple sign represents significant deviation from random at $P < 0.10$.

	Habitat Type					
Habitat Type	Hardwood/Chaparral	Coniferous Forest	Riparian/Grasslands	Barren	Urban	Rank
Hardwood/Chaparral		– – –	– – –	–	– – –	0
Coniferous Forest	+ + +		– – –	+ + +	– – –	2
Riparian/Grasslands	+ + +	+ + +		+ + +	–	3
Barren	+	– – –	– – –		– – –	1
Urban	+ + +	+ + +	+	+ + +		4

Table 12. Ranking matrix for bears generated by comparing proportional habitat use based on radio telemetry locations with proportions of total available habitat types within minimum convex polygon (MCP) home range estimates in Yosemite Valley, Yosemite National Park, California. A triple sign represents significant deviation from random at $P < 0.10$.

	Habitat Type					
Habitat Type	Hardwood/Chaparral	Coniferous Forest	Riparian/Grasslands	Barren	Urban	Rank
Hardwood/Chaparral		–	+	+ + +	–	2
Coniferous Forest	+		+ + +	+ + +	–	3
Riparian/Grasslands	–	– – –		+ + +	–	1
Barren	– – –	– – –	– – –		– – –	0
Urban	+	+	+	+ + +		4

Distance from development

Five hundred and sixty-six telemetry locations were collected and used to determine the distance bears were located from developed areas of YV during the 2001 and 2002 (Table 13). Significant differences were found in the distances each age-sex class were located from developed areas ($F = 7.70$, df = 3, $p < 0.001$). Subadult male bears were found significantly closer to developed areas than bears in the other age-sex classes. No significant differences in the distances from developed areas were found between adult male and female bears or between adult female and subadult female bears.

Bears also were located closer to developed areas during nocturnal periods ($\bar{x}$ = 107 m, SE = 11 m) than during diurnal periods ($\bar{x}$ = 238 m, SE = 8 m, $Z = 3.90$, df = 564, $p < 0.001$). Bears were located closer to developed areas during periods of activity ($\bar{x}$ = 187 m, SE = 11 m) than during periods of inactivity ($\bar{x}$ = 226 m, SE = 9 m, $Z = 3.90$, df = 564, $p < 0.001$). Each age-sex class was located significantly closer than random locations to developed areas ($F =$ 95.90, df = 4, $p < 0.001$).

Discussion

Yosemite National Park personnel, under the direction of the Human-Bear Management Program, have made efforts to restore and maintain the natural ecology of Yosemite’s black bear population. However, some elements of black bear ecology in YV continue to differ from that of bears in more wild settings. These differences were probably functional responses to the presence of humans through food resource enrichment and harassment.

Our results showed reductions in the size of bears in YV since the 1970s and consistency in size with bears in other areas of California. These results indicated that bears in YV returned

Table 13. Mean, standard error (SE), and range of distances (m) bears were located from developed areas of Yosemite Valley, Yosemite National Park, California, 9 July - 15 November 2001 and 3 April - 12 December 2002.

Age-Sex Class	n	Mean Distance (m) From Developed Areas ± SE	Range of Distance (m) From Developed Areas
Adult Male	182	202 ± 12	0 - 893
Adult Female	208	223 ± 11	0 - 771
Subadult Male	82	135 ± 18	0 - 882
Subadult Female	94	244 ± 17	0 - 915

to a more natural physical condition, following reductions in the availability to bears of human-provided food and garbage. Researchers in other areas have found that black bears with access to human food were significantly larger than wild bears (Alt 1980, McLean and Pelton 1990). McLean and Pelton (1990) also reported significant declines in the weight of bears with access to human food following management efforts directed toward public education, sanitation of campgrounds and trash cans, and relocation of problem bears in the Great Smoky Mountains National Park.

Significant decreases in the weights of adult males and the lack of a decrease in the weights of adult females since the mid 1970's could be attributed to a pattern of adult males making greater use of human-provided food in YV. Adult males and adult females were found to be involved in 55 and 41% of the documented human-bear interactions in YV between 1989 and 2002, respectively (Matthews unpublished data). Thus, reductions in human food availability would be more obviously reflected in the foraging habits and resulting weights of adult males than in adult females.

Home-range estimates for radio-collared male black bears in YNP were not greatly different from those determined for male bears in the central Sierra, California (41.7 km^2, Sitton 1982), the San Bernardino Mountains, California (22.4 km^2, Novick and Stewart 1982), Arizona (29.0 km^2, LeCount 1980), Washington (51.5 km^2, Poelker and Hartwell 1973), Idaho (109 - 115 km^2, Amstrup and Beecham 1976), and Prince William Sound, Alaska (70 - 100 km^2, Modafferi 1978). Home-range estimates for male bears in Yosemite were smaller than those reported along the Susitna River, Alaska (234 km^2, Miller and McAllister 1982).

Home-range estimates for female bears in Yosemite were similar to those determined for female bears in the central Sierra, California (40.4 km^2, Sitton 1982), the San Bernardino

Mountains, California (17.1 km^2, Novick and Stewart 1982), Arizona (17.9 km^2, LeCount 1980), Idaho (16.6 – 130.3 km^2, Amstrup and Beecham 1976), and Prince William Sound, Alaska (10 - 30 km^2, Modafferi 1978). Home-range estimates for female bears in Yosemite were larger than those reported for female bears in Washington (5.3 km^2, Poelker and Hartwell 1973) and smaller than those reported along the Susitna River, Alaska (200 km^2, Miller and McAllister 1982).

Home-range estimates for subadult male bears in Yosemite were smaller than those determined for subadult males in the central Sierra, California (118.6 km^2, Sitton 1982), Arizona (41.9 km^2, LeCount 1980), and Alaska (72.5 – 90.6 km^2, Modafferi 1978). The comparatively small ranges of the two subadult males in Yosemite could be attributed to their consistent use of one particular YV campground. Estimates for subadult females in Yosemite were similar to those in the central Sierra, California (33.9 km^2, Sitton 1982), but larger than those in Arizona (12.9 km^2, LeCount 1980) and Alaska (4.9 – 11.9 km^2, Modafferi 1978).

Despite YV having one of the highest concentrations of human food and garbage in YNP, only two bears were consistently located in YV. This finding demonstrates the connectivity between the bears found in YV, other developed areas of YNP, and backcountry areas. Graber (1981) suggested the seasonal availability of human food at higher elevations and distribution of optimal habitat along river corridors, providing sources of food and water, allowed for large variations in movement patterns exhibited by individual bears.

Our results indicated that human activity and use of developed areas in YV by bears result in behavioral differences between bears in YV and bears in areas with less human impact. Black bears were mostly diurnal in natural environments in Idaho (Amstrup and Beecham 1976), Washington (Lindzey and Meslow 1977), Tennessee (Garshelis and Pelton 1980), California (Ayres et al. 1986), and Québec (Larivière et al. 1994). Bacon and Burghardt (1976) and

Larivière et al. (1994) argued that diurnal patterns of bears could be explained by foraging behavior. Bears rely on visual cues and maybe more efficient foraging during daylight hours. Bears found foraging in campgrounds have demonstrated nocturnal behavior, most likely to minimize the chance of human harassment (Ayres et al. 1986, Larivière et al. 1994, Pelton 2000). Ayres et al. (1986) argued that human intervention through food resource enrichment and harassment prompted a transition to nocturnal behavior by bears in Sequoia National Park. Our findings in YV support those of Ayres et al. (1986) and provide further evidence for behavioral plasticity in black bears and the impact of recreational-use pressure on the activity patterns of bears. The nocturnal activity patterns of adult male bears in our study probably resulted from their consistent use of developed areas in YV. Subadult male bears also consistently used developed areas, but did not exhibit significant nocturnal activity patterns. A lack of significant nocturnal activity despite consistent use of developed areas by subadult males could have been the result of inexperience and/or competitive exclusion (Bunnell and Tait 1981, Young and Ruff 1982, Rogers 1987, Mattson 1990).

Ayres et al. (1986) presented evidence for behavioral plasticity between individual black bears which used developed areas of Sequoia National Park and those which used only natural areas. Anecdotally, we found evidence for behavioral plasticity within individual bears in YV, based on whether they used a developed area during a period of monitoring. We found one adult female (bear 2394) used only natural areas during 2 monitoring events and used developed areas during 2 other monitoring events. When she used only natural areas, her probability of activity during diurnal periods was 0.90 and during nocturnal periods was 0.37. Alternatively, when she used developed areas, her probability of activity during diurnal periods decreased to 0.45 and her probability of activity during nocturnal periods increased to 0.63. We found similar results for one subadult female (bear 3032), that used only natural areas during 4 monitoring events and developed areas during 2 other monitoring events. When she used only natural areas, her probability of activity during diurnal periods was 0.66 and during nocturnal periods was 0.62. Alternatively, when she used developed areas, her probability of activity during diurnal periods decreased to 0.53 and her probability of activity during nocturnal periods increased to 0.84. These data suggest that the shift in activity from diurnal to nocturnal was influenced by human activity and not ambient temperature as suggested by Garshelis (1978).

The use of urban habitats in YV by black bears was probably influenced by human intervention through food resource enrichment and the proximity of highly used, natural habitats. The natural habitats within YV provided a number of the habitat requirements for black bears identified by Pelton (2000), including fall sources of hard or soft mast, spring and summer feeding areas, escape cover, and movement corridors. Graber (1981) identified YV among the highest quality bear habitats in YNP. He attributed consistent bear use of YV to nutritious plant foods generally being available during all months of bear activity. The coniferous forest, hardwood forest, and chaparral habitats in YV provided areas of hard and soft mast crops, including California black oak (*Quercus kellogii*), Himalayan blackberries (*Rubus himalyala*), western raspberries (*Rubus* sp.), coffeeberry (*Rhamnus* spp.), manzanita (*Arctostaphylos* spp.), and apples (*Malus* spp.). The riparian and grassland habitats provided herbage and other food items for spring and summer feeding. The forested habitats also provided escape and movement corridors for bears throughout YV.

Our result indicating that subadult male bears were typically found closer to developed areas should make their management of special concern for YNP managers. Adult female and subadult brown bears have been documented to occupy areas near humans more than adult males

(Warner 1987, Mattson et al. 1987, and McLellan and Shackleton 1988). Subadult male brown bears comprised a large proportion of the bears using campgrounds in Yellowstone National Park (Mattson 1990). Subadult male black bears comprised a large proportion of bears using small dumps near developed areas in Alberta (Tietje and Ruff 1983). Mattson (1990) argued that habitat selection by adult males, typically in areas of rich food resources away from development, leaves adult female and subadult male bears to forage in areas closer to development. He also argued that the close proximity of humans might severe as a refuge for subadult males from adult males.

The activity of black bears closer to the developed areas of YV than expected by chance was probably a function of both food resource enrichment by humans and the presence of high quality natural foods near these developed areas. YV receives approximately 90% of the nearly 3.5 million people who visit YNP annually (Keay and Webb 1989, National Park Service Public Use Statistics Office www.aqd.nps.gov/stats). Additionally, 62% of the human-bear conflicts documented in YNP between 1989 and 2002 occurred in YV (Matthews unpublished data). Ayres et al. (1986) observed that bears foraging only on natural food items and never visiting campgrounds tended to center their activity away from areas of high human use, even though real distance to campgrounds was small in Sequoia National Park.

Human influences, including food resource enrichment and harassment, have resulted in alterations of the natural ecology of black bears in YV. Management efforts should continue to address issues related to both visitors and bears. Educational campaigns, improvements to food storage containers, effective waste management, and aversive conditioning continue to be promising methods in reducing the number of human-bear interactions. These management tools should be consistently utilized and refined to ensure the restoration of the natural ecological elements of Yosemite's black bear population.

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Black Bear Food Habits in Yosemite Valley, Yosemite National Park, California 2001-2002

National Park Service

Wildlife Conservation Society

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National Park Service

Human attitudes toward wildlife have changed dramatically in the last two decades. In the United States, wildlife managers currently face issues of endangered species recovery, non-game species management, and integrated management of entire systems. At the heart of this emerging consciousness is humans' ability to coexist with wildlife in ways that ensure both the continued existence of healthy wildlife populations and the maintenance of human lifestyles.

One traditional aspect of wildlife management that is currently being reshaped is the management of human-wildlife conflicts. Simple “control programs” are being phased out in favor of more integrated approaches. This transformation has stemmed from a demand voiced by both professional biologists and the general public for more enlightened, broad based management strategies. As humans invade wildlife habitat for recreation, transportation, or second home development, flashpoints for human-wildlife conflict are created. Successful management of these flashpoints is critical to the survival of key wildlife species and long-term ecological integrity.

Black bears (*Ursus americanus*) provide a good example of the challenges faced in learning to share our wild areas with wildlife. Humans have largely tolerated black bears because of their relatively unthreatening behavior compared to other large carnivores. For this reason, these resilient, adaptable animals exist in populations thriving throughout much of North America. Throughout the United States, humans and black bears are interacting with increasing frequency as population growth brings people into more remote areas and bears develop a taste for human food items (Thompson and McCurdy 1995, Beckmann and Berger 2003). Conflicts between humans and black bears have commonly centered around the availability of human-provided food for bears (Beeman and Pelton 1980, Graber 1981, Tate and Pelton 1983, Hastings et al. 1989, Mattson 1990, Wright 1992, Peine 2001). These human-black bear interactions prove especially challenging for wildlife managers, entrusted with protecting wildlife populations, human safety, and personal property.

Yosemite National Park (YNP) provides a unique opportunity for examining the problems that can arise between humans and black bears where bear populations are protected. Human-black bear conflicts are most pronounced at the interface of wild and developed areas (Beckmann and Berger 2003), such as in the Yosemite Valley (YV) region of YNP. These areas offer the greatest lessons in managing both human and bear activities.

YNP has a long history of humans and bears interacting and ensuing management issues are prevalent. The history of conflicts in YNP dates back to the arrival of non-native people to YV in 1851. European settlers quickly extirpated the grizzly bear (*Ursus arctos*) from the Yosemite region by 1895, an action which allowed black bears to inhabit previously occupied habitat areas. Increasing numbers of tourists further impacted the ecosystem and remaining wildlife species of YNP throughout the late 1800's. During this period, limitations in transportation restricted the removal of garbage and food waste from YNP, forcing Park managers and hotel operators to use open pit dumps to dispose of waste. These sites quickly became food sources for black bears. By the 1930's, as many as 60 bears were observed during the summer seasons in the 18 km^2 of YV (Beatty 1943).

In 1937, artificial feeding sites were established in undeveloped regions of the Park in order to draw bears away from the populated areas of the Valley. These feeding sites also provided the visiting public with a unique opportunity to observe large numbers of bears. As much as 60 tons of human-food scraps were fed to bears annually during this period (National Park Service 2003). By the 1940's, park managers realized that the continued feeding of bears, and the lethal control of problem bears, likely altered the natural ecology of Yosemite's bear population. As a result, the artificial feeding of bears was discontinued in the 1940's. Availability of human food was further reduced by closures of the garbage dumps 20 years later. The last garbage dumps in YV were closed in 1963 and throughout the Park in 1971. These closures were made possible with the introduction of dumpster-style trash containers that could be transported to landfills outside of the Park. Not surprisingly, the removal of these artificial food sources was followed by increases in human-bear conflicts as bears turned to raiding campsites and breaking into vehicles to obtain food.

To further reduce human-provided food and garbage accessible to bears, the National Park Service initiated the Human-Bear Management Program in YNP in 1975 (National Park Service 1975). Goals of the program included providing "bear-proof" food storage devices and garbage receptacles, relocation or destruction of problem bears, and research into the ecology of Yosemite's black bears. An element of the initial ecological research of bears in Yosemite was a quantification of bear food habits between 1974 and 1978 (Graber 1981, Graber and White 1983).

The purpose of our study was to assess the effectiveness of the Park's effort to reduce human-provided food to bears and secondarily to quantify non-native flora in bear diets. We provided Park managers with an updated description of black bear seasonal food habits and an indication of the extent to which bears continue to obtain human-provided food and garbage. Our results were compared to those of Graber (1981) and Graber and White (1983) to assess changes in the diets of bears in YV over the past 25 years. A comparison of the amount of human food in bears' diets before and after the implementation of current management practices provides a measure of the effectiveness of Park efforts to limit the use of human foods by bears.

A current analysis of food habits of bears also highlights the issue of non-native vegetation in YV. Managers are concerned about the presence of non-native apple orchards and blackberry thickets in close proximity to developed areas. Naturally foraging bears may be attracted to the abundance of apples and berries in these areas of high human density, and over time become habituated to the presence of people. Habituation, in turn, may lead to food conditioned behavior, a loss of fear of humans, and aggressive displays, which threaten visitor safety (McArthur Jope 1983). Habituated bears are more likely to be involved in human-bear incidents, may exhibit aggressive behavior toward people, and stand a greater chance of being killed to protect human safety and property (Gilbert 1989, Mattson et al. 1992). Non-native blackberry thickets are currently being eradicated throughout YV, but only one of the three apple orchards is scheduled to be removed (Thompson and McCurdy 1995, National Park Service 2000). Some managers advocate for the complete removal of the orchards on the grounds that they are non-native vegetation in a National Park. Others believe that the orchards are a significant historical resource and should remain to tell the story of early settlers to YV. The importance of apples to the diets of bears is of interest to Park managers in estimating the effects of removing the trees from the YV ecosystem.

Methods

We collected bear scat in YV 20 July - 1 November 2001 and 29 March - 4 November 2002 both opportunistically and on designated transects. Transect areas encompassed representative vegetation types and areas with and without concentrated human use. Each transect was flagged and walked at least twice a month 20 July - 1 November 2001. We also collected scat opportunistically while radio-tracking and in areas known to be used by bears. Several Park employees assisted in scat collection in areas where they regularly patrolled, such as in campgrounds and picnic areas.

We primarily used designated transects in 2001. The purpose of this systematic collection was to more accurately assign scat into seasonal categories. This method was found to be inefficient, and often times transects were completely void of scat. We focused on opportunistic collection methods in 2002 in an effort to increase our efficiency in collection. In order to age and thus classify scat into seasonal categories, we observed the drying process of fresh scat samples placed in locales of varying degrees of exposure. Fresh samples were obtained from trapped bears and placed in either direct sun or shade on a variety of substrates, such as grass, rock, and forest floor. Moisture due to rain was not a concern due to a lack of precipitation. We observed samples once a day and noted changes to the appearance and texture of samples both exteriorly and interiorly. We were able to age samples confidently by describing the moisture content at the time of collection and focused our efforts on collecting samples less than two weeks old.

This refinement in collection methods allowed us to collect more samples because we concentrated on areas known to be used by bears. Collection efforts were conducted throughout the Valley every two weeks. Efforts were made to ensure that samples were collected from areas representative of the entire Valley and not only from a few high use areas. This was accomplished through bi-weekly systematic collection efforts and record-keeping of collection results. Telemetry locations of radio-collared bears assisted us in locating day beds and other areas frequented by bears.

Scat for which age could not be determined was also collected from representative areas of YV. Although the data from these samples was not used for the seasonal analysis of diet, they offered important information for an annual compositional analysis of bear food habits.

We employed the same scat analysis methods used by Graber (1981) to facilitate a comparison of findings between the two studies. Each sample was either oven-dried (2001) or sun-dried (2002), re-hydrated in water with a surfactant, and then passed through a series of sieves (1mm and 0.4mm) to separate out equal-sized particles for identification. Food items were identified macroscopically and with the use of a dissecting microscope. Food items were keyed out to species, when possible. Each item was categorized into one of the following classes: herbage (including roots, stems and leaves); reproductive plant parts (including flowers, fruit, or seeds); human foods (including garbage and human-intended food); animal matter; debris (including items inadvertently consumed, such as wood, bark, stones, and pine needles).

Black bear food habits were quantified by determining the average proportional contribution of herbage, reproductive plant parts, human-provided foods, animal matter, and debris in collected scat samples within two-week intervals and annually. Seasonal analysis was completed by grouping scat samples of known-age into two-week intervals. The proportion of samples within each period containing major forage class items was graphed and seasonal patterns analyzed. The traditional seasonal divisions of spring, summer and fall were used following Graber (1981).

Percent volume of each food item class was measured by water displacement to the nearest 1%. Volumetric analysis alone tends to overestimate the proportion of herbage eaten and underestimate more easily digested reproductive plant parts and animal foods (Hatler 1972, Poelker and Hartwell 1973, Mealey 1980, Graber 1981, Graber and White 1983). To provide a more accurate assessment of food habits, the percent frequency of food items was also calculated. Percent frequency of occurrence was calculated as the percent of total scat samples in which an item comprised at least 1% of the volume of a sample (Graber 1981, Graber and White 1983). Percent frequency of occurrence and percent composition by volume were reported separately and compared to Graber (1981) and Graber and White (1983) where possible.

Graber and White (1983) quantified black bear food habits within three elevation classes throughout YNP: below 1,800 m; 1,800 to 2,400 m; and above 2,400 m. Although they did not quantify bear food habits in YV independent of other areas below 1,800 m, this elevation class included the Valley, much of the region surrounding Hetch Hetchy Reservoir, and Wawona. Graber (1981) did quantify food habits for YV specifically, but only as the proportion of major forage classes in bears' diets by percent volume. For this single expression of data, we were able to make direct comparisons between studies.

Results

We collected and analyzed 500 scat samples from YV during 2001 and 2002. Seventy-nine of the 162 samples collected in 2001 and 198 of the 338 samples collected in 2002 were aged to within two weeks and used for seasonal diet analysis. The rest of the samples fell into annual categories and were analyzed to complement the analysis of overall diet composition.

Annual Diet Composition

Vegetative and animal matter composed 80 and 3% of the diet by volume of bears in YV, respectively. Human food and garbage and debris (including unidentified matter) made up the remaining 6 and 10%, respectively.

Reproductive plant parts were the most used food source by black bears in YV, comprising an average 51% of the dietary volume and present in 83% of all scats annually (Table 14).

Table 14. The percent volume and percent frequency of occurrence of food items found in black bear scats (n=500) collected in Yosemite Valley, Yosemite National Park, California, 2001 and 2002. Listed items within each category comprised at least 1% of total scat volume.

	Spring (n=45)		Summer (n=136)		Fall (n=96)		Annually (n=500)	
Item	% vol.	% freq.	% vol.	% freq.	% vol.	% freq.	% vol.	% freq.
Reproductive plant parts	2.4	20.0	81.1	97.8	75.7	97.9	51.1	82.8
Acorns	0.0	0.0	0.7	2.8	30.5	54.2	4.3	13.8
Apples	1.6	11.1	59.5	79.1	38.5	57.3	30.8	57.2
Berries and other fruit	<0.1	8.9	20.9	39.7	6.7	27.1	16.0	38.0
Herbage	89.3	97.8	4.3	22.8	6.1	43.8	29.0	44.0
Grasses, sedges, rushes	86.3	95.6	3.6	16.9	4.0	35.4	25.2	37.6
Forbs	3.0	17.8	0.7	9.6	2.1	24.0	3.7	15.2
Animal matter	0.6	26.7	2.0	28.8	4.7	54.1	3.0	35.4
Insects	0.5	17.8	0.8	19.9	2.7	40.6	1.1	28.0
Other animals	<0.1	8.9	1.2	8.9	2.0	13.5	1.8	11.8
Human-provided foods	0.7	8.9	3.1	19.9	1.5	14.6	6.4	22.4
Debris	4.8	73.3	6.5	52.2	7.1	52.1	7.7	58.0
Unidentified matter	2.2		2.3		3.7		2.9	

Reproductive plant parts primarily included apple (*Malus* spp.), Western raspberry (*Rubus leucodermis*), Himalayan blackberry (*Rubus himalaya*), manzanita (*Arctostaphylos* spp.) and acorn (*Quercus* spp.). Non-native apples comprised an average of 30% dietary volume, and were represented in 57% of all samples. Other food items used in this forage class were blue elderberry (*Sambucus mexicana*), western chokecherries (*Prunus demissa*), coffeeberry (*Rhamnus* spp.), dogwoods (*Cornus* spp.), gooseberries and currents (*Ribes* spp.), thimbleberries (*Rubus* spp.), and Sierra plum (*Prunus subcordata*).

Herbage was the second most used forage class, comprising 29% of dietary volume and present in 44% of all samples (Table 14). Herbage included graminoids and graminoid-like plants such as sedges and rushes, leaves and stems, and forbs. The most used food items in this forage class were graminoids, comprising 25% of total scat volume and present in 38% of all samples (Table 14). Frequently consumed graminoids included *Poa* spp., *Avena* spp., and *Agrostis* spp. species. Frequently consumed forb species during our study included *Trifolium* spp., *Montia* spp., and *Lupinus* spp. Horsetail (*Equisetum* spp.) was present in 2.2% of all samples. Yampah (*Perideridia* sp.) and an unidentified mushroom were found in at least one sample each, and club moss (*Isoetes* spp.) was present in trace amounts during the spring.

We found that human-provided food and garbage comprised an average 6% of the dietary volume and was present in 22% of all samples (Table 14). Animal matter comprised 3% of total scat volume and was found in 35% of all scat samples collected (Table 14). Debris and other non-food items comprised an average of 10% of the dietary volume. These items were primarily wood, bark, pine needles, and rocks.

Insects were the most common animal matter used by bears, making up 1.1% of the total volume and present in 28% of all samples (Table 14). Insects of the families *Vespidae* (wasps), *Apiae* (bees), *Isoptera* (termites) and *Formicidae* (ants), especially carpenter ants (*Campanotus* spp.), were the most represented animal food items. Other identifiable animal remains found in scat samples were rodent hair and bones (including one specimen from the *Muridae* family), Mule deer (*Odocoileus hemionus*) hair and bones, raccoon (*Procyon lotor*) hair, bird feathers, and fish bones. A Park employee in wildlife management witnessed a male bear chase, kill and feed on a Mule deer buck in YV in the early fall of 2002.

Seasonal Diet Composition

Bears in YV varied their diets seasonally (Figure 10 and Figure 11). Herbage was the most important forage class in the spring, giving way to reproductive plant parts in the summer and fall (Figure 10 and Figure 11). Apples comprised the majority of reproductive plant parts consumed from mid-June through the end of September. In the summer months of late June to September, apples occurred in 79% of scat samples, and averaged 60% of dietary volume. Use of human food peaked from late June to early September, reflecting human visitation numbers to YV (Figure 10, Figure 11, and Figure 12). Acorns, which comprised the hard mast forage class, became an important food source for bears around the middle of September (Figure 10 and Figure 11), and comprised an average 41% of the diet during the month of October.

Animal matter comprised 0.6, 2.0, and 4.7% of total scat volume during spring, summer and fall, respectively. During these periods, animal matter was present in 26.7, 28.8, and 54.1% of scat samples, respectively (Table 14). This seasonal pattern can be largely attributed to fluctuations in the use of insects by bears, as the frequency of occurrence of other animal matter remained relatively consistent throughout the year. Use of other animal matter by percent volume was comparatively low during the spring season, averaging less than 1% of scat volume. Insects were used relatively consistently throughout the spring and summer, present in 17.8 and

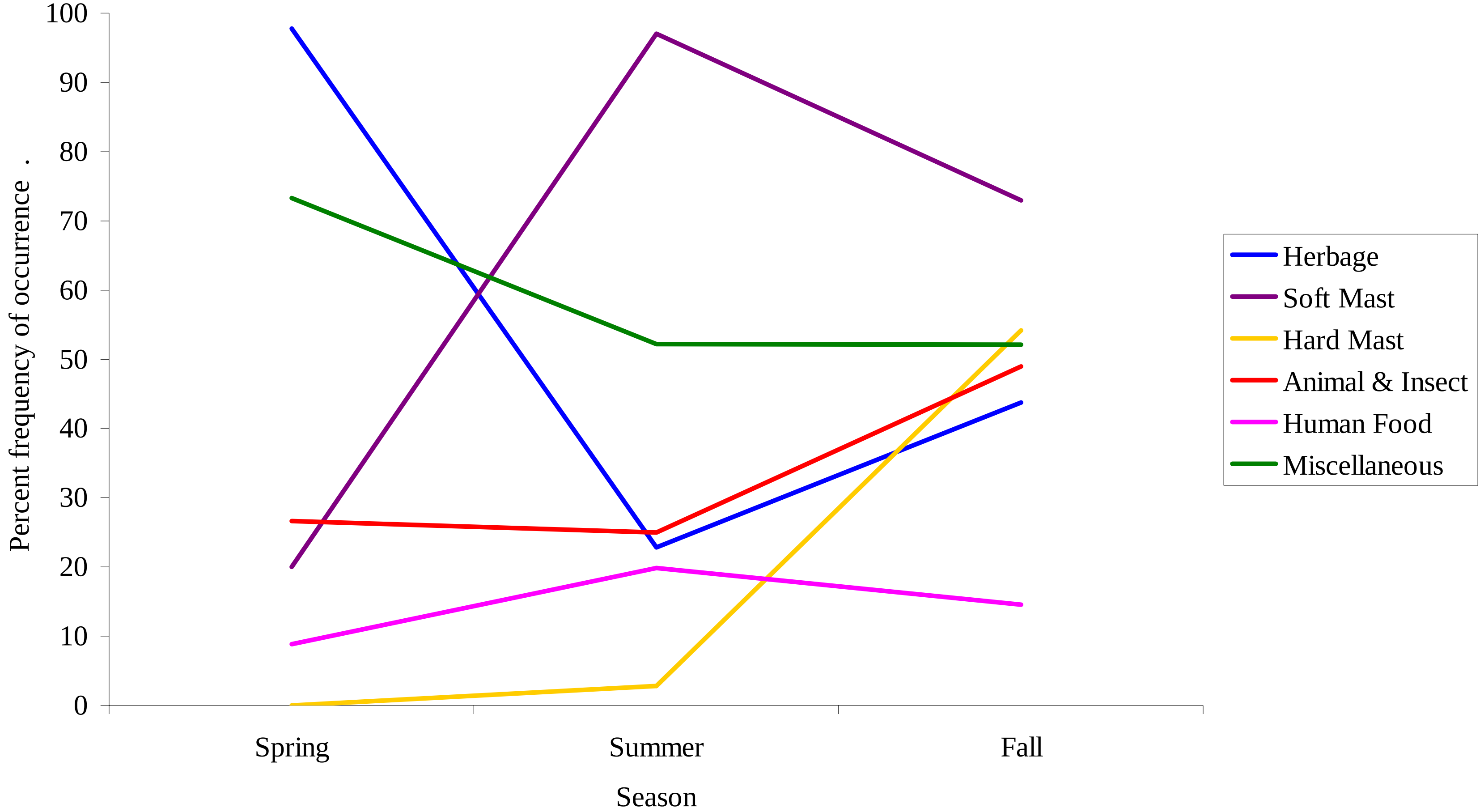

Figure 10. The spring (n=44), summer (n=137), and fall (n=96) percent frequency of occurrence of major forage classes used by black bears based on scat analysis in Yosemite Valley, Yosemite National Park, California, 2001 and 2002.

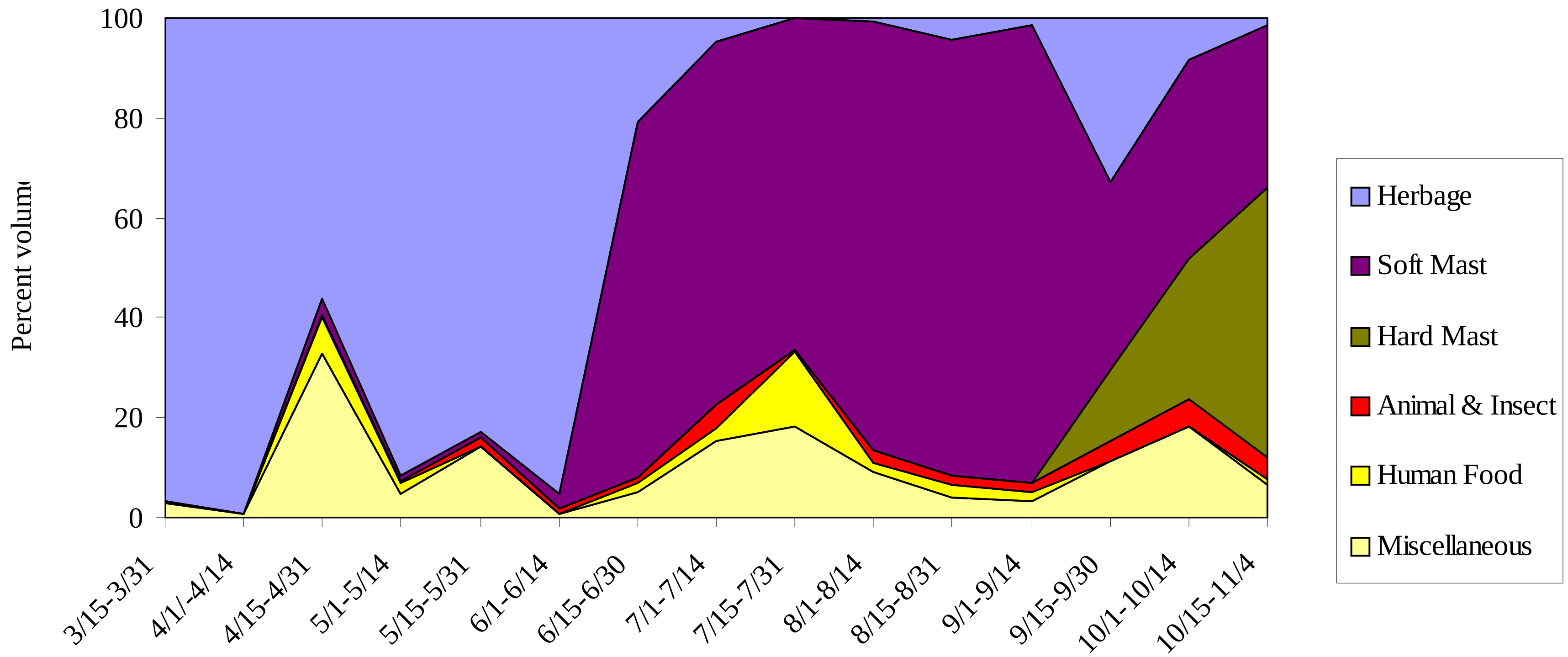

Figure 11. Percent volume of major food classes used by black bears by two week intervals 15 March - 4 November in Yosemite Valley, Yosemite National Park, California, 2001 and 2002.

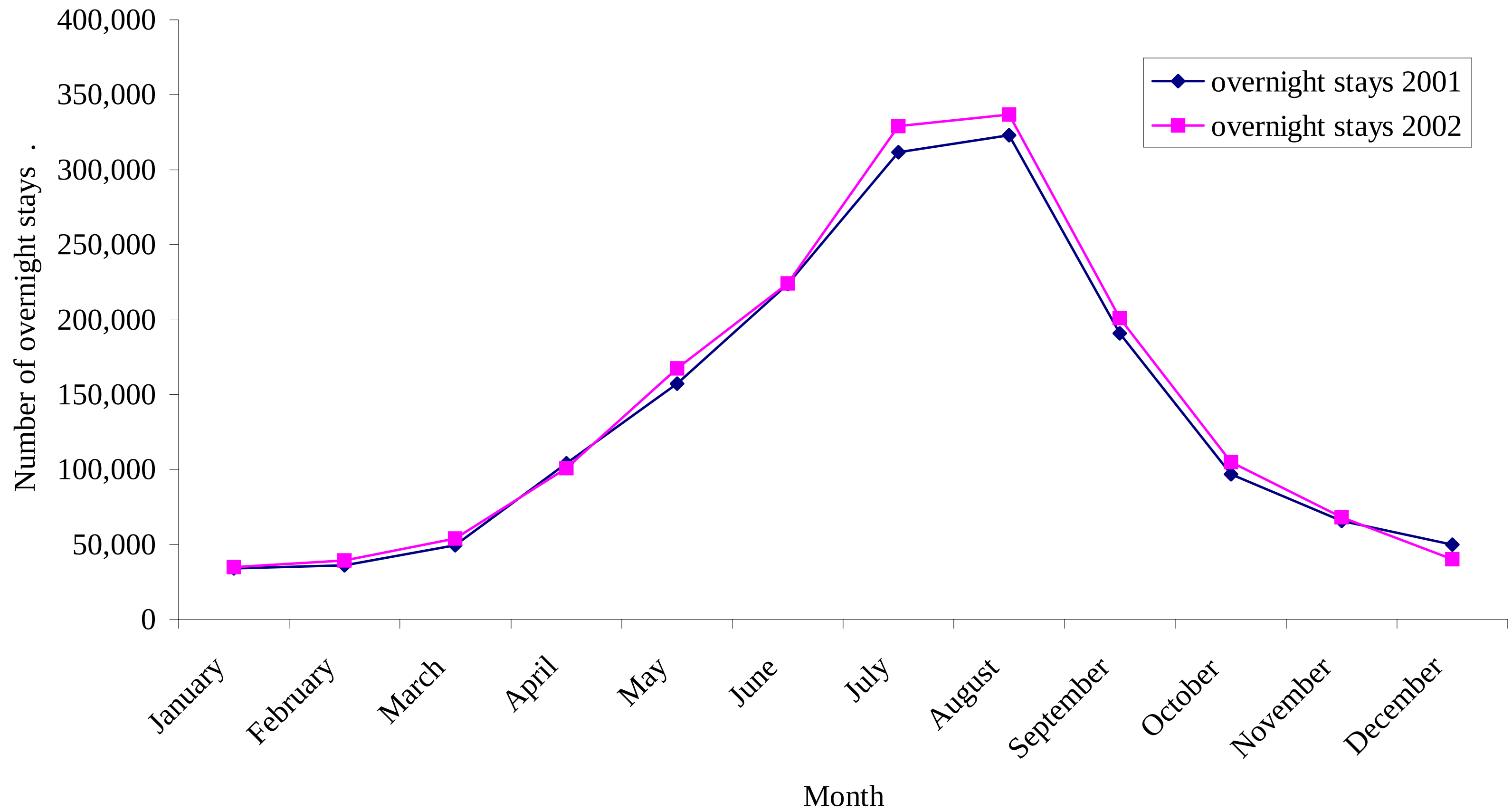

Figure 12. Visitation to Yosemite National Park by month, 2001 and 2002.

19.9% of samples and comprising 0.5 and 0.8% of total scat volume, respectively. However, the use of insects by bears nearly doubled in the fall. This finding was due to a high number of insects used in the fall of 2001. In 2002, for comparison, use of insects was relatively consistent throughout the summer and early fall.

Discussion

Our results indicate that reproductive plant parts, mainly from non-native flora, are the most important food source for bears foraging in YV, and that consumption of human food and garbage by black bears has decreased by more than 70% since the late 1970's. The current seasonal diet of black bears in YV is very similar to the findings reported for Yosemite (Graber 1981, Graber and White 1983) and other regions of North America (Beeman and Pelton 1980, Grenfell and Brody 1983, Hellgren and Vaughn 1989, Stubblefield 1993, Boileau et al. 1994).

Annual Diet Composition

Our finding that reproductive plant parts comprise the most important forage class for bears in YV is consistent with those of Graber and White (1983), who reported reproductive plant parts as the greatest contribution to bears' diets (41%) in regions below 1,800 m in elevation (Table 15). Graber (1981) reported similar results for YV specifically, where reproductive plant parts comprised 53% of bears' diets (Table 15).

Similar to our results, Graber and White (1983) reported use of manzanita berries, acorns, apples, and pears *(Pyrus* spp.) in YV, and pine nuts (*Pinus* spp.) and bitter cherries (*Prunus emarginata*) at higher elevations. Dogwoods, gooseberries, currants, blackberries, raspberries, thimbleberries, coffeeberries, western chokecherries, serviceberries (*Amelanchier* spp.), snowberries (*Symphoricarpos* sp.) and huckleberries and bilberries (*Vaccinum* spp.) were also reportedly found, but each comprised less than 1% of scat volume. The list of fruits represented

Table 15. The percent volume of food items in black bear scat samples collected in areas below 1,800m in elevation and in Yosemite Valley, Yosemite National Park, California, 1974 to 1978 (Graber 1981). Listed items within each category comprised at least 1% of total scat volume.

Item	Areas below 1,800m in elevation	Yosemite Valley
Herbage	35	17
Reproductive plant parts	41	53
Animal and Insect	3	2
Human Food	16	21

in our samples were similar to those found by Graber and White (1983), with the exception of pine nuts, bitter cherries, serviceberries, snowberries, huckleberries, and bilberries. Graber and White (1983) similarly reported use of yampah at elevations between 1,800 and 2,400 m in YNP and noted that the roots were an important source of starch for native Americans inhabiting Yosemite. Mealey (1980) also reported the use of yampah by bears in Yellowstone National Park. In agreement with our findings, Holcroft and Herrero (1991) report use of moss, but considered it to have been ingested incidentally.

Intensive use of fruits, nuts, and seeds as they became available has also been reported in black bear food habits studies in Pennsylvania (Bennett et al. 1943), Tennessee (Beeman and Pelton 1980), California (Grenfell and Brody 1983; Stubblefield 1993), Idaho (Beecham and Rohlman 1994), and Québec (Boileau et al. 1994). Considerable use of berries, especially *Rubus* species, was also reported in Alberta, Canada (Holcroft and Herrero 1991), and North Carolina (Hellgren and Vaughn 1989).

Apples were an important food item for bears in YV (Figure 13). The apple orchards provide consistent food for bears in close proximity to the developed areas of YV during peak human visitation. Not surprisingly, bears have frequented the orchards of YV for decades (Beatty 1943). Similar to the open-pit dumps of the nineteenth and twentieth centuries, the apple orchards may be serving as sites for habituation of YNP's black bears, by providing a unique opportunity for park visitors and employees to view bears foraging (Beatty 1943, Graber and White 1983). Other researchers have documented bears making consistent use of "wild" trees, abandoned, and maintained orchards, more often during years when native bear foods are in short supply (Bennett et al. 1943, Mattson 1990).

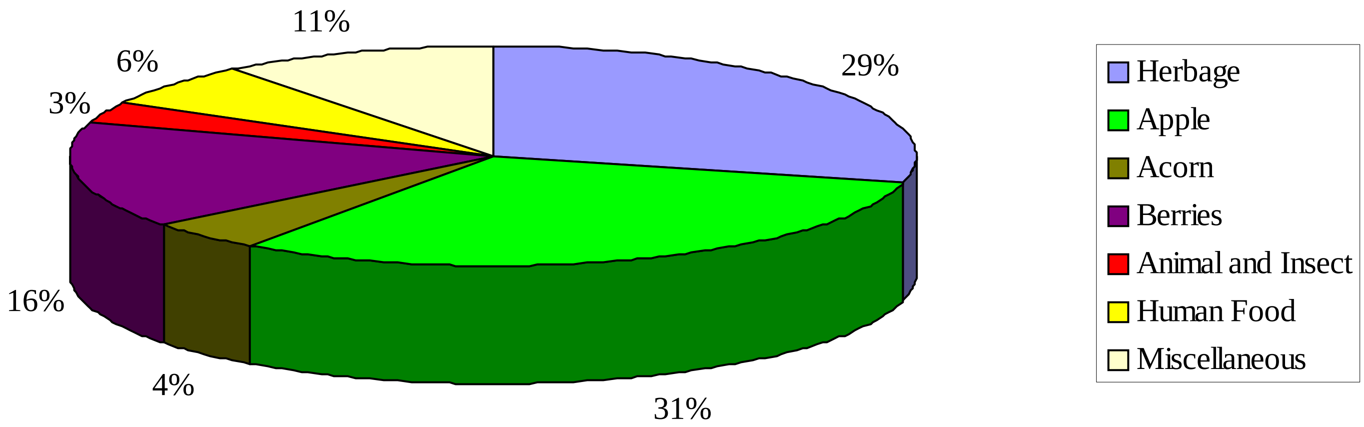

Figure 13. Average percent composition of food items in black bear diets in Yosemite Valley, Yosemite National Park, California, 2001-2002.

It is important to note that these data reflect bears' use of apples only while bears are present in YV. Since scat samples were only collected from areas within the Valley, our results do not depict the overall diets of bears that also forage outside of YV. Furthermore, our results may, in part, reflect researcher bias in collection efforts. Although collection efforts remained constant throughout all areas of YV, the orchards yielded high numbers of samples during the period when apples were ripe. Many bears frequented the orchards during this time (Matthews unpublished data), and fresh samples were easy to locate.

Bears' use of herbage in YV is consistent with food habits studies throughout North America, varying in species composition and depending on geographical location (Landers et al. 1979, Maehr and Brady 1984, Hellgren 1993). Our findings indicate that the composition and importance of herbage to bears' diets has changed little since Graber's work in the late 1970's (Table 15 and Table 16) (Graber 1981, Graber and White 1983).

In YV, Graber (1981) reported that human foods comprised an average of 21% of scat volume in comparison to our finding of 6% (Figure 14). These results suggest that bears are consuming about one-third the amount of anthropogenic foods as they were 25 years ago. Such a decrease in the amount of human food in bears' diets suggests that Park Service efforts to reduce the availability of human food to bears have been effective.

Another gauge by which to measure the success of the YNP Human-Bear Management Plan is an analysis of the number of human-bear incidents in YV over time. Concurrent with a reduction in the amount of human food and garbage consumed, we would expect a decline in the number of human-bear incidents. Harms (1980) and Keay and Webb (1989) assessed incident numbers for the entire Park between 1974 and 1978, the period during which Graber (1981) and Graber and White (1983) collected their food habits data. Over these 5 years, human-bear

Table 16. The percent volume and percent frequency of occurrence of food items found in black bear scats (n=1,404) collected in Yosemite National Park, California, 1974 to 1978 (Graber 1981). Listed items within each category comprised at least 1% of total scat volume.

	Spring (n=420)		Summer (n=897)		Fall (n=81)		Annually (n=1,404)	
Item	% vol.	% freq.	% vol.	% freq.	% vol.	% freq.	% vol.	% freq.
Reproductive plant parts	15	46	21	47	64	89	22	49
Arctostaphylos spp.	5	17	9	22	11	25	7	18
Acorns	9	13	4	7	11	17	6	9
Apples and Pears	<1	1	3	4	25	30	3	5
Pinus spp.	<1	1	1	2	7	17	1	3
Prunus emaringata	<1	1	2	4	5	14	1	4
Herbage	65	85	51	68	12	33	53	71
Grasses, sedges, rushes	43	70	35	58	10	30	36	60
Forbs	11	25	12	26	2	7	11	25
Animal matter	4	43	5	46	5	43	5	44
Insects	2	32	3	35	1	25	2	33
Other animals	2	9	2	9	3	18	2	10
Human-provided foods	11	29	17	31	9	21	15	30
Debris	3	30	5	29	9	27	5	29
Unidentified matter	1	2	1	2	3	5	1	2

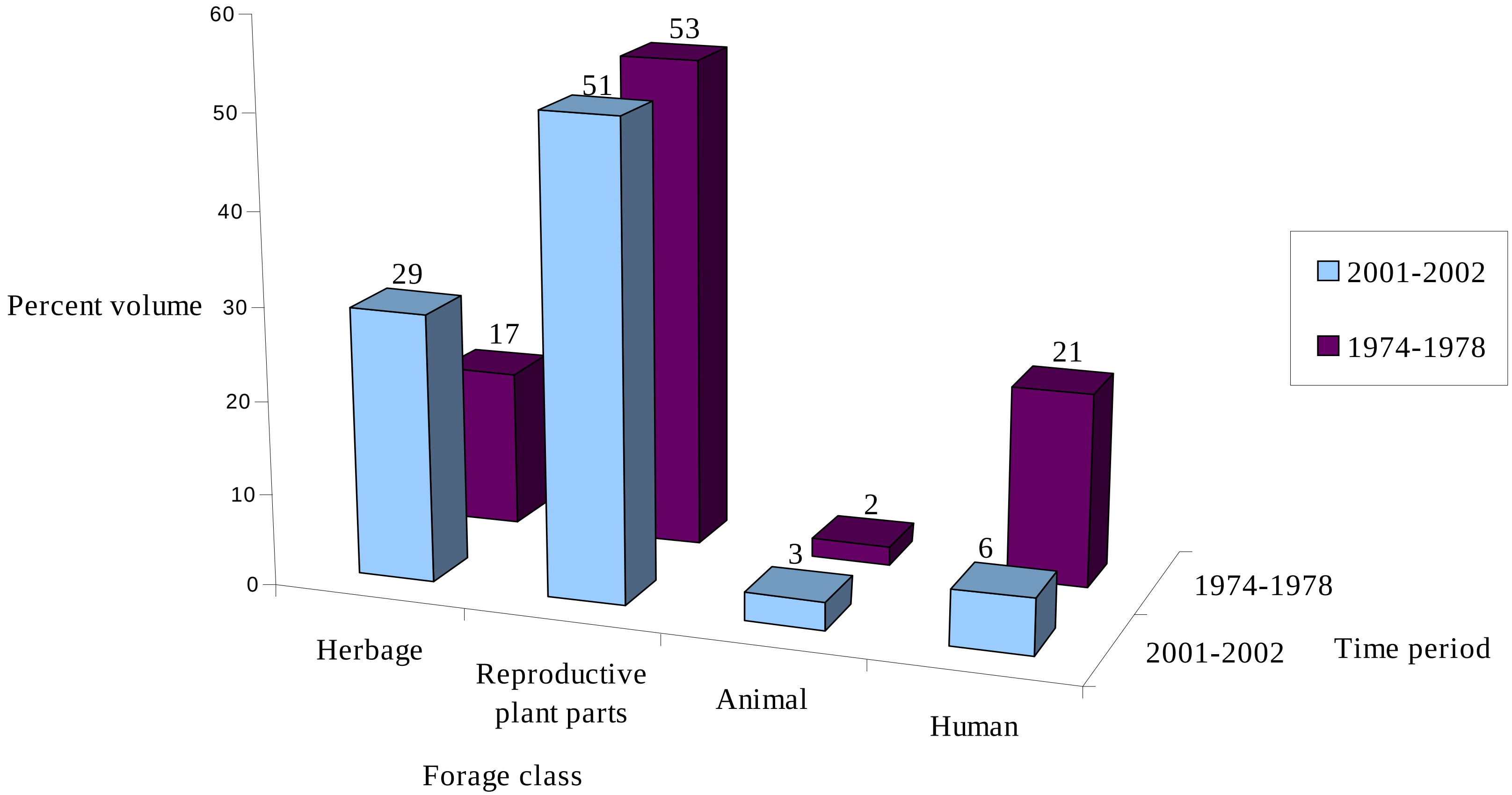

Figure 14 Percent volume of black bear food items in Yosemite Valley, Yosemite National Park, California, 1974-78 and 2001-02.

incidents averaged 683 per year Parkwide. Matthews (unpublished data) assessed human-bear incident numbers for the entire Park and YV during 2001-02. For these two years, incident numbers averaged 395 for the entire Park and 263 per year in YV.

Such a decrease in human-bear incident numbers may be the result of greater funding directed at the bear program since 1999. In that year, Congress appropriated $500,000 annually to the YNP Bear-Management Plan with which to address much-needed staffing and equipment demands. Funds were used to staff additional bear-related positions, purchase and install food storage lockers, improve public information, and conduct research. An organization with representatives from each Park division and Park cooperators was also formed to coordinate the Human-Bear Management Program.

Longer-term monitoring is necessary to determine the continued success of the Human-Bear Management Plan. However, the reduction in the amount of human food and garbage consumed by bears and in the number of human-bear incidents recorded in 2001-2002 suggests that the plan has achieved some levels of success. Measures such as bear-proof trash cans, dumpsters, recycling cans, and food storage containers, as well as an intensive educational campaign may have contributed to this (Lackey in press). Additionally, YNP employs interpretive rangers to patrol campgrounds each night, law enforcement rangers to enforce food storage regulations, and 24-hour bear management patrols during the busiest summer months to respond to incidents and use aversive conditioning practices on bears in developed areas.

Human food and garbage has been documented as a large proportion of the diet of black bears in other locales, especially in areas of high human recreational use. Garbage made up 33% of the diet and was found in 55% of the scats of black bears in the San Gabriel Mountains of southern California (Stubblefield 1993). Beeman and Pelton (1980) and Grenfell and Brody

(1983) found garbage and other anthropogenic foods made up as much as 6 and 4% of the annual diet of black bears in the Great Smoky National Park and in the Tahoe National Forest, California, respectively.

Garbage consumption by bears was reported to be insignificant on study sites in Trinity and Placer counties in California (Sitton 1982) and in Florida (Maehr and Brady 1984), but made up 5-10% of the diet of bears on a site in Tulare County, California (Sitton 1982). No human food or garbage was reported in bear scat collected in northern California (Piekielek and Burton 1975), Big Bend National Park (McClinton et al. 1992, Hellgren 1993), southeastern North Carolina (Landers et al. 1979), northern or west-central New Mexico (Costello et al. 2001), northwestern Wyoming (Irwin and Hammond 1985), and Gaspésie Park in eastern Québec (Boileau et al. 1994). In comparison to YNP, these areas typically had smaller black bear populations and/or less human recreational pressure.

Our findings suggest that use of animal matter was similar to the findings of Graber and White (1983) (Table 15 and Table 16). Consistent with their results, we found the volume of insects almost equal to the volume of other animal matter consumed. However, both studies found that insects were present in nearly three times as many samples as other animals. Overall, wasps, ants, and termites made up the largest contribution of insect matter to the diets of bears in YV. Many food habits studies have reported colonial insects as the most common animal matter used by of black bears throughout North America (Hatler 1972, Landers et al. 1979, Grenfell and Brody 1983, Maehr and Brady 1984, Hellgren 1993, Beecham and Rohlman 1994, and Boileau et al. 1994). Ants, specifically, have been reported as the most common insect species eaten by bears in Texas (Hellgren 1993), North Carolina (Landers et al. 1979, Hellgren and Vaughn 1989), Virginia (Kasbohm et al. 1995), Minnesota (Noyce et al. 1997), Quebec (Boileau et al

1994), Yukon (MacHutchon 1989), Alberta (Holcroft and Herrero 1991), and California (Grenfell and Brody 1983). Graber and White (1983) also reported ants, especially carpenter ants, to be the most heavily used insect in YNP. In contrast, we found wasps (*Vespula* spp.) to be more common in bear scat in YV, in part due to high numbers consumed in fall 2001. Wasps have been known to show strong annual variation in population numbers (Graber and White 1983), and it is possible that 2001 was characterized by high numbers of wasps in YV. Beeman and Pelton (1980) also found greater numbers of wasps than any other insects in bears' diets in the Great Smoky Mountains of Tennessee.

Bull et al. (2001) hypothesized that bears in Oregon consumed more insects to compensate for a shortage in fruit during one year of their study, and suggested that insects provided a compensatory food source when other resources were scarce. Likewise, Beecham and Rohlman (1994) found insects to be most important to bears during drought years. The relatively lower number of ants in our scat samples may be due to the abundance of other food sources in YV. YV is known to provide excellent bear habitat and was characterized by an abundance of herbaceous matter, soft mast, and acorns during the two years of our study.

Seasonal Diet Composition

Our results for seasonal diet composition were consistent with the general food habits of black bears previously described in Yosemite (Graber 1981, Graber and White 1983), California (Stubblefield 1993), Arizona (LeCount et al. 1984), the Great Smoky Mountains National Park (Beeman and Pelton 1980, Eagle and Pelton 1983), the Adirondacks of New York (Costello 1992), North Carolina (Landers et al 1979, Hellgren and Vaughan 1989, Hellgren 1993), Idaho (Beecham and Rohlman 1994), Virginia (Kasbohm et al. 1995), Florida (Roof 1997), and Québec (Boileau et al. 1994).

In general, the diet of black bears in YV was dominated by graminoids and other herbaceous matter in the spring, soft mast in the summer, hard mast in the fall, and animal matter and anthropogenic foods throughout the foraging season. These results were consistent with the seasonal food habits of black bears throughout North America. Other researchers found that herbaceous matter made up the majority of bears' diets in spring (Grenfell and Brody 1983, Hellgren and Vaughan 1989, Costello 1992, Boileau et al. 1994). Soft mast including reproductive plant parts, such as berries and fruits, dominated summer diets (Grenfell and Brody 1983, Boileau et al. 1994). Hard mast including acorns, beechnuts (*Fagus grandofolia*), saw palmetto (*Serenoa repens*), black gum (*Nyssa sylvatica*), and hickory (*Carya* spp.) comprised the majority of foods eaten during the fall (Landers et al. 1979, Beeman and Pelton 1980, Grenfell and Brody 1983, Maehr and Brady 1984, Hellgren and Vaughn 1989).

In YV, the predominance of apples in bears' diets during the late summer and early fall periods is of interest, reflecting the abundance of this non-native species. Coinciding with bears' hyperphagia period, the ripening of apples in YV appeared to offer bears a reliable and concentrated food source obtained without a major investment in foraging time. We also found manzanita to be an important fruit eaten in the late summer, similar to the findings of several other California studies (Graber and White 1983, Grenfell and Brody 1983, Stubblefield 1993). Manzanita appeared to be eaten in all stages of its phenology, as seeds appeared in scat in the early spring before berries were ripe. Bears may either have eaten unripe berries early in the season, fed on dried berries from the previous year (Grenfell and Brody 1983), or been targeting the leaves of the plants. We found that bears in YV used coffeeberry exclusively in the fall, as did Stubblefield (1993) in southern California.

The percent frequency of occurrence of human food and garbage was highest in the diets of bears in the summer months and lowest in the spring after den emergence. These results were consistent with visitation numbers to YNP and the number of overnight visitors to YV (Figure 12) (National Park Service Public Use Statistics Office www.aqd.nps.gov/stats). Our results were consistent with those of Grenfell and Brody (1983) who reported garbage consumption to be high during summer months in the Sierras, coinciding with frequent bear disturbances in campgrounds. Beeman and Pelton (1980) also reported anthropogenic food consumption by bears was correlated with visitor use of Great Smoky Mountains National Park.

We found animal matter, other than insects, was used fairly consistently throughout the year. These findings were consistent with the seasonal use of animals in Tennessee (Eagle and Pelton 1983), Oregon (Bull et al. 2001), Wyoming (Irwin and Hammond 1985), North Carolina (Landers et al. 1979), and the Yukon (MacHutchon 1989). Our results indicate that insects, specifically, were consumed least in the spring and with increasing frequency and in greater volumes in the summer and fall. These findings were not consistent with those of Graber and White (1983), who reported a steady use of insects throughout the year (Table 14 and Table 15).

Our analysis of the use of insects by bears in YV was influenced by data from a single year. Bears made greater use of wasps in the fall of 2001 compared to 2002. As a result, our findings for 2002 indicate more consistent use of insects across seasons than for the two years combined. Wasp population numbers may have been cycling high in 2001 making them abundant for consumption by bears during that year (S. Thompson, National Park Service, personal communication). Wasps were reportedly used most intensively during the late summer and fall seasons in Florida (Maehr and Brady 1984), Tennessee (Beeman and Pelton 1980), Virginia (Kasbohm et al. 1995), North Carolina (Landers et al. 1979), Alaska (Hatler 1972), Alberta

(Holcroft and Herrero 1991), Wyoming (Irwin and Hammond 1985), and California (Grenfell and Brody 1983).

Recommendations

Based on our findings of black bear food habits in YV, we offer the following recommendations in support of YNP efforts to reduce the number of human-bear conflicts in YV and ensure the long-term survival of wild bear populations in YNP.

Apples from the three historic orchards and other trees located throughout YV were an important food source for bears from mid-June until the end of September. YNP receives approximately 58% of its annual human visitation during this period (National Park Service Public Use Statistics Office www.aqd.nps.gov/stats). The apple orchards provide a food source for bears in close proximity to the developed areas of YV and serve as potential sites for habituation. If the goals of YNP are to continue to reduce human-bear interactions, we recommend that YNP proceed with the goals of the Yosemite Valley Plan to remove the historic Curry Orchard (National Park Service 2000). Similarly, trees should be incrementally removed from the Lamons and Hutchings Orchards. The current Yosemite Valley Plan calls for the retention and management of Lamons Orchard in order to preserve it as an historic and cultural resource. Hutchings Orchard will also be retained, but not managed. Of the three orchards mentioned in the Valley Plan, Curry Orchard is the most egregious because it also serves as a parking lot. Therefore, its removal should be of highest priority. Although Lamons and Hutchings Orchards are not developed, their proximity to developed areas and high levels of human use could be attracting bears to YV and contributing to habituation and human-bear conflicts.

Historically, immediate and complete removals of non-native food sources have been followed by increases in the number of human-bear conflicts in Yosemite (Beatty 1943) and Yellowstone (Craighead et al. 1974, Knight and Eberhardt 1985) National Parks. Thus, a gradual reduction in the availability of apples through the immediate removal of the Curry Orchard and the incremental removal of trees from Lamons and Hutchings Orchards would allow for a more gradual transition for bears from apples to alternate, natural food sources. Enforcement of food storage regulations and aversive conditioning will be critical, following the removal of Curry Orchard, as bears accustomed to foraging on apples seek out alternate food sources.

If the goal to reduce human-bear conflict cannot be achieved through gradual reduction of all orchards, we recommend continued proactive management of the orchards. Current orchard management practices include the mechanical removal of mature fruit from trees using aerial trucks, ladders, and rakes. The fruit is collected off the ground and disposed of in bear-proof dumpsters. These efforts should continue in order to minimize the impacts of the orchards on bear activity and foraging behavior, as called for in the Yosemite Valley Plan. In addition, the management of the orchards should include efforts to minimize bears' exposure to human presence by regulating access to the orchards and providing interpretive opportunities.

Finally, we recommend continued vigilance in implementing management strategies, in conjunction with research and monitoring to measure the success of YNP efforts. Our results indicate that current practices are effective in reducing the amount of human food and garbage available to bears in YV. YNP managers should continue to adapt and improve their management tools to address changing circumstances. Management efforts should focus on constantly upgrading proactive educational campaigns aimed at visitors and employees alike

(Lackey and Ham 2003, Lackey in press), strict enforcement of food storage regulations, waste management practices, and continued investigation of bear food habits in YV. Continued assessments of the diets and foraging behavior of bears will assure the best management practices aimed at reducing human-black bear conflicts and ensuring wild bear populations in YNP.

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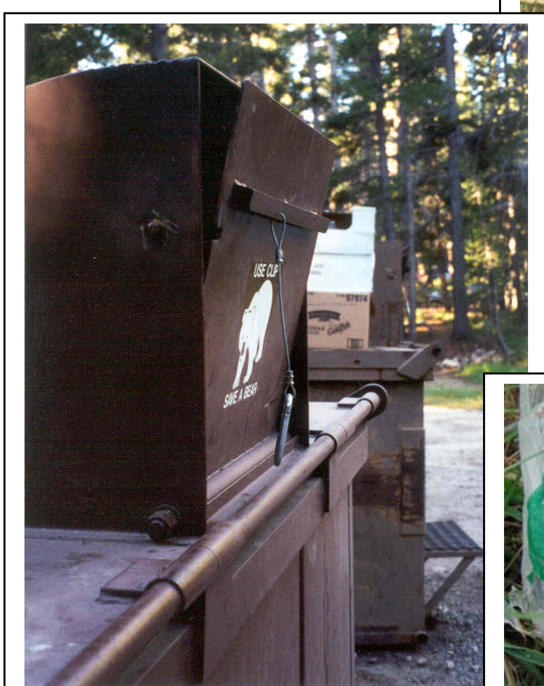
Sources of edible garbage available to wildlife from trash and recycling units in Yosemite Valley, Yosemite National Park, CA 2001

National Park Service

National Park Service



National Park Service

Wildlife Conservation Society

Human-recreational pressure has resulted alterations in the ecology of wildlife populations and increases in human-wildlife conflicts. The relationship between recreational pressure and wildlife is of particular concern in the heavily used park systems of North America. One of the most vexing relationships has been between the presence of garbage and its use by bear populations. Edible garbage has been documented as an important food source for a number of bear populations and served as an attractant to urban and other developed areas (Barnes and Bray 1967, Payne 1978, Craighead et al. 1995, Beckmann and Berger 2003). Edible garbage is a high quality food that has attributed to differences in weights and productivity among individual bears and populations (Rogers 1987, Stringham 1986, Mattson et al. 1987, Keay 1995).

Managers in Yosemite National Park (hereafter YNP) have addressed the use of edible garbage by park wildlife by closing all of the garbage dumps in YNP by 1971 (National Park Service 2003). Additional efforts have involved the "bear-proofing" of all the trash and recycling containers in YNP using a mailbox-drop system (Figure 15). The largest concentration of trash and recycling units in YNP is in Yosemite Valley (hereafter YV), with 723 containers to serve the over 3 million annual visitors (Keay and Webb 1989, National Park Service Public Use Statistics Office www.aqd.nps.gov/stats). Despite "bear-proofing" these containers, human failure to use containers correctly result in the availability of edible garbage by wildlife and provide an attractant for wildlife to developed areas.

Our objectives were to identify areas of consistent edible garbage availability and the sources of human error resulting in the availability of edible garbage to bears and other wildlife from trash and recycling units. Identification of these areas and sources of human error assisted YNP managers in targeting areas to increase collection efforts and/or provide additional

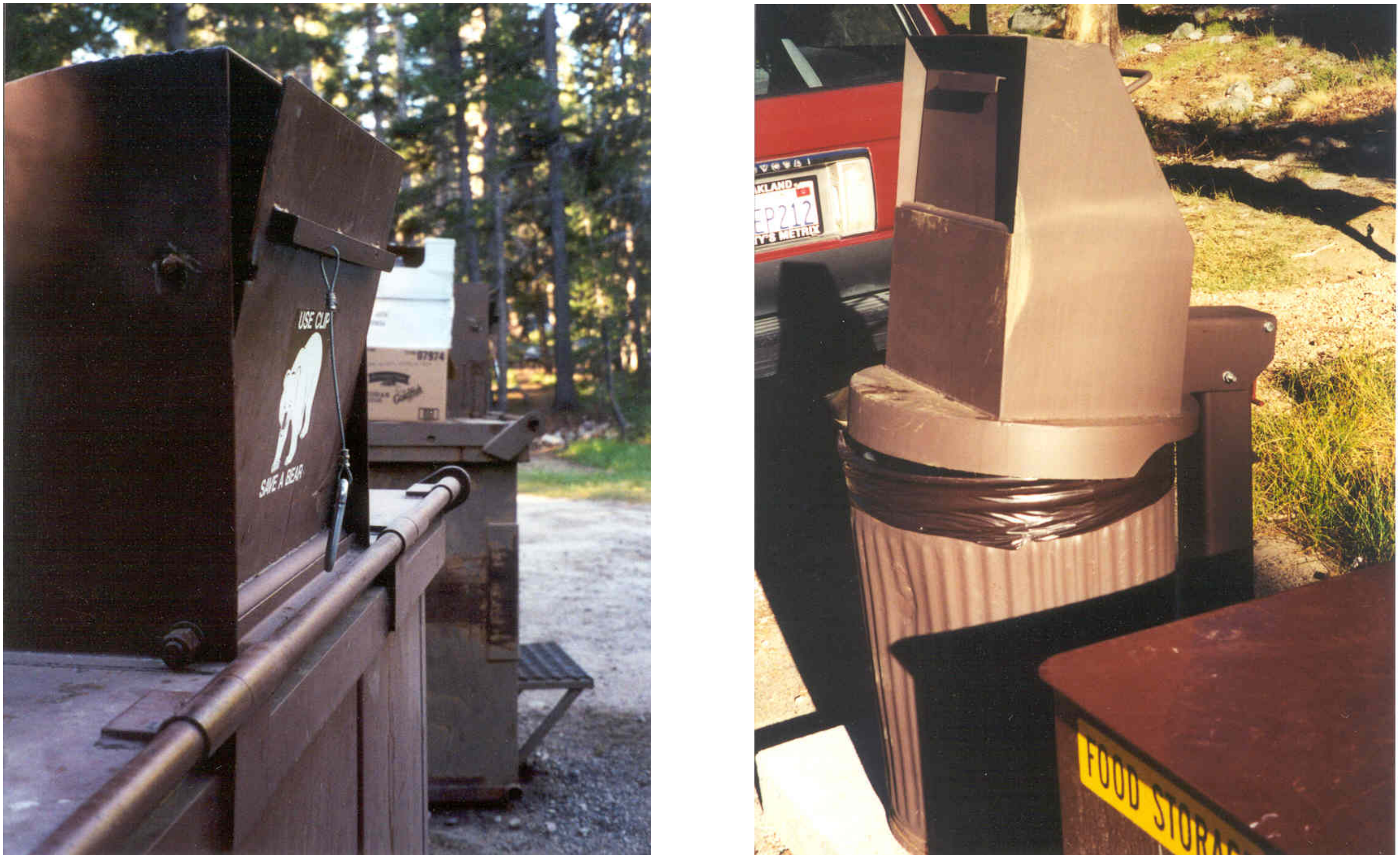


Figure 15. Mailbox-drop system on a dumpster and trash can in Yosemite Valley, Yosemite National Park, California.

containers. We also provided recommendations on methods to reduce human errors resulting in the availability of garbage to bears from trash and recycling containers. Our recommendations will become part of the ongoing efforts to reduce the attractiveness of developed areas to bears and the number of human-bear conflicts in YNP.

Methods

We conducted a pilot study during the summer of 2000 to assess methods to use to identify problems associated with trash and recycling units in YV. We inventoried and mapped all trash and recycling containers throughout National Park Service (hereafter NPS) and park concessionaire administered areas of YV. We used visual surveys to identify containers and the reason(s) why edible garbage was available to wildlife. Survey efforts were conducted from 29 June to 28 July 2000 between the hours of 0600 and 0800 and between 1800 and dusk.

We conducted a more thorough inventory of trash and recycling units during the summer of 2001. We mapped the location of each unit in a geographic information system (GIS, Figure 16). Visual surveys were conducted from 16 July to 30 September 2001. Efforts were made to survey locations on several different days of the week at varying of times of day. Based on our findings from the pilot study, we documented problem(s) resulting in the availability of garbage to wildlife for each container during our surveys. Problems included container (1) overflowing or trash around the base, (2) unlatched or unclipped, (3) broken, (4) cardboard boxes around base, (5) non-“bear-proof” container left out after dark, (6) non-“bear-proof” dumpster with food trash.

The placement of cardboard boxes around a container was identified as a concern because food trash was observed placed in the cardboard boxes around containers and thus accessible to wildlife. Non-“bear proof” containers were used in areas of high visitor use and an

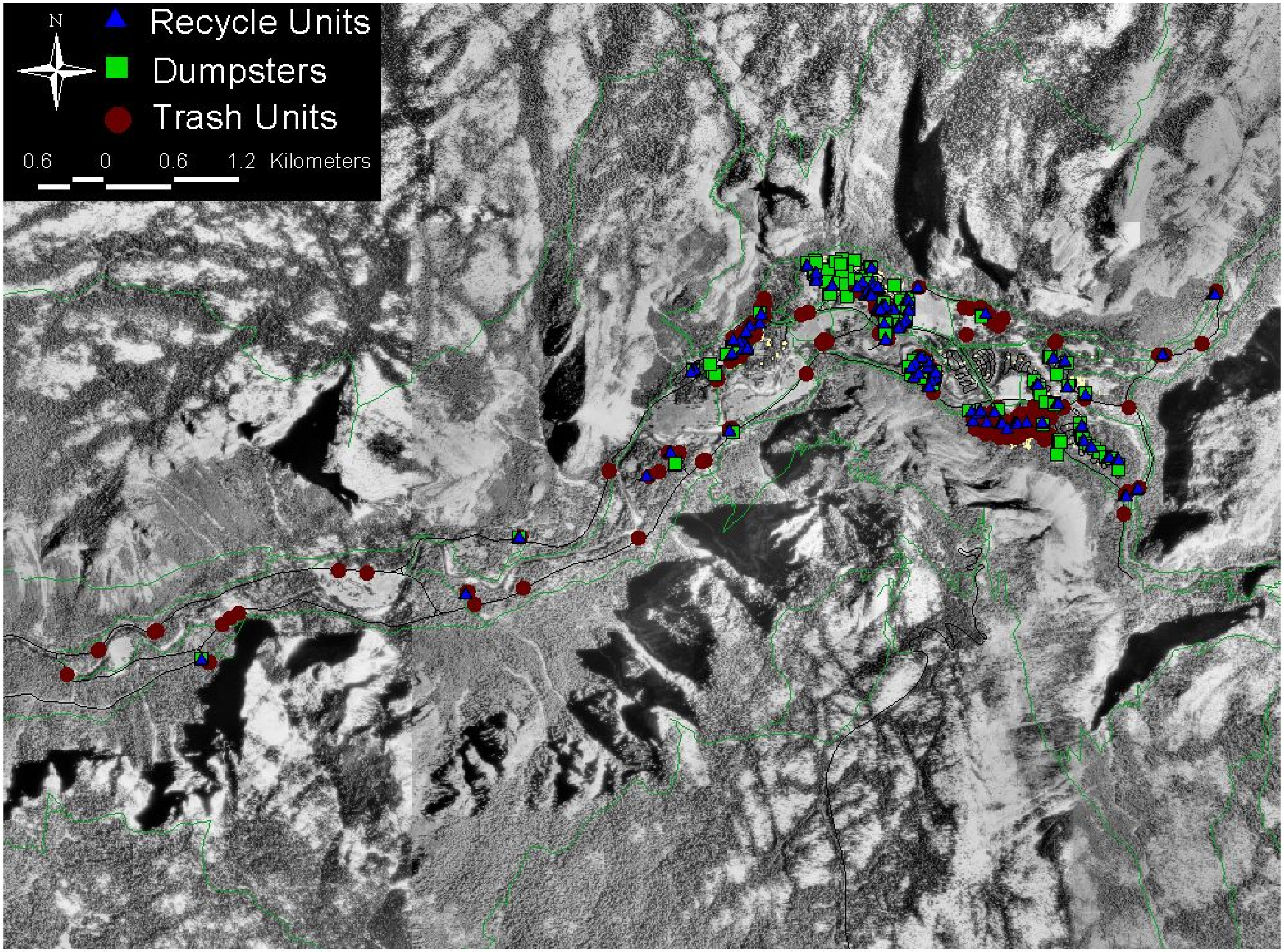


Figure 16. Locations of recycle, trash and dumpster containers in Yosemite Valley, Yosemite National Park, California, summer 2001.

abundant levels of food trash. These units were supposed to be secured inside buildings after dark to prevent garbage being accessible to bears. Non-"bear-proof" dumpsters were used in construction areas for non-food trash. These dumpsters were identified as a concern because food trash was occasionally found in them and thus accessible to wildlife.

We also compiled data collected by NPS employees who documented garbage problems in their nightly patrol logs. This included employees from wildlife management, campgrounds, interpretation, maintenance, and concessions management. These data were collected concurrently with our survey efforts. The NPS and our survey data were combined for our final analyses.

We calculated the probability of a problem being observed on any given day by dividing the number of survey days a problem was observed by the total number of survey days at each location. We used these probabilities to identify areas of particular concern. We calculated the average number of problems recorded at each location during a survey. We determined which type of problems were the most common and identified potential solutions.

Results

A total of 1,786 problems were found with trash and recycling containers. Problems were documented in NPS and concessionaire administered campgrounds, lodging facilities, employee residential areas, parking areas, picnic areas, and visitor center areas (Figure 17 - Figure 20). Trash cans in Curry Village Tent Camp were of particular concern, with a problem documented on every survey. Recycling cans in Curry Village Tent Camp and YCS residential areas, and dumpsters in NPS residential areas were also found with comparatively high probabilities of problems (Figure 17).

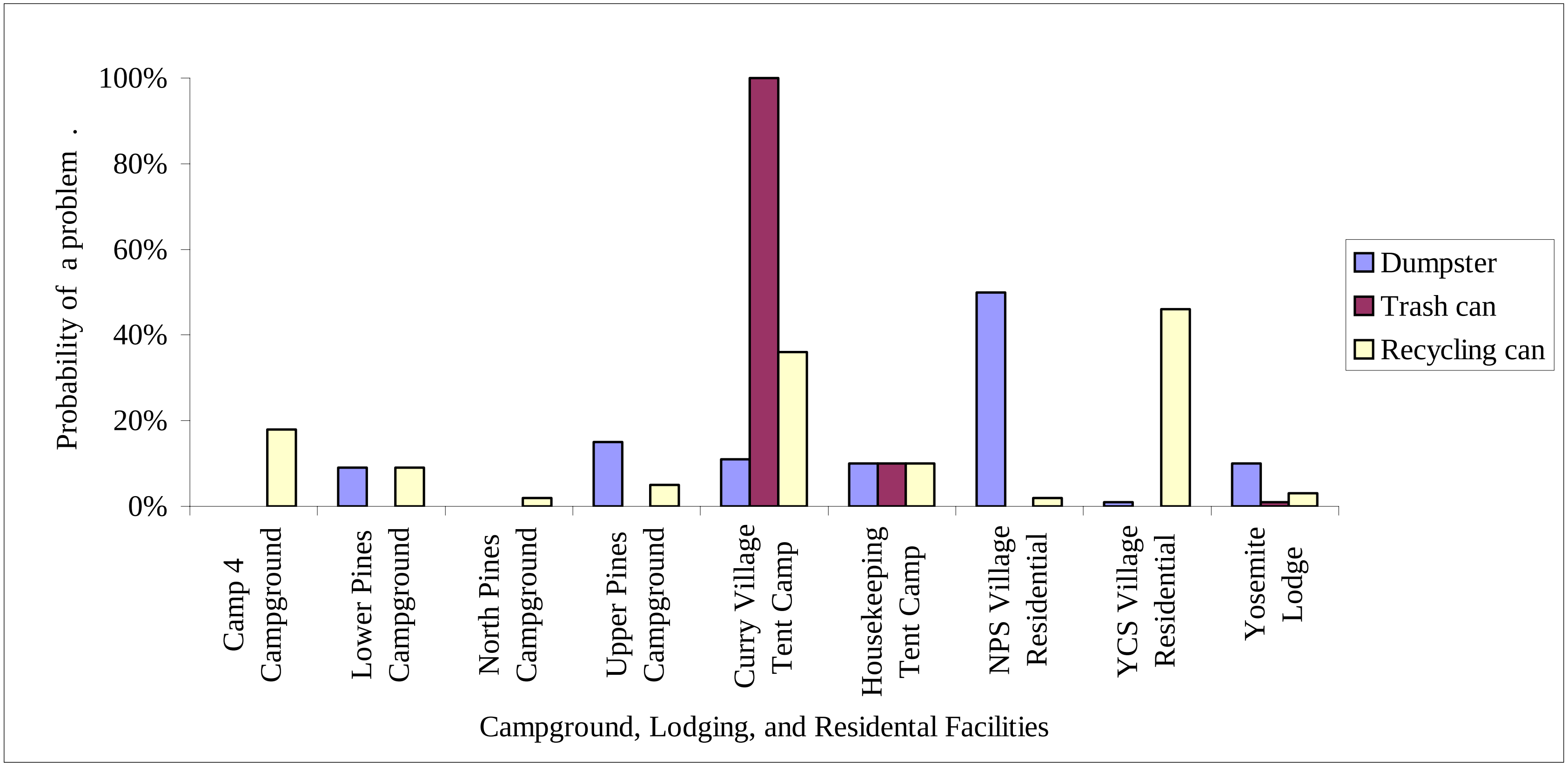


Figure 17. The probability of a problem being documented during a survey in campground, lodging, and residential facilities in Yosemite Valley, Yosemite National Park, California, summer 2001.

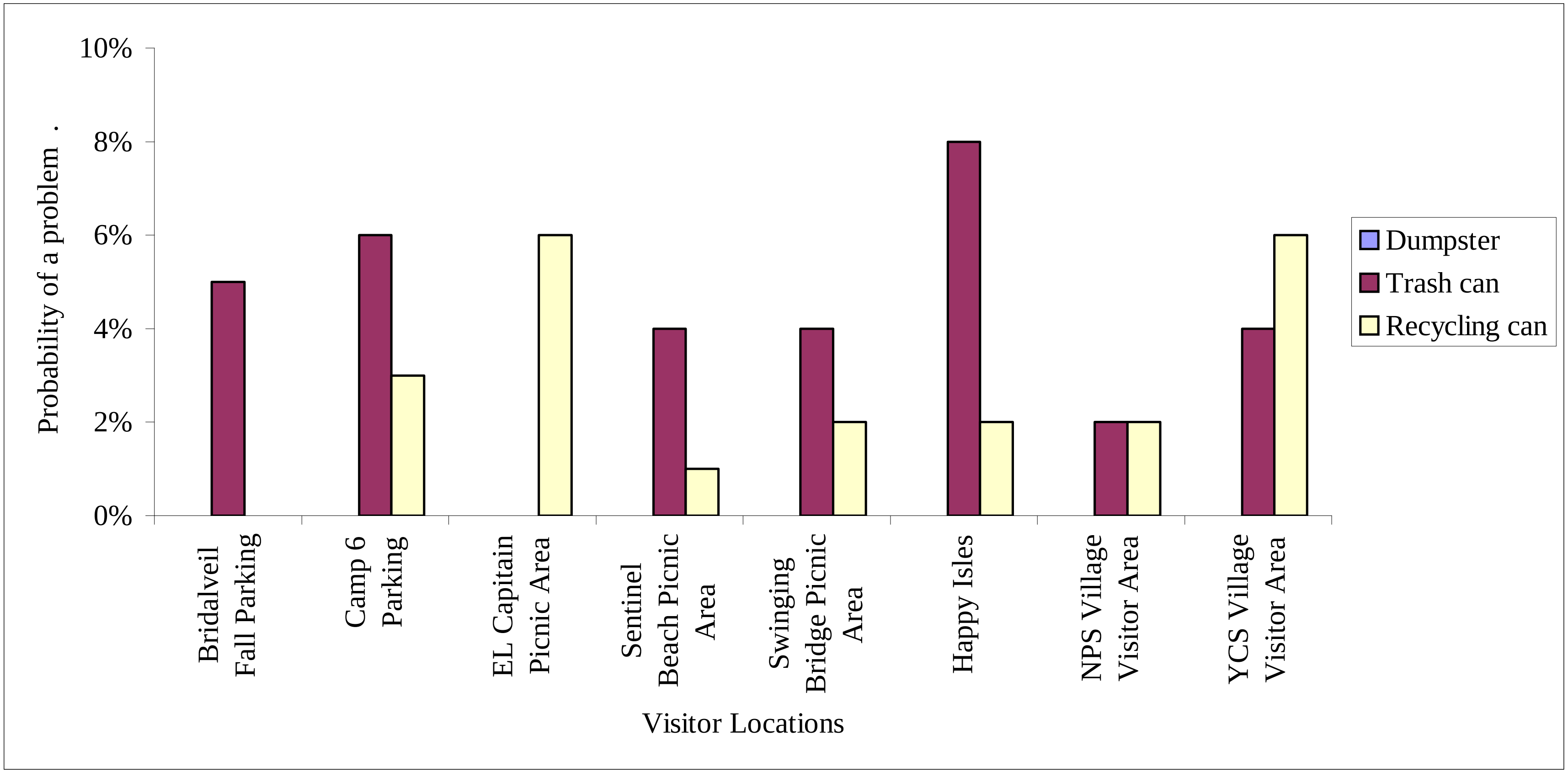


Figure 18. The probability of a problem being documented during a survey in parking areas, picnic areas, and visitor center areas in Yosemite Valley, Yosemite National Park, California, summer 2001.

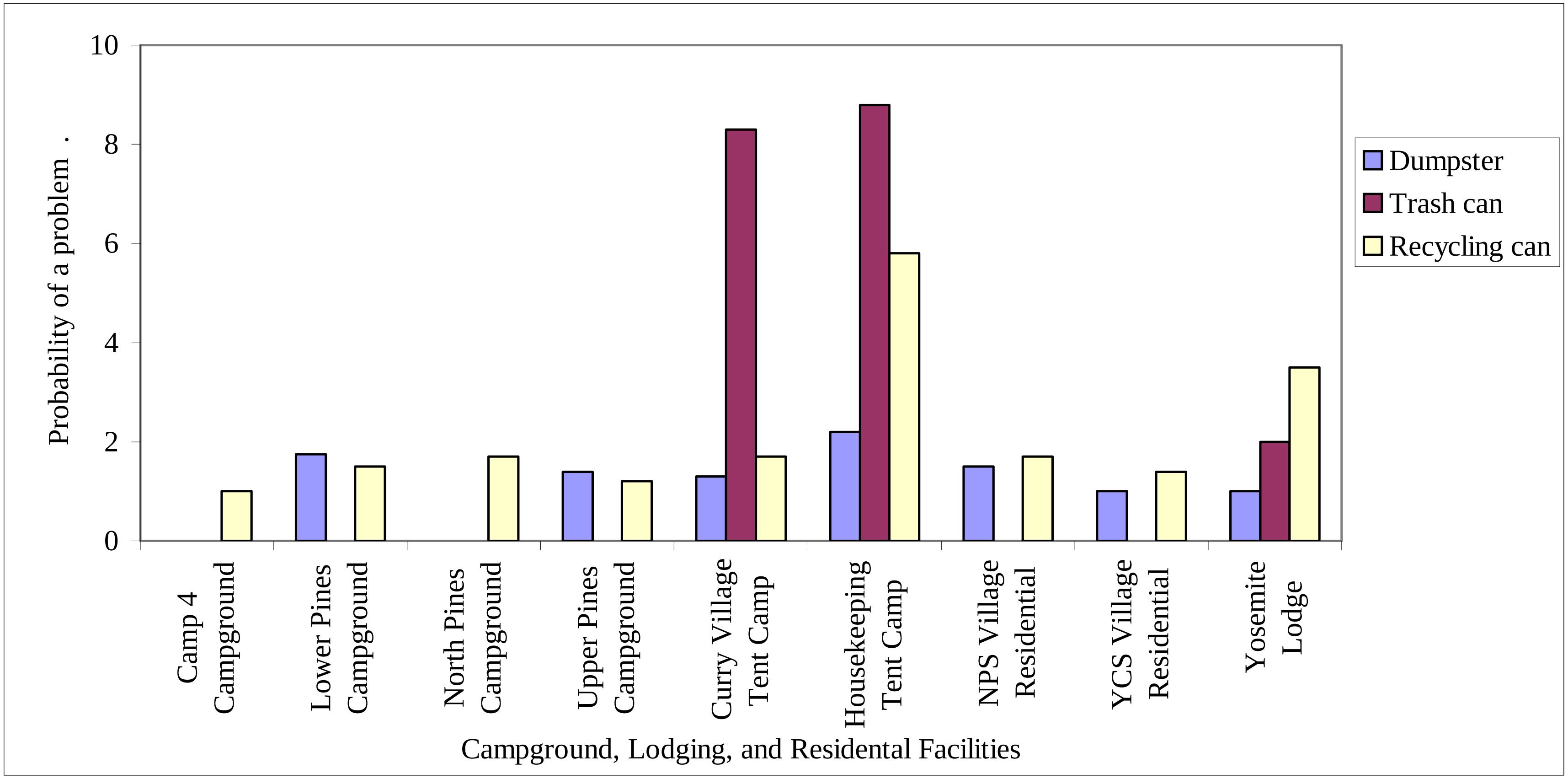


Figure 19. The average number of problems documented during a survey when a problem was found in campground, lodging, and residential facilities in Yosemite Valley, Yosemite National Park, California, summer 2001.

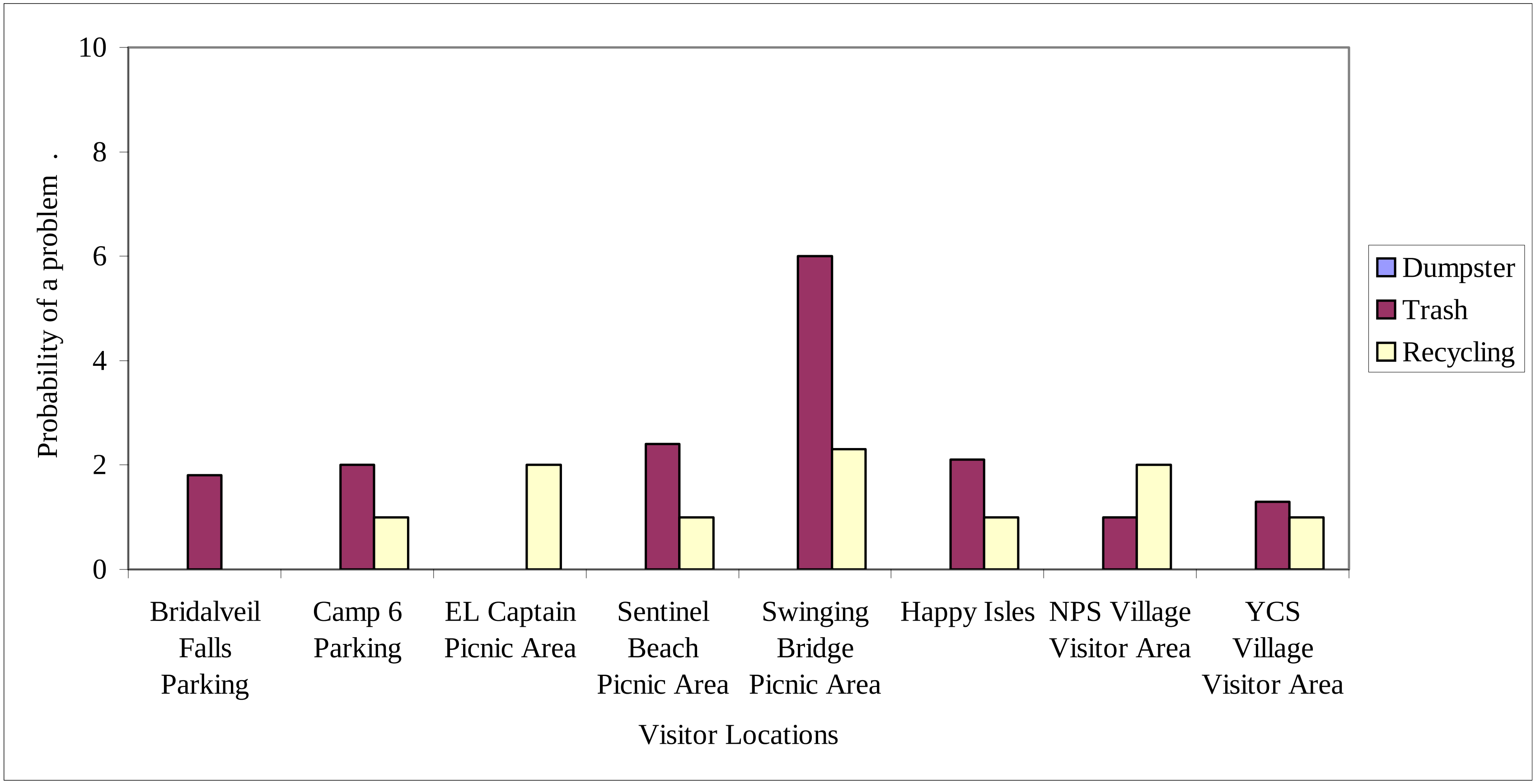


Figure 20. The average number of problems documented during a survey when a problem was found in parking areas, picnic areas, and visitor center areas in Yosemite Valley, Yosemite National Park, California, summer 2001.

Fifty-five percent of the documented problems were containers that were overflowing or contained trash around base. The most common areas for this type of problem were in Curry Village Tent Camp, Housekeeping Tent Camp, Upper Pines Campground, YCS village residential/administrative areas and Swinging Bridge picnic area. Forty-one percent of the documented problems were unclipped or unlatched containers. The majority of unlatched or unclipped containers were dumpsters found at the back dock of service areas. Other common areas for unlatched or unclipped containers were at NPS campgrounds and Housekeeping tent camp.

Less than 5% of the documented problems were broken containers, containers with cardboard around base, non-“bear-proof” containers left out after dark, and non-“bear-proof” dumpsters with food trash, combined. Of these documented problems, non-“bear-proof” containers left out after dark were of concern at Curry Village Tent Camp because of the amount of garbage these containers made available to bears.

Recommendations

Our results identify areas and reasons of edible garbage availability to wildlife. Efforts should be made to increase the frequency of pickup or provide additional containers in areas where overflowing containers were consistently found. This is especially true for glass and plastic recycling containers, which were the recycling containers most often found overflowing or with recycling around base. Efforts should also be made to encourage employees to properly secure trash and recycling containers when the units are emptied and to clip dumpsters in back dock areas. Efforts should also be made to continue and standardize data collection methods of monitoring problems with trash and recycling containers in YV. Attempts to combine our survey data and data collected by NPS staff proved problematic because some areas were monitored more intensively than others and NPS data was not collected on an individual container basis. Monitoring on an individual container basis would be helpful to identify containers with consistent problems. This will assist in continuing to identify problem areas which should be collected more frequently or have additional containers installed. Monitoring on an individual container will also help to identify containers which receive little or no use, which could be moved to higher use areas.

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Evaluation of "Bear-Proof" Food-Storage Containers in Yosemite National Park

Wildlife Conservation Society

National Park Service

National Park Service

National Park Service

Project Goals
1. Locate and inspect each type of bear box in the Park.
2. Assess each type for functionality and "user-friendliness".
3. Evaluate the new prototype bear boxes.
4. Record observations of boxes in use and make recommendations for improvements, if any.

Project Methods
1. Conduct direct observation of box construction and function.
2. Observe campers using boxes.
3. Interview campers and park personnel.

Overview
Bear boxes are provided for park campers to store their food out of the reach of bears. Bears that have gotten a taste for human food will go to great lengths to get it, including breaking into cars and buildings. Once bears have started eating human food regularly, they can sometimes become aggressive, which, unfortunately, can result in the necessity of them having to be killed for the protection of park visitors.

Over the years "bear boxes" have been developed to help keep bears and human food separated and break the cycle. These boxes need to meet several criteria:

1. They must keep bears, which are large and determined animals, from getting to human food. All current boxes are welded steel construction. Most are bolted to concrete pads.
2. The boxes must have an easy-to-operate, bear-proof latch. Latches range from simple spring clips to more elaborate "slam-to-shut" latches.
3. Having satisfied the first two criteria, the boxes should also be;
   a. Big enough for a large party to store several days food.
   b. Easily operated.
   c. Easily cleaned.
   d. Durable and long-lasting.
   e. Cost-effective.
   f. Field repairable.
   g. Safe to users, especially children.
   h. Easily installed and site-levelable.

Type and location of existing boxes

Types of Boxes	**Areas in Use**
Herrick with retrofit latch	Upper Pines Campground
	Lower Pines Campground
	North Pines Campground
	Backpacker's Campground
	Wilderness Parking Lot
	Yellow Pines Campground
	Housekeeping Campground
Gate Latch Boxes	Upper Pines Campground
Pop out Handle	Yellow Pines Campground
Old Foot Lockers	Yellow Pines Campground
	Curry Village
McClintock Boxes	Wawona Campground
	Horse Camp
Coin-operated Lockers	Curry Village
New BearSaver Box	Prototype at Wildlife Office
New BearSaver Key Locker	Prototype at Wildlife Office

Herrick with Retrofit

This is the “workhorse” bear box and by far the most common type of box in use in Yosemite National Park. The box itself measures 48 1/2” wide X 22 1/2” high and stands on legs that put the surface at 27” above ground level in most cases.

They are very robustly constructed. The box is made of simple slabs of heavy gauge steel plate which are welded together, rather than fabricated from lighter-gauge broken (folded) plate. This simple and stout construction allowed for later retrofitting of new latches when the need arose.

The top extends over the front doors, affording some measure of protection of the latch and the contents of the box from weather.

The latching system is effective but not slam-to-shut. It must be closed and then latched. They are padlockable, although that feature is rarely used. They are unventilated and not childproof. In the unlikely but not inconceivable event a child did get locked in, there is no panic hardware to get out.

These boxes have been cleverly retrofitted in some locations (including North Pines) with green and red reflective tape striping on the latching rod which allows for a one-glance “Latched/Unlatched” inspection by Park personnel at night with a flashlight.

Latched

Unlatched

Although these boxes have a relatively large opening of 18 3/4” X 45” several complaints were heard that they were not large enough to hold all the food some parties had brought, and that some of the newer large coolers would not fit into the box. They also can get extremely hot if located in the sun, as do all types of boxes.

Gate Latch Boxes

These are located only at Upper Pines and are scheduled to be replaced in the near future. They have two latches which must be closed and pinned individually. Free open area inside is 44” X 19” X 36”.

Pop-Out-Handle Boxes

These “Bearmaster” brand boxes are located at the Volunteer and Employee Campground at Yellow Pines. These are large double-door boxes with handles that are inserted over a rotating stud to latch. They are labeled with stickers explaining how the latch works.

“Footlockers”

These older boxes are still found at many locations in the Park. The latching system is a pair of simple spring catches such as might be found on a dog collar. These are relatively small boxes and one volunteer mentioned that bears can actually roll them over trying to get into them, but on the other hand, they are light enough that they can be lifted and are often seen in long-term camps sitting on top of a Herrick box, creating a serviceable “kitchen cabinet” setup.

McClintock “Hyd-A-Meal”

These are newer boxes, found only at Wawona Campground and Horse Camp, near Wawona. The latch is operated by tripping a lever that is concealed under a fixed steel cover on the right-hand door. It is assumed that this latch has been tested to be bear-proof, thought it is less obviously bear-proof than other existing latches. The latch is designed to be slam-to-latch, but that action worked better on one box than it did on another sample. This is a relatively large box with a free inside area of 20” X 34” X 41 1/2”,

The latch hardware is sturdy and appears to be panic-operable from inside. The latching mechanism is all exposed to view inside the door, which will likely facilitate maintenance over time. The doors have a cable which keeps them from being over-opened, a feature not seen on other models.

The particular box pictured is used for confiscated food items and has been retrofitted with a padlock hasp.

The opening of the door is 20 1/2” X 41 1/2”, which is taller but narrower than the Herricks. These boxes also sit on 14” legs, making them a little easier to use than a Herrick, for example. However, the top surface, at 37” above ground level does not serve the handy “tabletop” function as well as the Herricks do at 27”.

Coin-operated lockers

These smaller, stacked lockers are found only at Curry Village, where they appear to be in great demand. All of them were being used on the Tuesday they were observed. Although there were complaints that one has to put money in every time they are opened, the ability to lock up one's food and/or belongings seemed to be greatly appreciated.
Stacked lockers such as this should be secured to a building or otherwise anchored to prevent them from being tipped over by bears or people, the results of which could be traumatic.

Durability appears to be acceptable as all these boxes are still in good condition.

Placing them on a raised platform would improve the usability of the lower lockers.

Prototypes

There are two new "BearSaver" brand prototype boxes located at the Wildlife Office at the Park, one large new double-door model, and one key-operated locker.

Large BearSaver Box Prototype

This all-steel welded box has a smooth-finished exterior that looks attractive and should be easily cleanable. The large (28” High X 43” Wide X 36” Deep) opening should accommodate the largest coolers and the top surface is a good compromise at 33” above ground level.

The latch is designed to be slam-to-latch operation, but whether the relatively lightweight spring-loaded plunger latches have been tested in real world conditions of rain and snow, freezing and thawing, and spilled food is unknown. The latch is actuated by a hanging, but permanently attached stainless steel handle. Operation is simple, but not intuitively obvious.(These latches should be closely compared in this regard with the latch on the McClintock boxes, which are quite robust and self-explanatory. They should also be compared with the McClintocks from the point of view of these latches having non-visible parts, which may not contribute to easy maintenance.) There is escape hardware inside the Bearsaver box.

The doors appear to be of somewhat lightweight construction and there have been reports of doors bending and failing in another park location. This could potentially be improved by using a heavier gauge steel in the door, and possibly by the addition of a steel reinforcing bar on the inside of the door. The addition of cable “stops” as seen on the McClintock would prevent the door from being over-extended and bent. One has to imagine kids swinging on doors or cars backing into them over their years-long service.

This prototype has a food hanger device inside that will probably be used very little. Possibly this detail could be eliminated to offset the additional cost of sturdier doors.

Extending the top of the box out over the doors as seen on the Herricks would help keep rain, snow, and spills out of the door hardware and box interior.

Recommendations

Other possible improvements to these prototypes or any proposed box include:

1. More ventilation to keep heat under control.
2. Double-top design would also help heat problem.
3. Light colored interior to make contents more visible.
4. Built-in reflective open/closed indicator (see Herrick description).
5. Padlockability.
6. The box surface could be used as a place to print a Park Map, checkerboard or cribbage board, or bird and wildlife ID pictures.
7. Possibly a sliding sign indicating “Taken/Vacant” could be added.
8. Built-in levelling devices for installing on non-level surfaces.
9. Make a demo model of the latching system for educating campers at the kiosk when they first enter the campground, especially for campers entering a campground when the kiosk is closed
10. Begin a padlock rental or padlock deposit/loan system. Then, padlocks left on too long would be removable without resorting to bolt-cutters.

Note: Any proposed box design should be field-tested in a high-use area before a large-scale purchase is made.

Bearsaver Key-Operated Locker Prototype

These lockers are being proposed as a replacement for the coin-operated lockers at Curry Village. With an opening of 15” X 18 3/4”, they are not designed for storing large coolers, but are intended more for the safe storage of smaller food items, cosmetics (which bears are attracted to by their smell), and personal items of value.

Keys will be included in the cost of a tent rental at Curry so the additional cost of coins for the lockers is eliminated. There is always the potential for lost keys and jammed locks, but even so, these key-operated lockers will likely prove to be popular with Curry Village campers. Construction appears to be equivalent to the coin-operated lockers currently in use at Curry Village.

Again, some method of securely bolting the stacked lockers together and securing them against tipping over is essential. How that is to be accomplished is not immediately apparent from examining the single locker on display. Installation in a location with good lighting will also enhance their usability.

Site-Specific Observations

Curry Village.

The bear boxes at Curry are all clustered down by the parking lot at quite a long distance from many tent sites. Several campers expressed displeasure about this arrangement, as it is inconvenient to have to hike down to the box for every article of food. It is feared that this could result in people "cheating" with a few food items, which, of course, could mean having a bear visiting their tent later. Several campers were observed standing down at the bear boxes eating, which is not conducive to a pleasant camping experience. Most other park locations have one box per site. People seem to have a real need to have a specific box that is "theirs" for the duration of their stay.

Long-term campers.

Both at Yellow Pines and Little Yosemite Valley, long-term setups that include footlocker boxes installed on top of Herricks, appeared to be a valued "perk". Many boxes have been decorated with personal pictures and have evolved into an effective backcountry kitchen setup. This use of footlockers should be considered as the older boxes are phased out.

Housekeeping. Many of these sites also have the footlocker-on-Herrick setup. A few sites have boxes that are settling unevenly into the ground. This could result in doors that tend to swing shut on their own or contents spilling inside the box.

All locations. Bear boxes should always be installed in shady locations whenever possible. Dark brown steel boxes can get extremely hot sitting in the sun all day.

Conclusion

The introduction of people, cars, and human food to the park are unnatural elements that have altered an ancient and balanced ecosystem that has existed for thousands of years. Bear boxes and animal-proof garbage bins are good tools to use to help isolate our food supply system from theirs.

No one enjoys having to use the bear boxes, but most people do recognize that they are a necessary evil. All of the bear box designs in the park are doing the basic intended job of keeping bears out of people's food *provided they are used correctly*. However, any incremental improvements in the placement and design of the boxes which make them easier or more pleasant to use will help offset the unpleasant fact that they *must* be used and thus will improve compliance.

The new prototypes on display with their slam-to-latch doors and larger capacity are an improvement in many ways upon the older models. However, the value of simple and robust construction cannot be overemphasized. Longevity can ultimately only be proven by field-testing, and the workhorse Herricks, which are built like tanks, are testimony to the effectiveness of "over-building".

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