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SELECTIVE FORAGING FOR ANTHROPOGENIC RESOURCES BY BLACK BEARS: MINIVANS IN YOSEMITE NATIONAL PARK

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Black bears (*Ursus americanus*) forage selectively in natural environments. To determine if bears also forage selectively for anthropogenic resources we analyzed data on vehicles broken into by bears from Yosemite National Park, California. We classified vehicles into 9 categories based on their make and model and collected data on use (2001–2007) and availability (2004–2005). From 2001 to 2007 bears broke into 908 vehicles at the following rates: minivan (26.0%), sport–utility vehicle (22.5%), small car (17.1%), sedan (13.7%), truck (11.9%), van (4.2%), sports car (1.7%), coupe (1.7%), and station wagon (1.4%). Only use of minivans (29%) during 2004–2005 was significantly higher than expected (7%). We discuss several competing hypotheses about why bears selected minivans.

Key words: black bear, conflict, humans, minivan, resource selection, *Ursus americanus*, Yosemite National Park

In ecosystems throughout the world, maintaining viable populations of large carnivores will require that they coexist in a landscape with people that bring anthropogenic resources (e.g., livestock, trash, and pet food) and make them available to wildlife (Conover 2002; Linnell et al. 2001; Woodroffe et al. 2005a). Many large carnivores will readily use anthropogenic food sources, which often leads to conflict and can lower human tolerance for these species (e.g., Beckmann and Berger 2003; Packer et al. 2005; Woodroffe and Ginsberg 1998). Thus, reducing conflict can be a critical component of many conservation plans (Andren et al. 2006; Woodroffe et al. 2005b) as well as an important consideration for lowering economic impacts and threats to human health and safety (Conover 2002; Thirgood et al. 2005).

The black bear (*Ursus americanus*) is one of the most adaptable of all large carnivores and conflict with humans is a critical and growing management issue throughout its range (Baruch-Mordo et al. 2008; Hristienko and McDonald 2007; Pelton 2003). Black bears will readily raid trash cans, break into cars and houses, and steal food from campers, but there has been little effort in understanding details of these foraging decisions. In natural environments black bears are known to forage selectively (e.g., on ant species—Auger et al. 2004; Noyce et al. 1997), presumably to enhance energetic gains and lower foraging costs (Schoener 1971). It is reasonable to expect that black bears will show similar selectivity when using anthropogenic food sources as well. Our objective was to determine whether black bears in Yosemite National Park, California, foraged selectively for anthropogenic food sources. We focused on bears breaking into vehicles, but emphasize that understanding details of the foraging behavior of carnivores in anthropogenic environments can help reveal specific causes of conflict, leading to better strategies for reducing availability of anthropogenic foods and preventing conflict.

MATERIALS AND METHODS

Study site.—Yosemite National Park is notorious for its century-long conflict between bears and people and where nonlethal management of bears is a high priority (Graber and White 1983; Matthews et al. 2006). Yosemite National Park is located on the western slope of the Sierra Nevada in east-central California, encompassing more than 3,080 km^2. We restricted our analyses to Yosemite Valley, which is a small portion (<1%) of the entire park but is where the majority of people come when visiting Yosemite National Park. The valley contains natural habitat ideal for bears as well anthropogenic resources in the form of apple orchards and thousands of people camping each year that bring food attractive to bears. Detailed descriptions of Yosemite National Park and Yosemite Valley are found elsewhere (Graber and White 1983; Matthews et al. 2006) but relevant to this work is a description of the level of tolerance for bears in the park.

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National parks are required to protect wildlife (The National Park Service Organic Act [16 U.S.C. l, 2, 3, and 4]), and the Yosemite Human–Bear Management Program was designed to restore and preserve the natural ecology, distribution, and behavior of black bears by eliminating access to human food and minimizing the impact of human activities. Conflict management was a primary duty of park bear biologists with emphasis on nonlethal management of bears causing conflict and reducing availability of anthropogenic food through education and law enforcement. Bears consistently causing problems were commonly captured, tagged with a visible ear tag, and radiocollared, allowing personnel to monitor activity of individual bears and quantify the number of bears using Yosemite Valley each year. Park personnel spent considerable effort hazing bears that were caught in and near human development (e.g., campgrounds, structures, and parking lots). Any incident involving bears or park personnel hazing bears was recorded in an incidence database, which included bear identification, type of incident, date and time, and a variety of notes providing information relevant to the incident.

Selection of vehicles.—We gathered information on vehicles broken into by bears by accessing records from the incidence database spanning 2001–2007. Most reports contained information on the make and model of vehicles and additional information such as whether food was found in a vehicle, whether the vehicle broken into received a citation for food violations, and the severity of the food violation. From 2004 to 2005 we also measured availability of vehicles by recording the make and model of a sample of vehicles parked overnight in the parking lots of Yosemite Valley. Sampling for availability occurred throughout 2004 and 2005 during the same time period when bears were breaking into vehicles. Nearly all break-ins occurred at night, thus we sampled parking lots between 2200 and 0400 h. We classified all vehicles (used and available) as either coupe, minivan, pickup truck, sedan, small car, sports car, sport–utility vehicle, station wagon, or van based on the make and model of vehicles and classifications made in the Web site http://www.fueleconomy.gov/feg/byEPAclass.htm (accessed February–March 2006).

To test if black bears selectively foraged for a particular type of vehicle, we compared a census of used vehicles with the sample of available vehicles (Manly et al. 2002). We recorded use of vehicles by bears at the population level, that is, animals were not uniquely identified and use of resources was recorded for the population of animals under study. We used data from 2004 to 2005 for use of vehicles by bears and compared it to availability of vehicles parked overnight in Yosemite Valley during the same time period. Selection was determined by calculating the percent of each class available in parking lots and using these percentages multiplied by the total number of observed incidents to calculate an expected number of incidents for each class. We used a Pearson chi-square test to evaluate whether observed frequency of incidents summed over all classes of vehicles was significantly different than expected frequency of incidents. We then calculated confidence intervals for the population proportions of used resources for each vehicle class to determine if expected proportions fell outside the bounds of the calculated confidence interval. We applied a Bonferroni adjustment for the calculation of these confidence intervals (Manly et al. 2002). We present vehicle use data from 2001 to 2007 but limited our statistical analysis of selection to data from 2004 to 2005 because we only sampled availability during these years.

We used additional information from incident reports during 2004–2005 that described whether vehicles broken into contained evidence of food. Reports classified each incident as food present, food odors present, other attractants present, no attractants present, or unknown. We considered these data anecdotal information because of the lack of details and descriptions regarding the nature, amount, and type of food present. Thus, we did not perform any statistical analyses on these data but instead report them as raw data.

Results

Annually, between 10 and 15 bears used anthropogenic food sources in Yosemite Valley (including vehicles). From 2001 to 2007 a total of 1,111 vehicles was broken into by bears and we were able to use data on 908 of these incidents (Table 1). Every year minivans either had the largest or 2nd largest number of vehicles broken into (Table 1). From 2004 to 2005 we sampled 3,766 vehicles to determine availability.

Table 1.—The number and percent (in parentheses) of vehicles, by class type, broken into by black bears (*Ursus americanus*) in Yosemite National Park from 2001 to 2007. Vehicle class was determined by matching make and model of vehicles with class designation at the following Web site: http://www.fueleconomy.gov/feg/byEPAclass.htm (2006).

Vehicle class	2001	2002	2003	2004	2005	2006	2007
Coupe	2 (3.3)	4 (3.3)	1 (1.4)	2 (0.9)	2 (1.1)	2 (1.6)	2 (1.6)
Minivan	17 (28.3)	25 (20.7)	14 (20.0)	73 (31.2)	47 (26.9)	33 (26.8)	27 (21.6)
Truck	9 (15.0)	9 (7.4)	4 (5.7)	34 (14.5)	19 (10.9)	14 (11.4)	19 (15.2)
Sedan	6 (10.0)	18 (14.9)	14 (20.0)	32 (13.7)	26 (14.9)	14 (11.4)	14 (11.2)
Small car	11 (18.3)	34 (28.1)	8 (11.4)	36 (15.4)	31 (17.7)	16 (13.0)	19 (15.2)
Sports car	3 (5.0)	2 (1.7)	0 (0.0)	4 (1.7)	2 (1.1)	1 (0.8)	3 (2.4)
Sport–utility vehicle	9 (15.0)	23 (19.0)	19 (27.1)	50 (21.4)	42 (24.0)	33 (26.8)	28 (22.4)
Station wagon	0 (0.0)	0 (0.0)	4 (5.7)	0 (0.0)	2 (1.1)	2 (1.6)	5 (4.0)
Van	3 (5.0)	6 (5.0)	6 (8.6)	3 (1.3)	4 (2.3)	8 (6.5)	8 (6.4)
Total	60 (100)	121 (100)	70 (100)	234 (100)	175 (100)	123 (100)	125 (100)

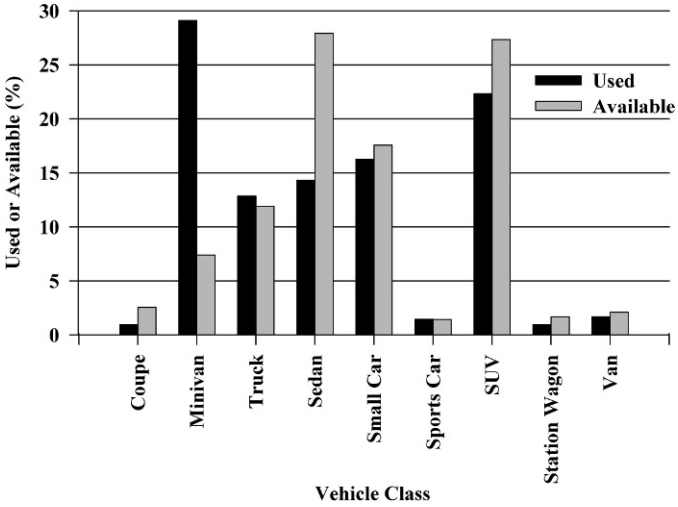

FIG. 1.—Percentage of vehicles broken into by black bears (*Ursus americanus*; used—black) and parked overnight (available—gray) by class of vehicle in 2004–2005. Only use of minivans surpassed availability and shows that black bears strongly selected for this class of vehicle.

During that period black bears broke into a total of 412 vehicles and exhibited a strong selection for minivans and against sedans ($\chi^2 = 299.8$, $d.f. = 8$, $P < 0.0001$). Use of minivans (29%) was more than 4 times higher than expected (7%). Use of sedans (14%) was 2 times lower than expected (28%; Fig. 1). In general, a high percentage (>40%) of vehicles broken into between 2004 and 2005 had evidence of food available that would attract bears, but there were no apparent differences between vehicle classes (Table 2).

DISCUSSION

Black bears forage selectively to balance energetic and nutritional gains with foraging costs. Selection of minivans by bears in Yosemite National Park was the likely consequence of efforts to maximize caloric gain and minimize costs by targeting vehicles with higher probabilities of payoff. Potential costs to bears came in the form of energy spent breaking into vehicles and considerable risk because park rangers were deployed nightly for surveillance and bears detected in or around campgrounds and parking lots received aggressive negative conditioning. The trade-off between food acquisition and penal actions by humans likely pressured bears to target vehicles with the highest probability of attaining food.

There are several non–mutually exclusive hypotheses for why bears selected minivans. First, it is possible that minivans were more likely to emit food odors regardless of whether they contained meaningful amounts of food available. This argument is based on the fact that minivans are designed for families with children and small children in particular are notorious for spilling food and drink while riding in vehicles. Thus, vehicles transporting children would emit greater food odors, making them attractive to bears. If this hypothesis is correct then any vehicle transporting small children, regardless of class type, should be targeted by bears. To test this supposition, park personnel collecting information on vehicles broken into should also note whether car seats were present, or whether small children are regularly transported in the vehicle, or both.

Second, it is possible that passengers of minivans were more prone to leave large caches of food (e.g., coolers or grocery bags) in vehicles parked overnight. Evidence from the incident reports (Table 2) supports this contention by indicating that most vehicles broken into (regardless of vehicle class) had evidence of available food. What is unknown from these reports is the amount and type of food available, which could vary from microtrash resulting from children to large quantities of food such as coolers or grocery bags. Passengers of all vehicles entering Yosemite National Park are exposed to the same educational material regarding storing food in food lockers rather than vehicles and it is difficult to imagine why drivers of minivans would be biased toward leaving food in their vehicles. Additional data to evaluate this hypothesis could include the quantity and types of food present in incidents.

Third, it is possible that minivans were structurally easier to break into than other vehicles. Our observations indicate that bears entering minivans typically did so by popping open a rear side window and it seems that this was easier for minivans compared to other vehicle classes. We note that bears are strong and well equipped (long claws) to open a variety of structurally sound materials (e.g., logs and ant mounds), and

TABLE 2.—The number and percent (in parentheses) of vehicles, by vehicle class, broken into by black bears (*Ursus americanus*) from 2004 to 2005 in Yosemite National Park with either human food present in the vehicle, no human food present, a detectable food odor, some other attractant, or unknown.

Vehicle class	Food present	No food present	Food odor	Other attractant	Unknown
Coupe	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Minivan	70 (58.3)	11 (9.2)	10 (8.3)	8 (6.7)	21 (17.5)
Truck	27 (50.9)	3 (5.7)	4 (7.6)	8 (15.1)	11 (20.8)
Sedan	28 (47.5)	8 (13.6)	9 (15.3)	5 (8.5)	9 (15.3)
Small car	28 (41.8)	9 (13.4)	5 (7.5)	5 (7.5)	20 (29.9)
Sports car	4 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	2 (33.3)
Sport–utility vehicle	46 (50.0)	6 (6.5)	10 (10.9)	9 (9.8)	21 (22.8)
Station wagon	3 (75.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)
Van	4 (57.1)	0 (0.0)	1 (14.3)	0 (0.0)	2 (28.6)

we commonly saw car doors bent open, windows on all sides of the vehicle broken, and seats ripped out, all of which appeared effortless for bears.

Finally, selection of minivans could reflect the foraging decisions of a few individuals that developed a learned behavior for breaking into minivans. Anecdotal evidence supports this idea and indicates that most of the break-ins resulted from a maximum of 5 bears and possibly as few as 2 individuals. Furthermore, the pattern of selecting minivans likely spanned 2001–2007 (Table 1) and known individuals suspected of breaking into vehicles were alive and in the area during this period. Genetic analyses of hair left in cars would allow identification of individual animals, and allow a better test of this hypothesis.

Although we have yet to determine why bears choose minivans, our results demonstrate the black bear's keen ability to adapt to novel food resources and the unpredictable consequences of having bears and people coexist. Lessons about emergent difficulties of human–bear coexistence are applicable not only to a growing number of systems with bear–human conflicts but also to a growing number of systems worldwide where large carnivores must coexist with people. Because it is primarily foraging decisions that bring large carnivores into conflict with people (Conover 2002; Fascione et al. 2004; Woodroffe et al. 2005a), we believe studying details of foraging behavior can help direct limited resources toward resolving conflict in a variety of systems. In the case of Yosemite National Park, examination of our data suggests that management strategies could include greater education efforts focused on vehicles carrying small children, increased enforcement efforts focused on vehicles violating food storage regulations, and management (euthanasia or translocation) of a few problem individuals.

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