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Author(s): Tyler H. Coleman, Charles C. Schwartz, Kerry A. Gunther and Scott Creel

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Influence of overnight recreation on grizzly bear movement and behavior in Yellowstone National Park

Tyler H. Coleman[1,2,4], Charles C. Schwartz[3], Kerry A. Gunther[2], and Scott Creel[1]

[1]*Department of Ecology, Montana State University, Bozeman, MT 59717, USA*
[2]*Yellowstone National Park, Bear Management, Yellowstone Center for Resources, Mammoth, WY 82190, USA*
[3]*C Schwartz Consulting, Bozeman, MT 59178, USA*

Abstract: Interactions among recreational users and grizzly bears (*Ursus arctos*) are a continuous challenge for bear managers. Yellowstone National Park, Wyoming, USA uses a system of designated backcountry campsites to manage overnight use and provides bear-resistant food-storage devices for recreational users. Few studies have evaluated how this type of management and recreation influences grizzly bear behavior. We used global positioning system (GPS) data for humans and bears to determine how overnight use influenced grizzly bear movement behavior. We determined times of day campsites were occupied and contrasted grizzly bear locations to random locations near occupied campsites. We conducted a similar analysis ignoring campsite occupancy to assess the utility of including a temporal variable. Grizzly bears were 0.35 times as likely as random locations to be ≤200 m from occupied campsites (95% CI = 0.19–0.62, $P \leq 0.001$). Conversely, when human occupancy was ignored, bears were 2.11 times more likely than random locations to be ≤200 m from campsites (95% CI = 1.85–2.41, $P \leq 0.001$). We conclude that overnight backcountry camping can displace grizzly bears within 200 m of campgrounds. To avoid confounding results, we suggest considering use of a temporal variable in studies of human–bear interactions.

Key words: bear management, global positioning system, GPS, grizzly bear, human–bear conflict, human–bear interaction, recreation, *Ursus arctos*, Yellowstone National Park

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In areas of the United States where humans are encroaching on wildlife habitats, land managers must balance recreational opportunities and conservation of threatened and endangered species. In Yellowstone National Park, Wyoming (hereafter Yellowstone Park), visitors can recreate in areas that are critical to the survival and recovery of grizzly bears (*Ursus arctos*). Grizzly bears in the lower 48 United States, including Yellowstone Park, were listed as threatened by the US Fish and Wildlife Service in 1975. Yellowstone Park officials have since been challenged with accommodating an increasing number of visitors while supporting grizzly bear conservation. Yellowstone Park is considered critical to grizzly bear recovery, yet backcountry recreation is an important part of the visitor experience (US Fish and Wildlife Service [USFWS] 1993). Overnight backcountry use has remained consistently high with an average of 42,000 user nights/year from 1972 to 2011 (National Park Service 2012c). To help accommodate these backcountry users, Yellowstone Park created a system of designated backcountry campsites to concentrate use and provide campers with bear-resistant food storage devices. Created in 1973, designated backcountry campsites (hereafter backcountry campsites) were placed along trails and lakeshores (National Park Service 1995).

Following the creation of backcountry campsites, Yellowstone Park implemented policies to provide additional protection for grizzly bears (Gunther 1994). A synthesis of these management policies (National Park Service 1982) reflected a plan for preserving critical grizzly bear habitat and preventing human–bear conflict. Following guidelines of Craighead (1980), the park set aside areas considered critical for grizzly bear recovery and identified them as Bear Management Areas (BMAs). Sixteen BMAs comprising a total of 188,032 hectares (21% of Yellowstone Park) were delineated and assigned

[4]ty_coleman@yahoo.com

unique management guidelines (Gunther 2003). Bear Management Areas seasonally restricted recreation in areas of the park with high concentrations of grizzly bears and bear foods. In several BMAs, backcountry campsites and trails were seasonally closed because they were within approximately 500 m of food sources considered critical to grizzly bear recovery. Campsite closures and restrictions were based on the assumption that backcountry campsites displaced foraging grizzly bears or increased risk to backcountry campers. Backcountry campsites outside of BMAs generally had no limitations. However, since the creation of the designated backcountry campsite system in 1973, and the subsequent seasonal closures of some campsites by the BMA program in 1982, little research has been done to determine how bears behave around occupied backcountry campsites.

Evidence suggests that non-motorized backcountry users can displace grizzly bears and potentially hinder foraging opportunities (McLellan and Shackleton 1989, Kasworm and Manley 1990, Mace and Waller 1996, Rode et al. 2007). This research has mostly been conducted during daylight hours involving groups of people hiking or recreating. In Yellowstone Park, thousands of backcountry users stay overnight in grizzly bear habitat, yet there is little empirical information whether bears are attracted to, or deterred by, this type of use. One study (Gunther 1990) suggesting that bears avoided occupied backcountry campsites was conducted during daylight hours, in an open valley, with a limited number of campsites ($n = 13$). Other research has focused on large camps or permanent developments such as paved campgrounds, outfitting camps, or multi-group sites (Mattson et al. 1987, Ruth et al. 2003). Most agencies that manage land surrounding Yellowstone Park require backcountry users to stay in multi-group campsites or allow people to select a camp location (National Park Service 2012a,b; US Department of Agriculture Forest Service 2012). Consequently, there is a lack of research on the effect of small party backcountry camping on grizzly bear movement behavior.

In Yellowstone Park, grizzly bears rarely attack hikers or overnight backcountry campers (National Park Service 2013). When attacks do occur, they most often involve recreational parties with group sizes ≤ 2 (Gunther and Hoekstra 1998). Grizzly bear attacks after dark often involve food-conditioned bears (*sensu* Hopkins et al. 2010). However, there are records of grizzly bear attacks on small overnight backcountry parties involving bears with no known management status (Gunther and Hoekstra 1998, Herrero 2002:68–71).

Opposing factors can influence bear movement behavior around backcountry campsites. Grizzly bears can associate a negative experience with people at a specific location or in a particular situation and thus avoid backcountry campsites (Herrero 2002: 189–195, 241). Alternatively, bears can be attracted to backcountry campsites because many are near trails and other travel corridors. In addition, natural or anthropogenic food sources can attract bears to backcountry campsites. Many backcountry campsites are near open meadows and riparian areas that provide water for campers but also herbaceous forage for bears (Despain 1990). Years of use by stock (i.e., horses, mules, and llamas) have allowed protein-rich exotic vegetation such as clover (*Trifolium* spp.) to grow near backcountry campsites historically used by horse and mule packers (Mealey 1980, Mattson 1991).

As part of a study investigating behavior and diet of grizzly bears around Yellowstone Lake in Yellowstone Park, we evaluated bear movement around backcountry campsites within and around 6 BMAs using global positioning system (GPS) data from bears and people. These data allowed us to determine if seasonal backcountry campsite closures reduced human-caused bear displacement and provided some evaluation of the BMA program.

We used 2 approaches to evaluate our research questions. We investigated bear movement behavior around backcountry campsites when humans were known to occupy them in addition to an analysis for which campsite occupancy was ignored. We compared these 2 tests to determine if bears responded to the presence of people or the campsites themselves. Specifically, we examined (1) patterns of recreation, including backcountry campsite occupancy, departure times, and arrival times; (2) GPS locations of sampled grizzly bears in areas with a large number of backcountry campsites; (3) the odds of grizzly bears being nearer occupied backcountry campsites relative to random locations; (4) the odds of a grizzly bears being nearer backcountry campsites than random locations when occupancy was ignored; (5) the distance bears responded to occupied backcountry campsites, compared to random locations; and (6) the distance bears responded to backcountry campsites compared to random locations when occupancy was ignored. Based on previous evidence that backcountry users can displace bears and that night-time bear attacks on backcountry campers are very rare, we hypothesized that bears avoid occupied backcountry campsites, but avoidance behavior diminishes incrementally as distance from occupied campsites increases. Also, because campsites are usually vacant, and some natural forage and travel corridors exist near backcountry campsites, we hypothesized that when occupancy is ignored, grizzly bears use backcountry campsites more than random.

Study area

We conducted our study from April 2007 to October 2009 in the southeast portion of Yellowstone Park (Fig. 1). The main geographic and recreational characteristic of the study area was Yellowstone Lake. Yellowstone Lake is a high elevation (2,359 m) oligotrophic lake that comprises 35,391 ha and has a mean depth of 42 m (Reinhart and Mattson 1990). The east and southeast drainage of Yellowstone Lake is dominated by larger stream tributaries draining from high-mountain topography, closed-canopy mixed forest, and subalpine meadows. The west and north drainages are characterized by smaller streams draining from low-relief plateau topography, lodgepole pine (*Pinus contorta*) forest, and alluvial meadows. The 10-year (1998–2008) mean high and low temperatures at Yellowstone Lake were −5.4°C and −17.0°C, respectively, in January, and 23.3°C and 4.6°C, respectively, in July (Western Regional Climate Center 2010). Approximately 80% of precipitation typically fell as snow (Reinhart and Mattson 1990, Fortin et al. 2013). Lodgepole pine commonly occurs at elevations adjacent to Yellowstone Lake where poor soils formed from rhyolite predominate. With increasing elevation, spruce (*Picea*)–fir (*Abies*) or subalpine forests dominate. Engelmann spruce (*Picea engelmannii*) and whitebark pine (*Pinus albicaulis*) occur at tree line, with alpine tundra at the highest elevations of all major mountain ranges (Patten 1963, Waddington and Wright 1974, Despain 1990).

Our study area covered all backcountry campsites extending from the southeast boundary of Yellowstone Park to the main park roads north and west of Yellowstone Lake (Fig. 1). The area ranged in elevation from the shores of Yellowstone Lake to Eagle Peak, the highest point in Yellowstone Park at 3,462 m. The study area was approximately 99% recommended wilderness, which prohibited or restricted motorized equipment and road building (Wilderness Act 1964, 16 USC 1131–1136). The area was accessible by non-motorized watercraft, foot, hooved stock, and motorized boats in limited circumstances. Yellowstone Lake has 177 km of shoreline, which provided near continuous access to the backcountry campsites on the lake. The study area had 3 major trailheads that provided foot or hooved stock access for overnight users (Nine-mile, Heart Lake, and South Boundary trailheads). The study area had 293 km of maintained backcountry trails and 88 designated backcountry campsites (26 accessible by boat only, 10 accessible by boat, foot, or hooved stock, and 52 accessible by foot or hooved stock); 25 and 63 were located in forested and open habitats, respectively. Backcountry campsites provided a specific area for camping and could only be reserved by one group. Campsites were identified by trail marker, but recreational users were allowed to select a general area for tent location.

Methods

We trapped and radiocollared grizzly bears using culvert traps placed within 1 km of Yellowstone Lake from September 2006 to June 2009. The Interagency Grizzly Bear Study Team conducted all trapping under procedures approved by the Animal Care and Use Committee of the US Geological Survey, Biological Resources Division. Grizzly bear captures were conducted under USFWS endangered species permit [Section (i) C and D of the grizzly bear 4(d) rule, 40 CFR17.40(b)] and Yellowstone National Park research permit YELL-00073. The team fitted all captured bears with Telonics Spread Spectrum GPS collars (Telonics, Inc., Mesa, Arizona, USA) with a biodegradable canvas spacer and a CR2-A programmable remote drop-off device. Collars attempted a position fix every 30 or 60 minutes. Collars shut off during denning season (15 Nov–14 Apr). We flew telemetry flights weekly from late-April through mid-October to retrieve collar data. We calculated fix success and excluded collars that malfunctioned due to antenna fatigue.

Human recreation sample

Using data from the Yellowstone Park backcountry permit reservation system, we selected a sample of overnight backcountry users in May, June, July, August, and September from 2007 to 2009. We

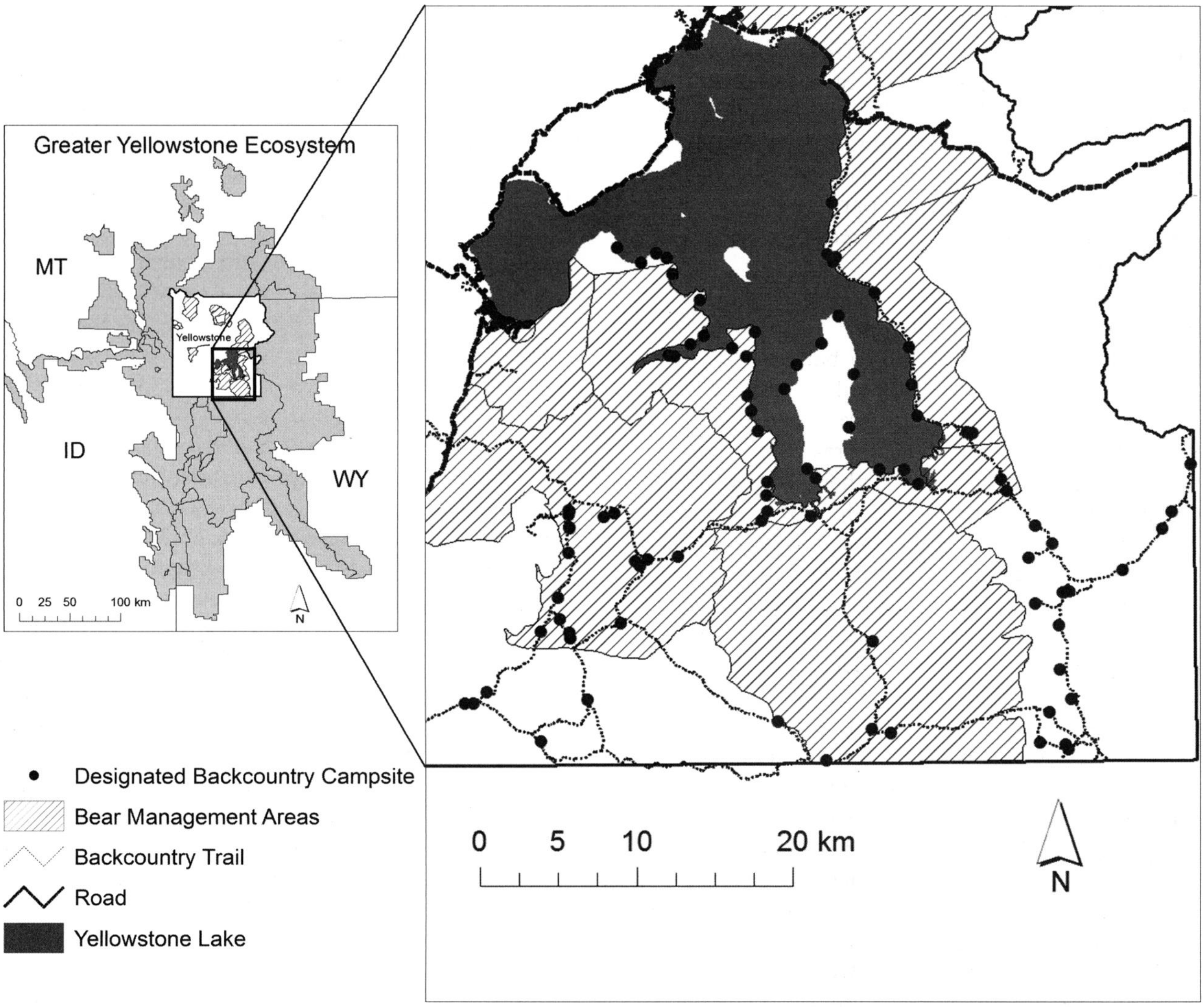

Fig. 1. Yellowstone National Park, Wyoming, USA. Highlighted areas display 6 Bear Management Areas and 88 designated backcountry campsites near Yellowstone Lake.

applied a stratified random sample design with proportional allocation among 3 strata: private users, outfitters, and administrative users (i.e., National Park Service or research groups). The sampling frame for overnight users was a list of the recreational parties that reserved at least one backcountry campsite that required travel through the study area into the 6 surrounding BMAs. We attempted to sample approximately 20% of users from each strata per week based on the list provided from the backcountry permit system.

We met sampled parties at their designated trailheads or boat access points on the morning of their departure. One member of each party was asked to carry a hand-held Garmin 12 XL or Garmin e-Trex GPS on their trip (Montana State University Institutional Review Board-Human Subjects Committee, protocol approval number TC042606-EX). We programmed GPS units to obtain 1 location/minute for trips $\leq$2 days and 1 location/2 minutes for trips >2 days. We asked individuals to leave GPS units on all day and record when they arrived at backcountry campsites in the evening and when they departed in the morning. Upon completion of their trip, we asked parties to return GPS units to Yellowstone Park staff via inter-park mail. All units were successfully received in good condition. If a party failed to accurately record their campsite location, arrival, or departure time, we excluded that night or time from analyses.

We used Garmin Map Source 4.0 (Garmin Inc., Olathe, Kansas, USA) to download all GPS data to a computer. The GPS units provided a UTM (universal transverse Mercator) location, date, and time for each fix. For each party we recorded the number of individuals and recreation type (hooved stock, foot, or boat).

Backcountry camp analysis

To evaluate bear response to backcountry campsite occupancy, we needed to determine the dates and times when campsites were occupied. Since it was not feasible to sample all recreational users in all 88 campsites, we used data gathered from our GPS sample, combined with the Yellowstone Park backcountry permit system database, to estimate dates and times campsites were occupied. All overnight users were required to obtain a permit, complete a trip plan, and reserve their backcountry campsites before leaving on their trip. Backcountry campsite reservation information was annually compiled into a database by park staff and used to determine campsite occupancy when we lacked direct GPS data from recreational users in our sample.

Occasionally, backcountry campers stayed at a campsite that did not agree with their permit and with the Yellowstone Park backcountry database. This likely occurred for several reasons including fatigue, weather, insects, a data entry error by park staff, or a change of plans (I. Kowski, Yellowstone Park Central Backcountry Office, personal communication, 2012). Since we wanted to use the park database to determine campsite occupancy, we first evaluated the backcountry database for accuracy by comparing our GPS samples to their paired records in the backcountry database. We used the GPS samples to determine exact campsite locations and then compared them to their reserved campsites and calculated percentage accuracy.

We then determined a cutoff time when people were most likely to be arriving and departing a backcountry campsite. We did this to estimate campsite occupancy times for parties not in our sample. We used the GPS location data from our sample to create a distribution of times when campsites were vacated in the morning and occupied in the evening. We considered campsites vacant when at least 25% of sampled parties had left in the morning and occupied when at least 75% of sampled parties had arrived for the evening. We were conservative with estimates of campsite occupancy times to avoid committing a type 1 error (suggesting a campsite was occupied when it was not). Finally, if a recreational party reserved a campsite for multiple days, we considered the campsite continuously occupied.

Bear distribution versus backcountry campsite analysis

To evaluate the relationship between backcountry campsites and bear movement behavior, we compared bear locations and random locations to campsite occupancy in space and time. To evaluate the relationship spatially, we measured the distance between locations and the nearest occupied and vacant backcountry campsite. We created random locations for each individual bear within the outer boundary of its defined home range. We created home ranges using the k nearest neighbor convex hull method (k-LoCoh) with $k = \frac{\sqrt{n}}{2}$, where n = number of individual bear locations (Getz and Wilmers 2004). We used the k-LoCoh method because it adequately delineated the shoreline of Lake Yellowstone, where several campsites were located. We created home range shapefiles using the LoCoh home range generator for ArcGIS 9 (University of California, LoCoh home range generator for ArcGIS 9, http://nature.berkeley.edu/~ajlyons/locoh/arcgis9, accessed 21 Apr 2011). We chose 100% isopleths as a boundary. We generated an equal number of random locations to GPS locations for each bear using the Alaska Pak Toolkit in ArcGIS 9.3 (Environmental Systems Research Institute, Inc., Redlands, California, USA). To evaluate the relationship between backcountry campsites and bear movement behavior temporally, we used the times associated with each GPS radiocollared bear location. We compiled times associated with each bear location and randomly assigned these times to random locations for each bear. This allowed us to contrast occupancy status of a campsite to a bear or random location at given distances from campsites.

We compared the times and distances ($\leq$1 km) of the bear and random locations to occupied and unoccupied backcountry campsites. We categorized locations into 5 ordinal distance bins (0–200 m, 201–400 m, 401–600 m, 601–800 m, and 801–1000 m). We chose a bin distance of 200 m to provide an adequate sample for each category. We generated statistics for

4 datasets: (1) bear locations within a given distance bin of occupied campsites; (2) bear locations within a given distance bin of a vacant campsites; (3) random locations within a given distance bin of occupied campsites; and (4) random locations within a given distance bin of vacant campsites. We created 2 x 2 x *K* contingency tables with K = individual bears, to control for individual bear effects. Finally, we generated similar statistics using bear and random locations within the given distance bins of backcountry campsites, ignoring campsite occupancy.

For both analyses we used an exact inference procedure to estimate odds ratios in the 2 x 2 x *K* contingency tables; campsite occupancy, bear or random location, individual bear and within or beyond the distance bin, bear or random location, individual bear. We conditioned our test on fixed-strata marginal totals and used an exact small-sample alternative to the Cochran-Mantel-Haenzel (CMH) test (Agresti 2007:114). Our null hypothesis was that the odds ratios were = 1.0 (equal odds). We accepted the alternative hypothesis for any odds ratio where the 95% CI did not overlap 1. A key assumption was that individual bears share a common odds ratio. We evaluated this by fitting log-linear models for each odds ratio scenario and plotting fitted values with observed values. The plot comparisons allowed for a visual assessment of the common odds ratio assumption and helped identify if any bears deviated from fitted values. (Haroldson et al. 2004). We conducted our analysis using the R statistical program (R Development Core Team 2012).

Results

We deployed 16 collars on 12 individual grizzly bears (9 M, 3 F) and successfully obtained 84% of 66,098 fix attempts (range = 75–91%).

Human sample

Mean party size for the 88 backcountry campsites was 3.6 people (SD = 2.7), median and mode were 2, and range was 1–15 people. There were 26 reservations/campsite/year for April–October 2007–09 on average, with a mean of 7 camps occupied each day. However, 36 campsites were closed during all or part of April, May, June, and early July due to BMA regulations. Annually, 92% of backcountry campsite use occurred during July–September.

We sampled 233 overnight parties that had reserved 1,101 camp nights. In our sample, 11 parties (4.7%) failed to record their campsite locations on their entire trip, 53 parties (22.7%) failed to record at least one campsite location, and 169 parties (72.6%) recorded campsite locations on their entire trip. Therefore, our backcountry campsite reservation accuracy, arrival times, and departure times were determined from 222 parties over 799 camp nights.

Backcountry campsites

The 222 parties stayed in backcountry campsites that agreed with the Yellowstone Park reservation database in 701 out of 799 occasions (87.7% accuracy). Of the 89 occasions that disagreed with the database, 43 (44%) were because parties abandoned their trip or did not take their trip and failed to notify park staff. The remaining 55 (56%) occurred because 15 parties failed to locate the correct campsites. Based on estimated accuracy, we concluded that the park reservation database was a suitable measure of campsite occupancy.

The lower quartile, median, and upper quartile were 0826 hours, 0932 hours, and 1054 hours (n = 701) for campsite departure and 1527 hours, 1653 hours, and 1814 hours (n = 668) for campsite arrival. Because we defined campsite occupancy when at least 75% of people had arrived in the evening or at least 25% of sampled people had left in the morning, we considered campsites occupied between 1814 and 0826 hours. We used our GPS sample to confirm occupancy, departure, and arrival times for 9.4% of the occupied campsites used in our analysis. We used the backcountry database to estimate occupancy and used the arrival and departure times listed above for the remaining occupied campsites.

Bears and backcountry campsites

Grizzly bears were less likely to be within 400 m of occupied campsites but not beyond 400 m, compared to random locations (Fig. 2). Grizzly bear locations were 0.35 times as likely as random locations to be within 0–200 m of occupied campsites (95% CI = 0.19 to 0.62, $P \leq 0.001$) and 0.56 times as likely as random locations to be within 201–400 m of occupied campsites (95% CI = 0.38 to 0.82, P = 0.002). At distances of 401–600, 601–800, and 801–1,000 m grizzly bear locations were 0.88, 1.09, and 1.20 times as likely as random locations to be near occupied campsites, respectively.

When campsite occupancy was ignored, grizzly bears were more likely to be within 600 m of

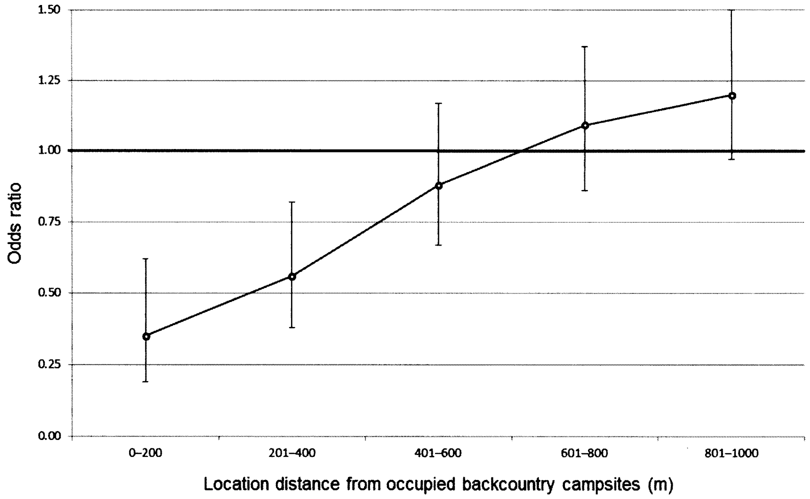

Fig. 2. Odds ratios (with 95% confidence interval) for grizzly bear compared to random locations within given distances to occupied backcountry campsites for a study in Yellowstone National Park, Wyoming, USA, Apr 2007–Oct 2009. Odds ratios <1 indicate that bears avoided occupied campsites. Bold horizontal line indicates equal odds.

campsites but less likely to be beyond 600 m compared to random locations (Fig. 3). Grizzly bear locations were 2.11 times more likely than random locations to be within 0–200 m of campsites (95% CI = 1.85 to 2.41, $P \leq 0.001$), 1.38 times more likely than random locations to be within 201–400 m of campsites (95% CI = 1.27 to 1.51, $P \leq 0.001$), and 1.11 times more likely than random locations to be within 401–600 m of campsites (95% CI = 1.03–1.20, $P = 0.005$). At distances of 601–800 m and 801–1000 m, grizzly bear locations were 0.86 and 0.90 times as likely as random locations to be near backcountry campsites. A visual comparison of the plots between fitted values from log-linear models and observed values suggested the common odds ratio assumption was met in all odds ratios.

Discussion

Grizzly bears avoided areas within 400 m of backcountry campsites when occupied, supporting our hypothesis. This avoidance response, however, diminished beyond 400 m. Bears also tended to be closer to backcountry campsites when occupancy was ignored. This was not surprising because on average, 92% of backcountry campsites were unoccupied each night. In many cases, campsites were vacant during the day following the departure of recreational users. Therefore, campsites were most often vacant so an odds ratio in the opposite direction corresponds with evidence of bear avoidance of people and not campsites locations.

Previous research has also found that bears avoid non-motorized recreational users in remote areas (Jope 1985, Gunther 1990, Kasworm and Manley 1990). Our study confirms that bears avoid humans even when humans are confined within predictable locations such as campsites. We suggest that areas near backcountry campsites around Yellowstone Lake are likely selected by bears unless occupied by people because campsites are near natural corridors (e.g., trails and streams), and contain herbaceous foods (Mealey 1980, Despain 1990, Mattson et al. 1991). Also, sign left by bears indicates that they occasionally frequent unoccupied campsites to investigate fire rings (YNP Bear Management Office, unpublished records). Some campers burn unconsumed food in fire rings and may inadvertently leave small pieces of unburned food scraps behind that may attract bears to campsites.

We were unable to include habitat characteristics in our analyses. Our data set provided a large number of bear locations; however, backcountry campsites comprised a relatively small spatial extent and thus we were constrained by small sample sizes per bear. A more frequent fix rate or larger sample of bears may have allowed for inclusion of habitat or vegetation types. For the same reason, we were unable to evaluate age and sex classes or recreation

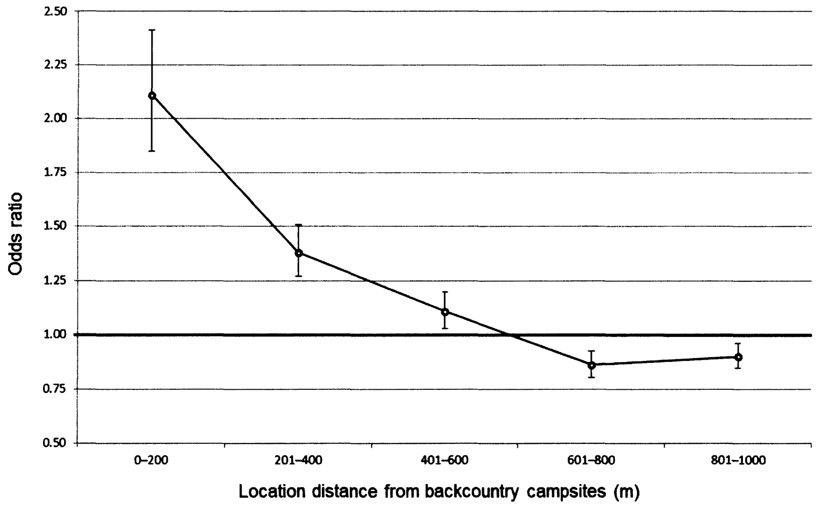

Fig. 3. Odds ratios (with 95% confidence interval) for grizzly bear compared to random locations within given distances to backcountry campsites, when occupancy was ignored for a study in Yellowstone National Park, Wyoming, USA, Apr 2007–Oct 2009. Odds ratios >1 indicate that bears selected campsites. Bold horizontal line indicates equal odds.

types and party sizes. However, our CMH assumptions test did allow for a visual evaluation of each bear for all odds ratio categories, and we not detect a difference by individual. A larger sample of bears may show that females and subadults have weaker avoidance of occupied campsites. Less dominant bears are often relegated to lower quality habitat, including places near humans (Mattson et al. 1987, Olson et al. 1998, Nevin and Gilbert 2005, Rode et al. 2006). Also, bears may exhibit stronger avoidance of campsites with larger human group sizes or hooved stock users because grizzly bears are less likely to attack or approach large groups of people (Gunther and Hoekstra 1998, Herrero 2002:5, Coleman 2012). Further evaluation is needed to determine if this avoidance occurs in backcountry campsites.

Global positioning system technology allows wildlife researchers to consider temporal aspects when evaluating animal behavior near human presence (Cagnacci et al. 2010). When time of day is considered in studies of human–bear interaction, a significant effect is often observed (Gibeau et al. 2002, Graves 2002, Graham et al. 2010). It has been suggested that studies of bear habitat selection should include a temporal component to reduce bias (Moe et al. 2007). Our results provide additional support for including a temporal component when evaluating studies of human–bear interactions. We demonstrated that if we assumed no knowledge of campsite occupancy, we would conclude that bears were attracted to these campsites. Including a temporal component allowed us to determine effects of human presence on bears. Furthermore, large-scale temporal or seasonal patterns should be considered. In our study area, most human use occurred in July–September, so our results were mostly confined to summer. If BMA restrictions were lifted and campsites were not restricted in spring and early summer, we may expect increased human–bear overlap because grizzly bears use low elevation and snow-free areas during this period (Mealey 1980, Blanchard and Knight 1991, Mattson et al. 1991, Coleman 2012). Also, different energetic or dietary demands associated with den emergence or the mating season could lead to different behaviors near humans (Nelson et al. 1983, Schwartz et al. 2003). Additional research in areas of Yellowstone Park with unrestricted backcountry campsite use in the spring and early summer is needed to evaluate these questions.

Management implications

The Yellowstone Park backcountry database is reasonably accurate and can be used to assess campsite occupancy and human–wildlife interaction. As incorporating temporal patterns of human use led to more direct assessments of bear movement behavior, we recommend that future studies of bear–human interactions consider time as a covariate. We observed that human occupancy of campsites can displace bears from habitats up to 400 m away and that campsite closures may enhance foraging opportunities for grizzly bears. We suggest that current BMA restrictions on backcountry campsites around Yellowstone Lake provide grizzly bears additional foraging opportunities and thus increase habitat effectiveness.

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