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Authors: Merkle, Jerod A., Robinson, Hugh S., Krausman, Paul R., and Alaback, Paul

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Jerod A. Merkle,* Hugh S. Robinson, Paul R. Krausman, and Paul Alaback

Boone and Crockett Program in Wildlife Conservation, Wildlife Biology Program, University of Montana, Missoula, MT 59812, USA (JAM, PRK)
Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, MT 59812, USA (HSR)
Department of Forest Management, University of Montana, Missoula, MT 59812, USA (PA)

* Correspondent: jerod.merkle.1@ulaval.ca

Understanding the relationship between foraging ecology and the presence of human-dominated landscapes is important, particularly for American black bears (*Ursus americanus*), which sometimes move between wildlands and urban areas to forage. The food-related factors influencing this movement have not been explored, but can be important for understanding the benefits and costs to black bear foraging behavior and the fundamental origins of bear conflicts. We tested whether the scarcity of wildland foods or the availability of urban foods can explain when black bears forage near houses, examined the extent to which male bears use urban areas in comparison to females, and identified the most important food items influencing bear movement into urban areas. We monitored 16 collared black bears in and around Missoula, Montana, during 2009 and 2010, while quantifying the rate of change in green vegetation and the availability of 5 native berry-producing species outside the urban area, the rate of change in green vegetation, and the availability of apples and garbage inside the urban area. We used parametric time-to-event models in which an event was a bear location collected within 100 m of a house. We also visited feeding sites located near houses and quantified food items bears had eaten. The probability of a bear being located near a house was 1.6 times higher for males, and increased during apple season and the urban green-up. Fruit trees accounted for most of the forage items at urban feeding sites (49%), whereas wildland foods composed <10%. Black bears foraged on human foods near houses even when wildland foods were available, suggesting that the absence of wildland foods may not influence the probability of bears foraging near houses. Additionally, other attractants, in this case fruit trees, appear to be more important than the availability of garbage in influencing when bears forage near houses.

Key words: black bear, conflicts, food, foraging behavior, human–bear interactions, Montana, phenology, time-to-event modeling, *Ursus americanus*, Weibull distribution

Factors influencing animal movement are generally linked to how animals weigh the benefits and costs of foraging (Lima and Dill 1990; Stephens and Krebs 1986). In human-dominated landscapes the benefits and costs, real or perceived, are changing (Frid and Dill 2002). These areas may provide rich forage for wildlife, a benefit, but sometimes also present a risk of conflict with humans, an often lethal cost (DeStefano and DeGraaf 2003). Animals generally respond to this trade-off by avoiding human-dominated landscapes, adjusting their foraging behavior spatially or temporally to avoid conflicts, or by simply ignoring the risk and foraging in a normal manner (Knight and Cole 1991; Whittaker and Knight 1998). Understanding the relationship between foraging ecology and the increasing presence of human-dominated landscapes is essential for conservation and the management of human–wildlife conflicts.

Understanding this relationship is particularly important for American black bears (*Ursus americanus*). As opportunistic foragers, black bears exploit a variety of different food types (including human-based foods) to meet their energetic needs (Cottam et al. 1939; Landers et al. 1979; Raine and Kansas 1990). Because urban landscapes contain food sources not available in wildlands, bears often use these areas to forage (Larivière 2001) even when the costs of foraging within urban

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areas may be higher. The risk of mortality for bears through direct or lethal management actions and bear–vehicle collisions is higher when foraging in and near urban areas (Baruch-Mordo et al. 2008). Bears normally do not spend their entire lives within urban areas (but see Beckmann and Berger 2003a, 2003b), but move in and out of the urban area depending on season and forage availability (Lyons 2005).

Previous research has provided 2 explanations to describe the process behind bear movement in and out of urban areas (i.e., bear movement in proximity to humans): scarcity of wildland food and attraction to human provided food sources. Reports of the frequency of bear conflicts suggest that they often increase when wildland foods are scarce (Knight et al. 1988; Mattson 1990; Peine 2001). For example, Knight et al. (1988) suggested that grizzly bears (*U. arctos*) in Yellowstone National Park exploited human foods during low annual habitat productivity (years 1977 and 1981), and were consequently involved in conflicts. Based on this pattern, we should expect that bear movement from wildlands into urban areas would be correlated with a decrease in wildland food availability (e.g., mast crop failures). Indeed black bear foraging behavior in wildlands is related to phenological dynamics of vegetation (Amstrup and Beecham 1976; Davis et al. 2006; Mosnier et al. 2008), where changes in peak green-up and mast availability can predict bear movement and distribution (Amstrup and Beecham 1976; Mace et al. 1999; Reynolds and Beecham 1980).

Second, because of the quality of human-provided foods, bears may forage on them when they are available, regardless of the availability of wildland foods. Garbage can be a predictable high-calorie food source available to bears that use urban areas (Beckmann and Berger 2003a), and the majority of studies that report bear foraging on human foods identify garbage as the main attractant bringing bears near humans (Badyaev 1998; Rogers et al. 1976; Spencer et al. 2007; Thiemann et al. 2008). Because of the quality of human foods such as garbage, we should expect bear movement from wildlands into urban areas when garbage is temporally available, such as during "garbage night." Other attractants, such as fruit trees and green vegetation, also have been identified as high-quality foods (Greenleaf et al. 2009; McKinney 2002). Although not usually reported as important as garbage, the availability of these attractants also may influence bear movement from wildlands into urban areas.

In addition to these explanations, sex-based differences in foraging strategies may explain variation in bear behavior (Mattson et al. 1992). In urban areas, male black bears have been reported at higher densities than females (Beckmann and Berger 2003b; Rogers et al. 1976). For example, in the upper peninsula of Michigan, 67% of 126 bears captured at dumps, campgrounds, and in residential areas were males (Rogers et al. 1976). The high density of males within urban areas has been explained by describing male bears as despots precluding females from foraging in urban areas (Beckmann and Berger 2003b), supposing female bears avoid urban areas due to risk from infanticide by male bears (Ben-David et al. 2004;

Wielgus and Bunnell 1995), and suggesting male bears have higher probability of encounter with urban areas because they have larger home ranges (Bunnell and Tait 1985). Although not previously quantified, these patterns may be reflected in movement in and out of urban areas, where male black bears should be in closer proximity to urban areas than females.

Over recent decades, bear conflicts have increased in number and extent throughout North America (Baruch-Mordo et al. 2008; Hristienko and McDonald 2007). Identifying whether the availability of food within urban areas is more important than that in wildlands, and which human foods attract bears, is essential when developing conflict-minimizing methods that alter food availability to bears. Using a time-to-event modeling framework we developed a series of candidate models exploring the relative influence of wildland food availability, urban food availability, and sex on bear movement in proximity to humans within an urban area in western Montana. Our objectives were to test whether the scarcity of wildland foods or the availability of urban foods can explain when bears forage near houses, to examine the extent to which male black bears use urban areas in comparison to females, and to identify the most important food items influencing black bear movement into urban areas.

Materials and Methods

Study site.—Our study was conducted in the northern periphery of Missoula, Montana, including urban and exurban development in Butler, Grant, Rattlesnake, and Marshall Creek watersheds in the foothills of the Rattlesnake Mountains (Fig. 1). Missoula's 65,000 people used 25,000 housing units covering 61.9 km^2 (numbers approximated from United States Census Bureau 2000). The topography was characterized by flat valleys in the urban area and steep slopes and canyons (978–2,766 m) with forest vegetation in the wildlands. Temperatures range from a mean high in July of 28.4°C to a mean low in December of –7.2°C (Western Regional Climate Center 2012). Precipitation averaged 43.3 cm per year (Western Regional Climate Center 2012).

Fruit-bearing vegetation within the study area included serviceberry (*Amelanchier alnifolia*), huckleberry (*Vaccinium caespitosum* and *V. globulare*), strawberry (*Fragaria virginiana*), gooseberry and currant (*Ribes* spp.), tartarian honeysuckle (*Lonicera tatarica*), chokecherry (*Prunus virginiana*), blue elderberry (*Sambucus cerulea*), and Oregon grape (*Mahonia* spp.). Within Missoula, vegetation included exotic and native species, including plum (*Prunus* spp.), pear (*Pyrus* spp.), cherry (*Prunus* spp.), apricots (*Prunus* spp.), and especially apples (*Malus* spp.—Merkle et al. 2011). Other potential foods for bears were garbage, birdseed, compost, domestic chickens, and household barbeque waste (Booth 2005).

Capture and monitoring.—We captured bears from September 2008 until November 2009 using culvert traps (Teton Welding, Choteau, Montana) set on private lands near houses. We immobilized bears using Telazol (8 mg/kg; Fort
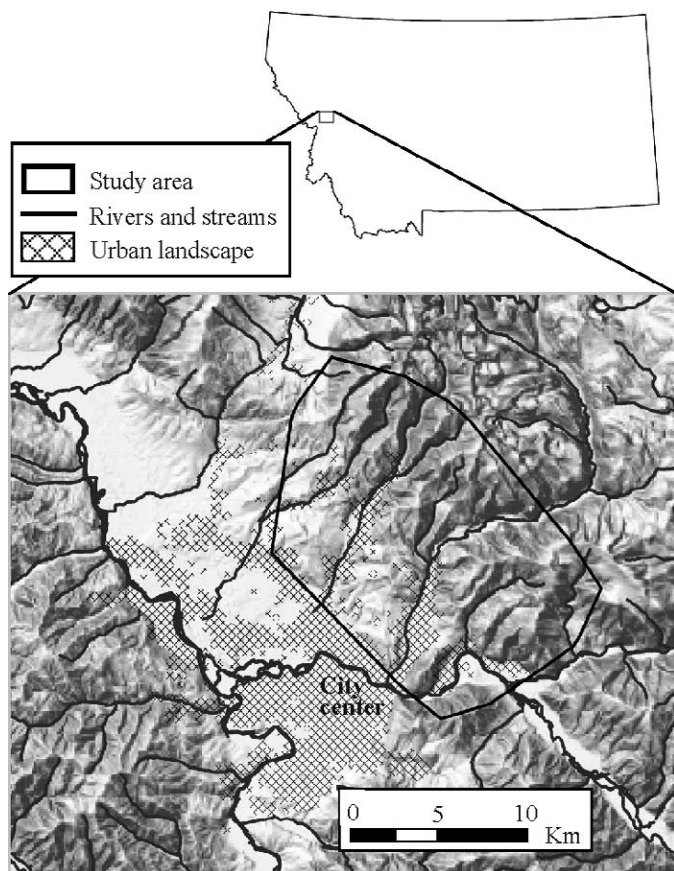
Fig. 1.—Overview of the study area in Missoula, Montana, indicating the spatial arrangement of the urban landscape within Missoula school districts with respect to wildlands (i.e., hill shading) and rivers and streams. Outline of the study area indicates a minimum convex polygon of all black bear (*Ursus americanus*) locations collected between 2009 and 2010.

Dodge Animal Health, Fort Dodge, Iowa [Jonkel 1993]), and fitted bears ≥ 36 kg with global positioning system radiocollars (Globalstar DD-cell wildlife GPS radiocollar; North Star Science and Technology, LLC, King George, Virginia). Collars were programmed to collect 8 evenly distributed locations per day, and had a release mechanism programmed to release 10 October 2010. Using a Globalstar transmitter, the collars attempted to upload successful fixes to an online data and mapping application available to us in real time. Thirty-nine percent of the collars released prematurely. Capture and handling protocols were approved by the University of Montana Institutional Animal Care and Use Committee (Animal Use Protocol 004–08 PKECS-072508), and met the requirements of the most recent guidelines of the American Society of Mammalogists (Sikes et al. 2011).

Time-to-event framework.—We used a parametric time-to-recurrent-event modeling framework (Hosmer et al. 2008) to quantify the effect of phenology-related variables on the probability of a bear being located within 100 m of a house (i.e., an event). We chose 100 m as our threshold because it represents the typical size of a neighborhood block within our

study area, and it is the safe distance that Montana Fish, Wildlife and Parks recommends when encountering a bear. We identified each housing location within our study area using a geographic information system. We obtained National Agriculture Inventory Program imagery (2005, 1-m resolution; United States Department of Agriculture—Farm Service Agency, Aerial Photography Field Office, Salt Lake City, Utah) and used ArcGIS 9.2 (ESRI, Redlands, California) to locate the centroid of the roofline of each residential dwelling (Goldberg et al. 2008).

Independent variables.—We applied phenology-based indexes for wildland and urban foods to a map of the study area with a superimposed grid (250-m resolution). For wildland foods, we developed a 100% minimum convex polygon of all bear locations and subtracted from this polygon all areas within 100 m of a house. We indexed rate of change of green vegetation, or wildland green-up, using the enhanced vegetation index (EVI) calculated from MODIS data. The EVI indexes rate of change of photosynthetic activity (Justice et al. 1998) and dormancy dynamics (Zhang et al. 2003). We calculated mean EVI at 16-day intervals for all cells in our polygon (EVI_{wild}). We estimated EVI for each day during the study by linearly extrapolating between each 16-day interval.

Similar to other black bear populations living in wildlands in the region, we assumed wildland berries are a food source for bears using areas adjacent to Missoula (Holcroft and Herrero 1991; Jonkel and Cowan 1971). We monitored native berry phenology along a 2-km transect adjacent (<1 km) to the study area. This transect has been monitored weekly since 1996 for a larger study of plant phenology and climate change (P. Alaback, in litt.). We noted the date of 1st fruiting (i.e., presence of ≥3 ripe fruits/shrub), peak fruiting (i.e., presence of >50% of berries/shrub ripe), and end of fruiting (i.e., >50% of berries dispersed) for 5 fleshy-fruited woody shrub species: serviceberry, chokecherry, blue elderberry, tartarian honeysuckle, and waxy currant (*Ribes cereum*). We developed an index of berry availability (*Berry*) by summing the number of species in which ripe berries were available (i.e., from date of 1st fruiting until end of fruiting) on each day during the survey. We then estimated berry availability for each day during the study by linearly extrapolating the index between each survey date.

Within the urban area we indexed rate of change of green vegetation (i.e., urban green-up), garbage availability, and apple availability. For urban green-up, we calculated mean EVI values for all grid cells that intersected 100-m buffers around houses. As with wildland areas, we estimated EVI for each day during the study by linearly extrapolating between each 16-day interval (EVI_{urban}). We indexed garbage as available at each house only from 1800 h the evening before weekly garbage pickup until 1800 h on garbage day (*Garbage*), because most of the residents store their garbage indoors during the rest of the week (Merkle et al. 2011).

We indexed apple availability within the urban area by selecting 10 representative apple trees in each of 2009 and 2010, and picked 3 apples from each weekly from 15 August to 31 October. We pressed apples using a Jack LaLanne vegetable

juicer (Tristar Products Inc., Fairfield, New Jersey), and measured the percent sugar per apple using a common hydrometer, noting the date of peak sugar content for each apple tree monitored. We characterized apples as available from 6 days before the date that the earliest tree was at peak fruiting until 6 days after the date that the latest tree was at peak fruiting (*Apples*—Peirs et al. 2005).

Analysis.—Because most of our variables varied with time equally for each individual (e.g., all animals are exposed to apple season at the same time), we could not use the more traditional Cox semiparametric model, and instead used a parametric time-to-event modeling framework (Hosmer et al. 2008). To convert black bear location data into a time-to-recurrent-event framework, we collapsed global positioning system locations into a daily response variable that identified whether ≥1 bear global positioning system–collar location was within 100 m of a house. We restricted our analysis to the bears' active period, 1 March–30 November (275 days).

The parametric proportional hazards model summarizes the times to an event (in this case, ≥1 bear location per day within 100 m of a house) as a baseline hazard (parameterized by some functional form) multiplied by the effects of a set of variables (Hosmer et al. 2008). Variables can be time-varying (e.g., EVI values) or can be fixed (e.g., sex). We used the Weibull distribution (Weibull 1951) as our baseline hazard (i.e., the baseline distribution describing how the probability of an event changes over time without the influence of variables), because of its versatility and wide application. Hazard ratios constitute the relative effect of each covariate on the event variable (Hosmer et al. 2008).

Model building and selection.—We initially tested a null hypothesis, that the probability of a bear being located within 100 m of a house is constant throughout the active period for bears. We tested whether the shape parameter in the Weibull distribution was different from 1 using a Wald's test, where a significant difference would allow us to reject our null hypothesis and assume that probability of a bear near a house varied over time (Hosmer et al. 2008). Next, we used an information theoretic approach (Burnham and Anderson 2002) to rank a variety of models developed from our objectives. We developed 2 types of models, wildland and urban, totaling 21 models. Wildland models combined wildland green-up, our berry index, and sex (i.e., 6 models not including sex by itself). If supported by the data, wildland models would suggest that the probability of a bear foraging near a house is related to the availability of wildland foods. Urban models were based on all combinations of urban green-up, garbage availability, apple availability, and sex (i.e., 14 models not including sex by itself). If supported by the data, urban models would suggest that the probability of a bear being located near a house is associated with the availability of human foods. To identify the most important food items influencing black bear movement into urban areas, we assessed which food items were descriptive within the most-parsimonious model (Burnham and Anderson 2002). We compared the ability of each set of models to describe the probability of a bear being located near

a house using Akaike's information criterion (AIC—Burnham and Anderson 2002). We used Pregibon's link test (Pregibon 1980) on the model with the lowest AIC value to test whether models were correctly parameterized. Analyses were conducted using Stata 10 (StataCorp, College Station, Texas).

Foraging site analysis.—Because we received global positioning system fixes in real time, we investigated as many locations near houses within 24 h as possible to document sign of bear behavior. We described bear behavior as feeding, resting, traveling, unknown, or other activity at locations on roads or within private yards. We searched for sign of bear activity (e.g., broken branches in berry bushes or fruit trees, garbage containers tipped over, bird feeders destroyed, fresh scratching on trunks and stems, and digging) within approximately 30 m (allowing for global positioning system error) of each location. Each description of activity was assigned a confidence level of absolute (i.e., definitive signs of activity), probable (i.e., sign is apparent, but not definitive), or none (i.e., cannot decipher bear activity at location). We classified food items at feeding sites as fruit tree, garbage, bird feeder, wild berries, or other (e.g., garden, barbeque grill, grain, or pet food). Resting sites were identified by searching for fresh beds containing bear hair. Sites where bears were traveling were identified based on observed fresh tracks. We report results using feeding sites with only absolute and probable confidence.

RESULTS

We captured and fit global positioning system collars on 16 individual bears (10 females and 6 males), averaging 915 (± 731 *SD*) locations per bear between 1 March 2009 and 10 October 2010. The area of the 100% minimum convex polygon of all locations was 252.7 km^2, and the urban landscape (area within 100 m of houses) comprised 9.0% of the area. Use of the urban landscape varied among individuals, averaging 34% (± 20% *SD*) of relocations per individual were within 100 m of a house.

Wildland green-up peaked on 26 June in both 2009 and 2010. Urban green-up peaked on 9 May in 2009 and on 26 June in 2010. In both years, fruit was available from mid-June into late October (Table 1).

The Weibull shape parameter for all models was >1 (range = 1.87–2.26, Wald's test statistic range = 10.78–19.36, *P* < 0.0001), suggesting that the daily probability of a bear located within 100 m of a house was not constant throughout the year (i.e., March through October). Without the influence of variables, the daily probability of a bear located within 100 m of a house (i.e., the smooth hazard function) has an upward trend throughout the active period with peaks in mid-June and late September (Fig. 2).

Variables included in top models (ΔAIC < 24) were all urban variables (*Apples*, EVI_{urban}, and *Garbage*) and *Sex* (Table 2). Models that included wildland variables (i.e., EVI_{wild} and *Berry*) were unsupported by the data. Apple season, sex, and urban green-up were all significant descriptors in the most-

TABLE 1.—Periods of time when 5 species of wildland berries and apples were available to black bears (*Ursus americanus*) during 2009 and 2010 in Missoula, Montana. Data were collected during weekly sampling periods.

Species	2009 availability		2010 availability	
	Start	End	Start	End
Serviceberry	9 July	20 August	30 June	14 August
Chokecherry	4 August	20 September	14 August	10 October[a]
Elderberry	27 September	18 October	7 September	10 October[a]
Honeysuckle	9 July	27 September	14 August	10 October[a]
Waxy currant	10 June	20 September	20 June	14 August
Apple	3 September	21 October	16 September	10 October[a]

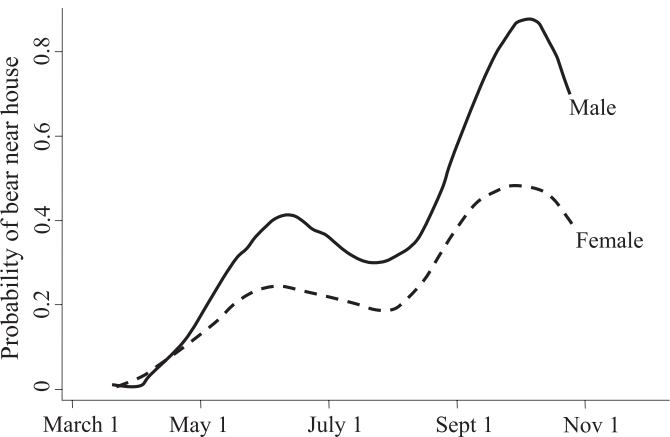[a] Fruit still available at end of study (10 October 2010).

FIG. 2.—Smoothed hazard function based on the daily probability of a male or female black bear (*Ursus americanus*) being located within 100 m of a house between 1 March and 30 November. Data were obtained from 16 global positioning system–collared black bears living in and adjacent to Missoula, Montana, from 2009 to 2010.

parsimonious model, but the availability of garbage was not (Table 3). The daily probability of a bear being located near a house was higher for males, and increased during apple season and the urban green-up (Fig. 2). The top model was properly parameterized ($Z = 1.15$, $P = 0.251$).

We visited 265 global positioning system locations ($n = 9$ bears) from March 2009 until October 2010. We documented 173 foraging, 19 traveling, 1 resting, and 72 sites with other or unknown activities. We documented food 187 times at

foraging sites (Table 4). Percent frequency of occurrence of forage items varied by month for fruit trees (0–57.1%), garbage (18.9–100%), bird feeders (0–14.3%), wild berries (0–13.2%), and other (0–13.2%). Overall, bears foraged on human foods, and fruit trees accounted for 49% of bear foraging sites near houses (Table 4).

DISCUSSION

We found that variation in the availability of urban-based food best described when bears foraged near houses in Missoula, Montana. We also found that a high proportion (>90%) of urban feeding sites were associated with human foods, and few (<10%) were associated with wildland food items (Table 4). Apple season and the urban green-up influenced when bears foraged near houses, but garbage did not (Table 2). This result was supported by our foraging site analysis, where fruit trees accounted for 49% of foraging sites, and garbage less than 35% (Table 4). Finally, male bears were 1.6 times more likely to forage near houses than females, and on any given day during apple season, the probability of a male black bear moving within 100 m of a house can be >80%. Bears living in and around Missoula, Montana, foraged close to houses when human foods were available, not when wildland foods were scarce, and they were attracted mainly to apple trees.

Our results suggest that black bears near urban areas may have completely changed their foraging dynamics to capitalize on high-quality foods available within urban areas (Beckmann and Berger 2003a). Based on these outcomes, researchers investigating the foraging ecology and movement of black bears

TABLE 2.—Parametric proportional hazards models describing the daily probability (from March through October) of a black bear (*Ursus americanus*) being located within 100 m of a house in Missoula, Montana. Data were based on 16 global positioning system–collared black bears from 2009 to 2010. Top 10 models are presented based on ascending Akaike's information criterion score. *EVI* = enhanced vegetation index.

Model	Model type	*d.f.*	AIC	ΔAIC
Sex, Apples, EVI_{urban}	Urban	5	−4,764.80	0.00
Sex, Apples, Garbage, EVI_{urban}	Urban	6	−4,763.12	1.68
Sex, Apples	Urban	4	−4,762.25	2.55
Sex, Apples, Garbage	Urban	5	−4,760.58	4.22
Sex, EVI_{wild}	Wildland	4	−4,740.51	24.29
Sex, Berry, EVI_{wild}	Wildland	5	−4,739.25	25.55
Sex, Berry	Wildland	4	−4,737.37	27.43
Sex	Wildland and urban	3	−4,735.93	28.87
Sex, EVI_{urban}	Urban	4	−4,735.67	29.13
Sex, Garbage	Urban	4	−4,734.28	30.52

TABLE 3.—Top parametric proportional hazards model describing the daily probability (from March through October) of a black bear (*Ursus americanus*) being located within 100 m of a house in Missoula, Montana. Data were based on 16 global positioning system–collared black bears from 2009 to 2010. Model selected based on Akaike's information criterion. *EVI* = enhanced vegetation index.

Variable	Hazard ratio	Coefficient	SE (hazard ratio)	P
Sex	1.6141	0.4788	0.1228	<0.001
Apples	1.6529	0.5025	0.1510	<0.001
EVI_{urban}	1.0003	0.0003	0.0001	0.039
Constant	0.0008	−7.0977	0.0005	<0.001

will benefit from integrating forage dynamics of urban areas and wildlands, particularly when the bear population under investigation is situated adjacent to an urban area. Past studies have shown that foraging strategies of these bear populations differ from those in wildlands. Life-history characteristics of black bears using urban areas show larger body sizes, better reproductive abilities, shorter activity periods, and shorter denning periods in comparison to wildland populations (Beckmann and Berger 2003a, 2003b), all traits consistent with a generally higher quality of forage. Because food availability within urban areas can change regionally, we suggest that researchers interested in black bear foraging ecology take inventory of the foods that bears eat when in the urban area, and investigate how the temporal availability of these foods affects movement. Like our study, this framework for understanding bear behavior can provide a clearer picture of what factors drive the development of bear habituation to humans, and help predict the likelihood of associated bear conflicts.

Our study is unique in that we examined within-year bear movement, in contrast to other studies that consider bear behavior among years (Knight et al. 1988). Using this framework, we revealed foraging patterns that do not align with other studies addressing when bears forage on human foods. Because we did not monitor abundance, but rather phenology of available foods, it is possible that wildland food abundance during our study affected our results. Indeed, other studies report that abundance and spatial distribution of resources can influence bear behavior and habitat selection (Bastille-Rousseau et al. 2011; Mitchell and Powell 2007). Nevertheless, examination of precipitation data during the study suggested average snow and rainfall accumulation (Natural Resources Conservation Service 2012; Western Regional Climate Center 2012), providing evidence that the study was not conducted during an extreme berry crop failure. To clarify the extent of influence of abundance, researchers

continuing to investigate foraging ecology of black bears within years should simultaneously monitor phenology and abundance within urban areas.

Our research brings to light questions about how black bears perceive the costs associated with foraging within the urban area. Factors such as human-induced stress (Ditchkoff et al. 2006) and changes to perceived mortality risk (Frid and Dill 2002) can increase costs to animals foraging within urban areas. Indeed, it has been reported that black bears shift their activity patterns to forage at night within urban areas (Ayres et al. 1986; Beckmann and Berger 2003a), presumably to avoid encounters with humans. Furthermore, the presence of humans has been shown to affect foraging behavior in grizzly bears, where intake rate of food decreases (Rode et al. 2006). We did not explore factors associated with costs associated with foraging in the urban area, and assessing these factors may complete our understanding of the mechanisms influencing the foraging dynamics of black bears and other animals within urban areas. For example, perhaps the costs involved with accessing garbage are higher than those of accessing apples, which may explain why temporal availability of garbage does not influence bear movement.

In addition to costs such as human-induced stress and perceived mortality risk, it may be possible that the profitability (handling time/energy content) of apples was higher than that of wildland foods and even garbage during our study, providing an explanation for the pattern we found. Although garbage containers can sometimes be ubiquitous, particularly during garbage night, we assume that there is a wide distribution of the amount of accessible calories within each container. In other words, some households may have more edible waste than others. Because bears must assess the quality of each garbage container, and make the decision whether or not to forage in each garbage container, the costs of accessing garbage can increase. For apples on the other hand, the trees

TABLE 4.—Percent frequency of occurrence of food items identified at black bear (*Ursus americanus*) foraging sites within the yards of residents in Missoula, Montana, in 2009 and 2010. Foraging site locations were identified within 24 h of the fix time from global positioning system–collared black bears ($n = 9$).

Month	n	Fruit tree	Garbage	Bird feeder	Other	Wild berries
May	8	0.0	100.0	0.0	0.0	0.0
June	7	0.0	85.7	14.3	0.0	0.0
July	3	0.0	100.0	0.0	0.0	0.0
August	18	38.9	55.6	0.0	5.6	0.0
September	53	52.8	18.9	1.9	13.2	13.2
October	98	57.1	28.6	1.0	3.1	10.2
Total	187	48.7	34.8	1.6	5.9	9.1

are spatially static and predictable, and the size of apples can likely provide a higher intake rate of energy. A better understanding of the foraging efficiency of different human foods may shed light on the mechanisms influencing bear foraging decisions near human developments.

As with other findings (Beckmann and Berger 2003b; Bunnell and Tait 1981; Rogers et al. 1976), the response of black bears to houses within Missoula depended on sex. As expected, the higher density of males reported within other urban areas is reflected by the frequency of males visiting Missoula. This result is important for the development of management plans to reduce bear conflicts while conserving population size. Female bears have a higher reproductive value than males because mating in black bears is promiscuous, and recruitment is therefore based on the number of females in the population. Management plans should be developed to integrate this difference, particularly given that wildlife managers and conservationists may be able to expect conflicts with males almost 2 times more often than with females. To fully understand this pattern, future research should compare behavior of males and females in urban areas, while including estimates of bear density and the costs and benefits of different human foods.

Using a time-to-event modeling framework, we found that fluctuations in wildland food availability did not describe when bears forage near houses, and that garbage was not the most important attractant related to bear movement near houses. These results elucidate 3 important concepts that can be applied to conservation efforts to reduce bear conflicts. First, a time-to-event modeling framework may be highly useful for describing when conflicts will occur and why they occur. As opposed to other procedures (e.g., generalized linear models), time-to-event models incorporate time into descriptive models, leading to more accurate estimations of when and why conflicts arise. Second, the frequently cited concept that bear conflicts are associated with wildland food failures should be integrated into management and conservation plans with caution. Our results clearly show that the probability of a bear foraging near a human home was based on the availability of urban foods, even when wildland foods were still available. Finally, our results suggest that the availability of garbage, the attractant most widely cited as the cause of bear conflicts, was less important than other attractants such as fruit trees in affecting when bears forage near houses. For urban areas in dry climates where multiple attractants are available (e.g., garbage and avocado trees—Lyons 2005), such as our study site and other areas within the interior western United States, the magnitude of bear dependence on garbage relative to other attractants should be carefully considered when developing proactive management plans to minimize the frequency of bear conflicts.

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