Living on the Edge: How Natural-Urban Edges Impact the Mass and Diets of Brown Bears in Aspen, CO

Quinn Johnshoy

Regis University

November 30, 2016

Contact: qjohnshoy@regis.edu

Abstract

Urbanization has led to several problems for wildlife, including habitat loss and fragmentation as well as loss of biodiversity. Several species have adapted their behavior to deal with increasing human dominance of the landscape, including the brown bear *Ursus actos*. In many instances, brown bears display an avoidance behavior to minimize contact with humans; however, when the urbanization causes an edge between a natural area and the urban area, bears have been known to stay close to the edge to utilize the different resources. I propose a study to examine the prevalence of brown bears in the natural areas and on the edge of an urban area and to also look at how any differences in foraging behavior may affect the bears' body size. I will use radio collars to track the bears to see where they spend most of their time and also take note of their foraging behavior to classify the types of food they eat. I will then use an allometric equation to estimate the weight of the bears and compare the masses between the natural and edge groups. This study could be useful when there is a plan to develop an area because it could show what types of impacts it has on the wildlife, and it could also help us to understand how to improve habitats for both bears and humans.

Introduction

Over the last few decades, we as humans have been drastically changing the natural environment to better suit our needs. This changing of the environment is also posing huge threats to different species; we are in the middle of the sixth mass extinction because of human efforts to change the natural world. One of the biggest contributors to this human-accelerated environmental change is land use, specifically urbanization. Urbanization leads to habitat loss and habitat fragmentation, which both influence biodiversity and ecological processes (Liu et al., 2016). With increasing urbanization and habitat loss, there is a loss of biodiversity in those areas because only a few species can tolerate such rapid environmental alterations (Sih et al., 2011).

One of the species that has been affected by increased habitat loss and urbanization is the brown bear *Ursus actos*. When faced with the possibility of human encounter, which increases when their habitat is lost to urbanization, brown bears preferentially select areas where they limit the likelihood that they will encounter humans (Apps et al., 2004; Martin et al., 2010; Ordiz et al., 2011).

Despite the avoidance behavior, there are instances where they prefer to be in anthropogenic edges rather than natural edges. Some female brown bears prefer the anthropogenic edges while the males prefer the natural areas (Stewart et al. 2016). The reasons for the preferences aren't clear. However, brown bears do choose to be near human-dominated areas if they know that they can find food there (Elfström et al., 2014). Brown bears differentially select their habitats according to their needs for food and shelter, so it is possible that they would choose to be on the urban-natural edge more if there is a higher availability of resources (Moe et al. 2007). This increase in bear density near urban edges has changed the seasonal composition of their diets to include anthropogenic sources of food (Kavčič et al., 2015). However, the more important factors of their diets can't be found easily by rummaging through human trash, so it is more likely that the bears would spend more time in a natural area rather than on the urban edge (Stenset et al., 2016). This means that the bears on the edge could be smaller than the ones in the natural area because their food on the edge is less than ideal compared to their natural diet. Despite that, an increase in population density of brown bears negatively impacts their body size, so the bears in the interior of the natural area could be smaller because the area is more densely populated (Zedrosser et al., 2006).

I propose a study to assess the bear prevalence at an urban edge as compared to an adjacent natural area to assess if the edge effect is strong when next to an urban area. The second part of the study will be to measure how the effects of foraging at the edge versus the interior impact the bears' size. I hypothesize that there will be a higher prevalence of bears in the natural area than in the edge area. I also hypothesize that the bears in the natural area will have a higher average mass compared to the bears that are on the edge because they'll be eating their natural diet. However, there is a possibility that the bears on the edge will have a higher body mass than the natural bears because anthropogenic foods have a higher caloric, protein, and fat value compared to a bear's natural diet (Baldwin & Bender, 2009). My alternative hypothesis is that the bears on the edge will have a higher average body mass than the natural bears because they have easier access to food with higher caloric content on the edge. Because the effects of urbanization on the body mass of brown bears hasn't been studied thoroughly, this study could be useful when deciding where to develop more land for urbanization because its effect on wildlife will be better understood and it could also give insight for how to improve habitats for both bears and humans in the Front Range area.

Methods

Study Area

I will conduct this study in Aspen, Colorado by the Roaring Fork River and Ute Avenue. Ute Avenue, located at 39°10'51.0°N 106°48'39.4°W, is what I will define as my edge. On one side of Ute Avenue, there is a natural forest area, and the on the other side is the developed area of the city of Aspen. The area I plan to assess along Ute Avenue is from where Ute Avenue goes from its dead end to Ute Place, which is roughly a half-mile stretch in total (Figure 1). Because it is close to the mountains, there are many bears there, including brown bears, and they have been known to enter the city of Aspen from the surrounding forest area.

Data Collection

The first thing that I will do is count the number of bears that are on the edge by Ute Avenue and count the number of bears that are in the adjacent forest area to assess the bear prevalence in each area. I will consider the edge area to be a tenth of a mile away from the road. To do this, I will be a tenth of a mile away from the edge of Ute Avenue in the middle of the half-mile stretch that I am using as my edge. For five consecutive days, I will spend four hours during the middle of the day in that spot and recording the number of bears that I see that are in the edge area. Another person will spend the same amount of time in the center of the forest area (which is located at 39°10'39.2"N 106°48'53.0"W) counting the bears that they see.

After receiving permission from the Institutional Animal Care and Use Committee and the city of Aspen, I will tranquilize and put radio collars on two bears, one found in the forest area and the other found in the edge area. I will then use a tape measure to measure their chest girth to relate it to their overall weight. The radio collar collects GPS data and stores it in the collar itself, and that information will be used to assess the proportion of time that each bear spends in a day on the in the city/in the edge area and the natural forest area. After leaving the collar on for two weeks, the bear will be tranquilized again and the collar will be taken off. The data from the collars will be transferred to a computer and then erased from the collars. I will repeat this process three more times to get information from eight bears total, with four of the bears being found in the edge area and the other four being found in the forest area. This is how I will determine how much time each bear spends in both areas.

During the second week that the bears have the collars on, I will monitor one bear while someone else monitors the other and we will track the amount of time it spends feeding and the amount of time it spends doing things other than eating using instantaneous focal sampling. We will watch each bear for six hours for five consecutive days and take note of what it does once every five minutes. While the bear is feeding, we will note what it is eating both from the natural area and the edge area (if it applies). Once each bear's activities and food intake are recorded, I will tranquilize them again to remove the radio collars. We will then repeat this process for the remaining six bears. I don't anticipate any negative impacts on natural resources; however, the bears do need to be carefully monitored upon being tranquilized to make sure that their health isn't adversely affected by the drug.

Data Analysis

With the data collected from counting the bears at each site, I will conduct a t-test with a significance level of 0.05 to determine if the prevalence of bears at one area is significantly higher than at the other area.

I will classify any bear that spends >30% of its time in the edge area to be an "urban" bear, and any bear that spends ≤30% of its time in the edge area as a "forest" bear. Using that criteria, I will calculate the proportion of time that each bear spends eating vs. not eating and average that out for the "urban" group and the "forest" group (Figure 2). I will conduct a t-test to determine if one group spends more time eating than the other group. If the difference is significant with a p-value of ≤0.05, then any significant difference in weight between the two groups could be attributed to more time spent eating, not because of a difference in diet.

For each group, I will also average the proportions of the types of foods they were eating and present it in a stacked bar graph (Figure 3). I will conduct a chi-square analysis to determine if the distributions of the types of food eaten are significantly different with a p-value of ≤0.05.

To determine the weight of each bear, I will use the chest girth measurement and put it into equations found by Kolenosky et al. (1989) to be accurate for bears weighing more than 100 kg. The equations differentiate the weight based on sex, and they are as follows: male weight in kg=0.00476(chest girth in cm)$^{2.69}$ (r^2=0.97) and female weight in kg=0.000775(chest girth in cm)$^{2.69}$ (r^2=0.95). I will then plot the differences on two scatterplots (one for females and one for

males) comparing time spent in the edge area to overall body mass and use a linear regression to determine if there is a correlation (Figure 4). I will consider an $r^2>0.90$ to be significant.

Figure 1. This figure shows the proposed study area in Aspen, CO. The length of the edge along Ute Avenue is denoted by the red stars.

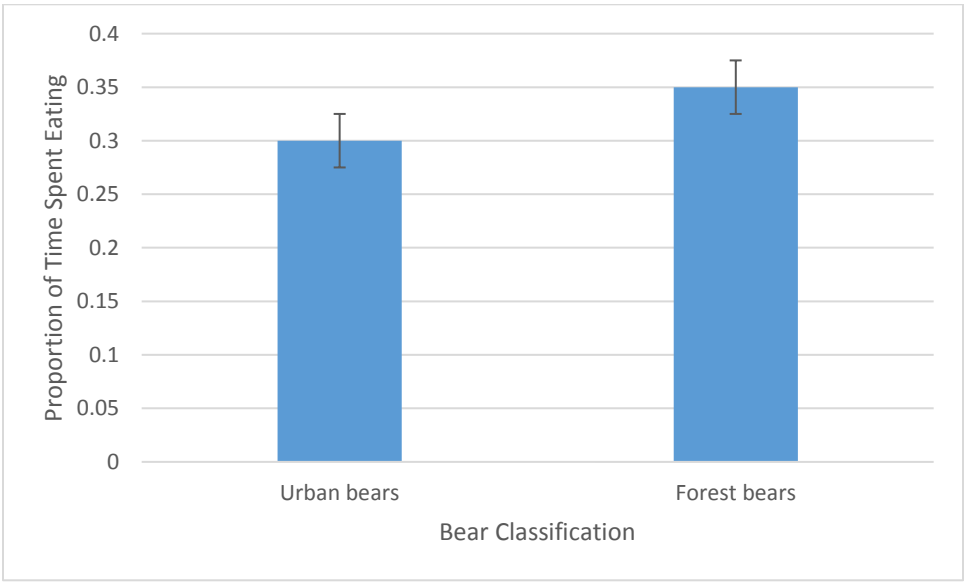

Figure 2. A sample bar graph showing the average proportion of time spent eating by the urban bears and the forest bears.

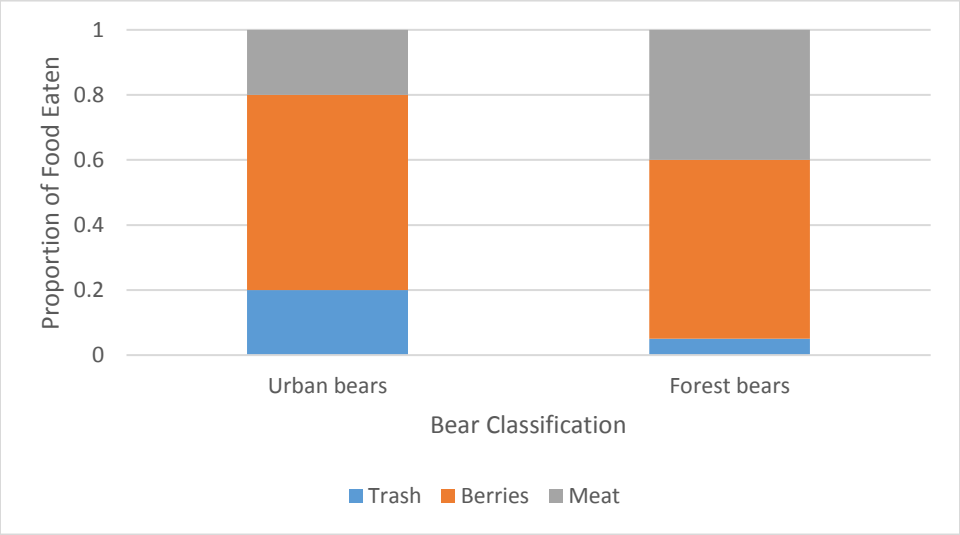

Figure 3. A sample stacked bar graph showing the average proportions of each type of food eaten by the urban bears and the forest bears.

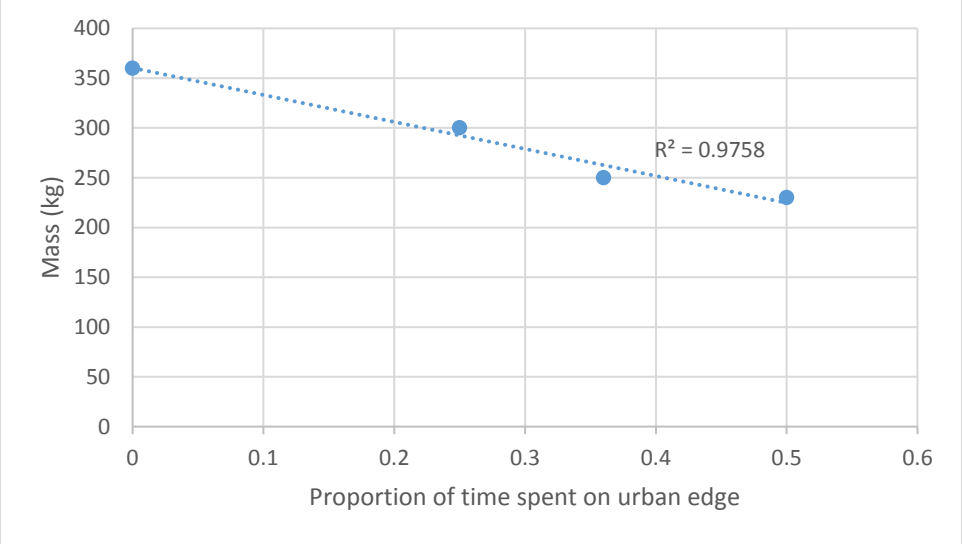

Figure 4. A sample scatterplot relating proportion of time that female bears spent in the edge area to their mass. A linear regression line was added because of a significant r^2 value.

Appendix

Table 1. This is the proposed project schedule.

DATE	ACTIVITY
June 1-5, 2017	Count bear prevalence in natural area and edge area, select 2 bears, put radio collars on them and measure chest girth
June 6, 2017	Put radio collars on two bears and measure chest girth
June 13-17, 2017	Collect data on feeding behavior and food eaten for the two collared bears
June 17, 2017	Remove radio collars and download data; put radio collars on two different bears and measure chest girth
June 24-28, 2017	Collect data on feeding behavior and food eaten for the two collared bears
June 28, 2017	Remove radio collars and download data; put radio collars on two different bears and measure chest girth
July 5-9, 2017	Collect data on feeding behavior and food eaten for the two collared bears
July 9, 2017	Remove radio collars and download data; put radio collars on two different bears and measure chest girth
July 16-20, 2017	Collect data on feeding behavior and food eaten for the two collared bears
July 20, 2017	Remove radio collars and download data
July 21, 2017-August 3, 2017	Data analysis
August 4-17, 2017	Report write-up
August 18, 2017	Final report submission

Table 2. This is a sample data collection sheet for the eight bears being monitored throughout the study.

Bear number and sex	Chest girth (cm)	Time spent eating natural food	Time spent eating anthropogenic food	Time spent not eating
Bear 1 Male				
Bear 2 Male				
Bear 3 Female				
Bear 4 Male				
Bear 5 Female				
Bear 6 Male				
Bear 7 Female				
Bear 8 Female				

Table 3. This table shows the anticipated budget expenses for the proposed study. I will hire an assistant to help monitor the bears. The total grant award amount is $5,000.

Item	Justification	Cost per unit (Source)	Number Needed	Total
Radio collars	Needed to obtain GPS data on bear locations	$300 (Biotrack)	2	$600
Xylazine tranquilizer	Needed to tranquilize bears to put on/take off radio collars	$27 (Medi-vet)	16	$432
Tape measure	Needed to measure chest girth	$1 (Widget Supply)	1	$1
Field Assistant	Needed for help with behavioral monitoring	$9/hr	140	$1260
Personal Stipend	Compensation for research	$10/hr	205	$2050
Direct Cost Total				$4343
Regis University Overhead (15% of direct costs)				$651.45
TOTAL				$4994.45

References

Apps, C. D., McLellan, B. N., Woods, J. G., & Proctor, M. F. (2004). Estimating grizzly bear distribution and abundance relative to habitat and human influence. *Journal Of Wildlife Management, 68*(1), 138-152.

Baldwin, R. A., & Bender, L. C. (2009). Foods and nutritional components of diets of black bear in Rocky Mountain National Park, Colorado. *Canadian Journal Of Zoology*, 87(11), 1000-1008.

Elfström, M., Zedrosser, A., Jerina, K., Støen, O., Kindberg, J., Budic, L., & ... Swenson, J. E. (2014). Does despotic behavior or food search explain the occurrence of problem brown bears in Europe?. *Journal Of Wildlife Management, 78*(5), 881-893.

Kavčič, I., Adamič, M., Kaczensky, P., Krofel, M., Kobal, M., & Jerina, K. (2015). Fast food bears: brown bear diet in a human-dominated landscape with intensive supplemental feeding. *Wildlife Biology, 21*(1), 1-8.

Kolenosky, G. B., Lunn, N. J., Greenwood, C. J., & Abraham, K. F. (1989). Estimating the weight of polar bears from body measurements. *Journal of Wildlife Management*, 188-190.

Liu, Z., He, C., & Wu, J. (2016). The relationship between habitat loss and fragmentation during urbanization: an empirical evaluation from 16 world cities. *Plos ONE, 11*(4), 1-17.

Martin, J., Basille, M., Van Moorter, B., Kindberg, J., Allainé, D., & Swenson, J. E. (2010). Coping with human disturbance: spatial and temporal tactics of the brown bear (Ursus actos). *Canadian Journal Of Zoology*, *88*(9), 875-883.

Moe, T., Kindberg, J., Jansson, I., & Swenson, J. (2007). Importance of diel behaviour when studying habitat selection: examples from female Scandinavian brown bears (Ursus actos). *Canadian Journal Of Zoology*, *85*(4), 518-525.

Ordiz, A., Støen, O. G., Delibes, M., & Swenson, J. E. (2011). Predators or prey? Spatio-temporal discrimination of human-derived risk by brown bears. *Oecologia, 166*(1), 59-67.

Sih, A., Ferrari, M.C.O. & Harris, D.J. (2011). Evolution and behavioural responses to human-induced rapid environmental change. *Evolutionary Applications*, 4, 367–387.

Stewart, B. P., Nelson, T. A., Laberee, K., Nielsen, S. E., Wulder, M. A., & Stenhouse, G. (2013). Quantifying grizzly bear selection of natural and anthropogenic edges. *Journal Of Wildlife Management, 77*(5), 957-964.

Zedrosser, A., Dahle, B., & Swenson, J. E. (2006). Population density and food conditions determine adult female body size in brown bears. *Journal Of Mammalogy, 87*(3), 510-518.