

**A DIET COMPARISON OF BLACK BEARS, BOBCATS, AND COYOTES IN  
WESTERN MARYLAND**

by

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A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Honors Bachelor of Science in Wildlife Conservation with Distinction

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## ABSTRACT

Scat surveys can provide valuable insight into a predator's role in its ecosystem through nonintrusive and inexpensive means. Here I've conducted a scat survey to examine the diets of black bears (*Ursus americanus*), bobcats (*Lynx rufus*) and coyotes (*Canis latrans*) in Western Maryland. The three study sites were each 2,000 ha in Savage River, Green Ridge, and Potomac-Garrett state forests. We collected scats opportunistically for 4 months in the summer ( $n=36$ ) and sorted the contents into deer, small prey, invertebrates, and plants. We only collected 3 bobcat scats so I did not include them in any statistical analysis. I calculated the frequency of occurrence of each category and used several overlap indices to determine the similarity of black bear and coyote diets, both among study sites and compared to each other. Black bears ate primarily plant matter, and coyotes most frequently ate small prey items followed by white-tailed deer (*Odocoileus virginianus*). Black bear and coyote diets did not differ among sites, and their diets did not overlap at each site and overall. The bears' consumption of plant matter as well as the occasional white-tailed deer was consistent with existing research. The coyote diets were also consistent with the current literature, although they are not often documented to eat such large numbers of invertebrates.

## Chapter 1

### INTRODUCTION

Determining the diet of carnivores provides critical insight into various other traits of their life history and their role in the ecosystem, but this task is typically hard to accomplish due to the secretive nature of these predator species. Scat surveys are often the method of choice when examining predator diets because they are non-invasive, inexpensive, and scats are relatively easy to acquire compared to attempting to observe these species' behavior.

Black bears (*Ursus americanus*), coyotes, (*Canis latrans*), and bobcats (*Lynx rufus*) reside in western Maryland, where overlap in their diets may require the need for resource partitioning. The general diets of these species have been studied throughout their ranges, but the exact diet composition of the populations inhabiting Maryland's Garrett and Allegany counties has never been examined. Therefore it remains to be seen if bobcats, black bears, and coyotes significantly overlap in the food items they consume here.

Black bears (hereafter referred to as bears) were abundant in this area until they were extirpated from all but the mountainous region of western Maryland in the mid-1800's (Fecske et al. 2002). Bears were protected by the Maryland Department of Natural Resources [MDNR] in 1972 and have been abundant enough to be considered a game species since 1985 (Fecske et al. 2002). A 2011 study estimated the current



population in Garrett County to be 425 individuals and 295 in Allegany County, for a total of 720 bears in the two counties examined in this thesis (Jones 2012). Black bears have been described as opportunistic omnivores whose diets are dominated by plant matter with occasional prey items (Benson and Chamberlain 2006). Their diets tend to shift throughout the seasons in response to changes in food availability; for example, Benson and Chamberlain (2006) found white-tailed deer (*Odocoileus virginianus*) to be the most common mammal consumed by bears in the summer and fall, during fawning and deer-hunting seasons (2006).

Coyotes have not historically occupied the Mid-Atlantic States, but in recent years their range has expanded rapidly throughout the eastern United States (Crimmins et al. 2012). Studies conducted in West Virginia and Mississippi found coyotes to be seasonally omnivorous: white-tailed deer made up most of the biomass consumed in both studies, followed by a combination of rodents, rabbits, and fruits (Crimmins et al. 2012, Chamberlain and Leopold 1999).

Bobcats are known to be present in western Maryland, but no studies have yet been conducted to determine their current population size. Bobcats tend to be more specialized predators and consume less plant matter than black bears and coyotes (Chamberlain and Leopold 1999). White-tailed deer and rabbits are typically the most often consumed prey items, followed by rodents and other small mammals (Progulske 1952, Fritts and Sealander 1978, Chamberlain and Leopold 1999).

My objective with this study is to provide the first examination of the composition of black bear, bobcat, and coyote diets in western Maryland. Through a

scat analysis, I have identified food items consumed by these predators in order to gain a broad understanding of their general summer diets. I have also determined if the diets of the 3 species overlapped and if the diet of each species differed among the 3 study sites.

## **Chapter 2**

### **STUDY AREA**

We collected scat samples from 3 2,000 ha sites in Maryland's 2 westernmost counties. The first site lies within Green Ridge State Forest, located in the ridge and valley area of Allegany County. Green Ridge was the largest patch of upland forest in Maryland, containing mostly even-aged oaks as well as various mixed-aged pines and understory trees like redbud (*Cercis canadensis*) and flowering dogwood (*Cornus florida*) (MDDNR 2016a). The forest had a relatively dry climate, receiving an average of 36 inches of rainfall annually.

The second site, Savage River State Forest, sits west of Green Ridge on the Appalachian plateau in Garrett County. Considered a second growth mixed hardwood forest, it contained predominantly oaks (*Quercus spp.*), sugar and red maples (*Acer saccharum* and *A. rubrum*), black cherry (*Prunus serotina*), hickory (*Carya spp.*), and ash (*Fraxinus spp.*) (MDDNR 2016c). Similar wildlife species inhabited Savage River as did Green Ridge State Forest (MDDNR 2015).

Farther west into Maryland lays Potomac-Garrett State Forest, the last study site, also in the Appalachian plateau region of Garrett County. This site also held a second growth mixed hardwood forest and contained similar vegetation as the other two locations (MDDNR 2016c). All three sites hosted similar common wildlife species, including white-tailed deer (*Odocoileus virginianus*), gray and fox squirrels

(*Sciurus carolinensis* and *S. niger*), red fox (*Vulpes vulpes*), wild turkey (*Meleagris gallopavo*), ruffed grouse (*Bonasa umbellus*), black bears (*Ursus americanus*), bobcats (*Lynx rufus*), and coyotes (*Canis latrans*) (MDDNR 2016a).

### **Chapter 3**

#### **METHODS**

We collected scats from May to August 2015. Rather than using transects, we collected scats opportunistically while hiking throughout each site. We placed each scat in a Ziploc bag labeled with the suspected species, date, and GPS location, and froze each sample within 12 hours of collection.

Before thawing the samples I weighed each one and took a subsample that would remain frozen for potential future genetic testing. I placed each sample in a nylon stocking and then put them in a water bath for approximately 4 hours to thaw; the nylon allowed the water to permeate the sample in order to speed up the thawing process without losing any of the scat's content.

Once the scats thawed I removed them from the nylon and rinsed them in a 3.35mm No. 6 and a 355 $\mu$ m No. 45 U.S.A. standard test sieve (Fisher Scientific Company) to remove as much fecal matter as possible while still retaining small objects like seeds and hair. I placed the rinsed samples in Ziploc bags and put them back in the freezer until they could be dried. Before drying we thawed the samples in their bags for 4 hours. We then removed the contents from the bags and placed them in a dryer for 24 hours at 75° Celsius.

I sorted the contents of the dried scats into 4 categories: deer, small prey, invertebrate, and plant. I defined small prey items as rodents, soricomorphs, birds, and

lagomorphs. I then identified the contents to the most specific taxonomic level possible. As they were usually too disturbed from digestion to properly identify, I identified invertebrates only to the order level.

Avian remains could be identified by the presence of structures like bills, feathers, and intact feet. I could not determine the species of the avian prey, but I could identify the order based on the characteristics of the bills and feet. I identified mammals by examining their bone and hair structures. I placed hairs on microscope slides coated with clear nail polish and then examined them using standard microscope procedures. In order to identify the species or order of the hair I examined the medulla and cuticle and referenced dichotomous keys (Debelica and Thies 2009, Huffman et al. n.d.). I identified plant matter and seeds using reference samples collected from the study sites and other keys and reference material (UNH Cooperative Extension 2013).

I assessed the importance of a food item to each species' overall diet using frequency of occurrence, which I found by dividing the number of scats in which a food item was found by the total number of collected scats (Klare et al. 2011). I weighted the food item found in each scat by visually estimating the volumetric proportion of the scat that item made up; I discarded any item with a proportion less than 0.15 from analysis because I assumed it was incidentally consumed as the animal ate the main food item. I used several approaches to analyze the overlap of the predator's diets, both as a comparison of each species among the study sites and as a comparison of the different species' diets overall and per site. I used Pianka's index to find a symmetric level of overlap, meaning the outcome will always be the same

regardless of the order of calculation (Krebs 1999). I also calculated percentage overlap, which provides an easily interpreted representation of niche overlap (Krebs 1999). Furthermore I found Morisita's index of overlap, a model based on information theory (Krebs 1999). For each test a result of greater than 0.60 or 60% indicated significant overlap (Krebs 1999).

## **Chapter 4**

### **RESULTS**

We collected 16 bear scats, 17 coyote scats, and 3 bobcat scats from the 3 sites (Table 1). An additional 3 samples could not be identified to species, and 1 scat collected belonged to a red fox. Because the sample size of bobcat scats was so low, I did not include them in my statistical analyses.

Bear diets consisted primarily of plant matter, at each site and overall (Table 3, Fig. 1, Fig. 2). Invertebrates and small prey were not important food items for bears. Coyotes consumed small prey items more than any other food category, followed by deer (Table 3, Fig. 1, Fig. 2). Plants were not an important food item for coyotes overall or at any of the sites. The diets of coyotes and black bears did not show any differences between each site (Table 2). Each overlap index indicated that bears and coyotes did not significantly overlap at each site and overall (Table 3).



## **Chapter 5**

### **DISCUSSION**

Our findings support the notion that black bears are opportunistic omnivores (Benson and Chamberlain 2006). Like other black bear diet studies, we found that plant matter made up most of the food items eaten (Benson and Chamberlain 2006, Dobe et al. 2005, Romain et al. 2013).

The frequency of occurrence of white-tailed deer in the bear scats from our study sites was consistent with the available literature (Benson and Chamberlain 2006). Bear diets were statistically similar at Savage River and Green Ridge, which we expected due to the similarity of the vegetation at each site.

We found that small prey was the main food item consumed by coyotes in this area, followed by deer. These results are consistent with a similar study conducted in West Virginia, which found that coyotes rely more heavily on rodents and other small mammals and birds than deer in the summer (Crimmins et al. 2012). Coyotes are not often documented to consume invertebrate species, yet invertebrates made up approximately 20% of their diet at these sites. They ate a diverse variety of invertebrates, with grasshoppers (Orthoptera) and beetles (Coleoptera) being the most common. As with the bears, the coyote diets did not differ between each site.

The small sample size of 3 bobcat scats makes drawing conclusions about bobcat diet difficult. One bobcat scat contained deer and unknown rodent remains, the

second contained remains from an unknown rodent, and another contained remains of a mole. These findings are consistent with the available literature (Progulske 1952, Fritts and Sealander 1978, Chamberlain and Leopold 1999, McLean et al. 2005), though if we had found more bobcat scats we would expect to find more lagomorph remains present. We would also expect to see considerable overlap between bobcats and coyotes, especially in regards to deer and small prey. However, further data collection will be required to establish a more conclusive representation of bobcat diets in this area.

The diets of bears and coyotes did not overlap at Savage River, Green Ridge, and overall, which we expected given that bears tend to consume far more plant matter and coyotes more prey items. Bears and coyotes experienced the largest overlap with the amount of deer consumed but they likely do not experience much competition over this resource, as deer are not the most frequently consumed food type for either species.

The results of this study act as a general overview of the components of black bear, bobcat and coyote diets in Western Maryland and provide a basis for future research on this subject; because of the relatively small sample size of 36 scats we can only draw somewhat speculative conclusions from the data.

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**Appendix A**  
**TABLES AND FIGURES**

Table 1. Total number of scat samples collected per species from May through August 2015.

	Bear	Bobcat	Coyote
Savage River	11	1	6
Green Ridge	5	1	8
Potomac-Garrett	0	1	3
Total	16	3	17

Table 2. Overlap of bear and coyote diets at Savage River, Green Ridge, and Potomac-Garrett state forests from May through August 2015.

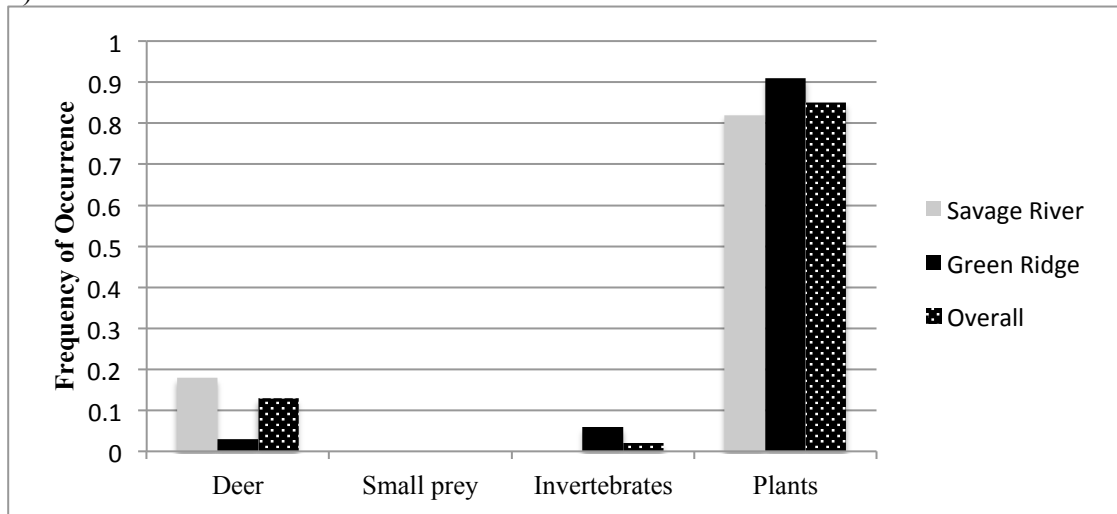
Index	Savage River/Green Ridge		Savage River/Potomac-Garrett		Green Ridge/Potomac-Garrett	
	Coyote	Bear	Coyote	Bear	Coyote	Bear
Pianka's	0.98	0.98	0.71		0.65	
% Overlap	90%	85%	59%		53%	
Morisita's	0.98	0.97	0.70		0.64	

Table 3. Frequency of occurrence of each food category per species at Savage River, Green Ridge, and Potomac-Garrett and overall from May through August 2015, with weighted number of food items found in parentheses. Indices indicating level of overlap present in bear and coyote's diets per site and overall.

Food Item	Savage River		Green Ridge		Potomac-Garrett		Overall	
	Bear	Coyote	Bear	Coyote	Bear	Coyote	Bear	Coyote
Deer	0.18 (2)	0.42 (2.5)	0.03 (0.15)	0.42 (3.35)	0 (0)	0 (0)	0.13 (2.15)	0.34 (5.85)
Small prey <sup>a</sup>	0 (0)	0.38 (2.25)	0 (0)	0.43 (3.45)	0.55 (1.65)	0 (0)	0 (0)	0.43 (7.35)
Invertebrates	0 (0)	0.21 (1.25)	0.06 (0.3)	0.10 (0.80)	0.45 (1.35)	0.02 (0.30)	0.02 (0.30)	0.20 (3.40)
Plants	0.82 (9)	0 (0)	0.91 (4.55)	0.05 (0.40)	0 (0)	0 (0)	0.85 (13.55)	0.02 (0.40)
Overlap Index								
Pianka's	0.15		0.11				0.13	
% Overlap	18%		14%				17%	
Morisita's	0.14		0.11				0.12	

<sup>a</sup>Small prey includes rodents, soricomorphs, lagomorphs, and birds.

a) Black bear



b) Coyote

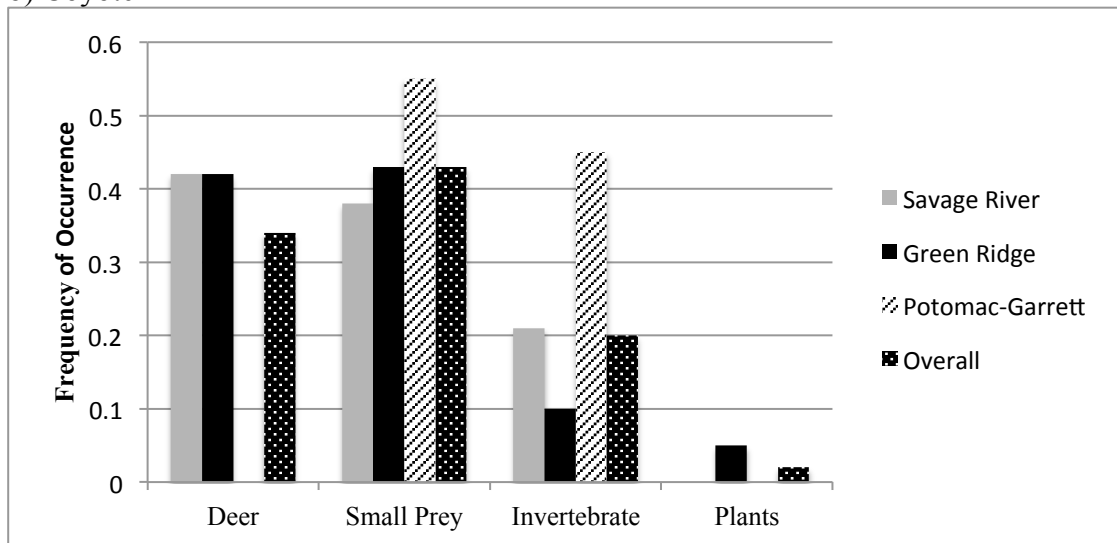


Figure 1. Comparison of black bear diets (a) and coyote diets (b) at Savage River (gray bar), Green Ridge (black bar), and Potomac-Garrett (striped bar) from May through August 2015.



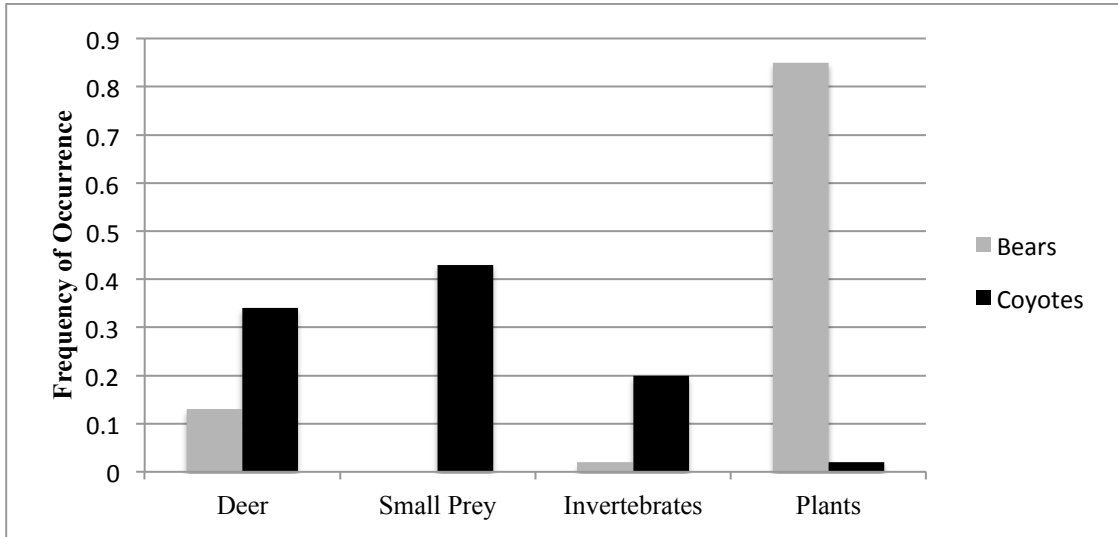


Figure 2. Comparison of black bear (gray bar) and coyote (black bar) diets at Savage River, Green Ridge, and Potomac-Garrett combined from May through August 2015.

Table 4. Number of scats containing each food item at all sites with frequency of occurrence of main categories in parentheses. Scats were collected from Savage River, Green Ridge, and Potomac-Garrett state forests from May through August 2016. Asterisk indicates some of the food item were omitted from analysis because of assumed accidental consumption.

Food Item	Bear (n=16)	Coyote (n=17)	Bobcat (n=3)
<b>Deer</b>	5 (0.13)*	8 (0.34)	1 (0.33)
<b>Small Prey</b>	0 (0)	12 (0.43)	0 (0)
Passeriformes	0	1	0
Phasianidae	0	2	0
Rodentia	0	5	0
Soricomorpha	0	1	2
Lagomorpha	0	2	0
<b>Invertebrate</b>	8*	11*	0
Arachnid	0	1	0
Coleoptera	6*	6*	0
Lepidoptera	0	3	0
Orthoptera	2*	7*	0
Hymenoptera	4*	4*	0
Diptera	0	1	0
Hemiptera	0	2*	0
Crustacean	0	1	0
Gastropod	0	1*	0
<b>Plant</b>	14 (0.85)	4 (0.02)*	0 (0)
Sunflower ( <i>Helianthus spp.</i> )	0	1*	0
Hickory ( <i>Carya spp.</i> )	2	0	0
Squawroot ( <i>Conopholis americana</i> )	2	0	0
Skunk cabbage ( <i>Symplocarpus foetidus</i> )	1	0	0
Goldenrod ( <i>Solidago spp.</i> )	1	0	0
Smooth blackberry ( <i>Rubus canadensis</i> )	5	2	0
Jack-in-the-pulpit ( <i>Arisaema triphyllum</i> )	1	0	0
Spruce ( <i>Pinaceae sp.</i> )	0	1*	0
Corn ( <i>Zea mays</i> )	1	0	0