

Black Bear Abundance, Habitat Use, and Food Habits in the Sierra San Luis, Sonora, México

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Abstract—We studied black bears to determine habitat use, food habits, and abundance between April 2002 and November 2003 in the Sierra San Luis, Sonora. We utilized transects to determine spoor presence, camera traps for abundance, and scat analysis. During 2002, bears fed principally on plant material, and for 2003 on animal matter, namely livestock. Habitat use differed between years and seasons. In general terms, we recorded black bears more frequently during 2002 than 2003, attributing this change to a lack of resources, fruits, and water in our study area.

Introduction

Black bear populations in Mexico have been severely affected by many adverse factors such as habitat loss, poaching, and illegal trade among others. Consequently the species is classified as “endangered of extinction” by Mexican laws (SEMARNAT 2002). Species distribution is poorly known in Mexico, only having verified records for the Mexican states of Sonora, Chihuahua, Coahuila, Nuevo León, Zacatecas, and Durango. The bear’s historical distribution is thought to have been reduced by 20% (SEMARNAP 1999). To date, black bears in Mexico have only been studied to detail in Coahuila (Doan-Crider 1995). This lack of information prevents the formulation of sound management decisions concerning the conservation of black bears in Mexico. The main objectives of this study are to determine food habits, habitat use, and abundance of Mexican black bears in the Sierra de San Luis, Sonora.

Study Area

During the 2002-2003 period we studied black bears at El Pinito ranch (68.8 km²), located in the Sierra San Luis, Sonora, between 108° 56' 46" N latitude and 31° 11' 49" W longitude (figure 1). The area according to the Mexican national forestry inventory is covered by pine forests, pine-oak forests, pine-oak forests with second growth, open low forest, grasslands, and chaparral (Palacio-Prieto et al. 2000). The second year of the study (2003) was characterized by the El Niño phenomenon, exacerbating the already harsh drought conditions of the area.

Methods

We used wildlife and human-made trails in El Pinito to set up transects of 3 km length between April 2002 and early December 2003 to detect patterns of habitat use and food habits

by black bears. We walked these trails every other week, looking for spoor (i.e., footprints and scats). We complemented habitat use data with camera traps (Camtracker™) placed along the trails, nine in 2002 and six in 2003. We used commercial sardines to attract black bears. Camera traps were checked every three weeks, to replace the batteries and review if any photo was taken. Survey periods were divided into three biologically meaningful seasons: dry (April 20 to July 5, 2002, and April 2 to July 31, 2003), wet (July 6 to October 9, 2002, and August 1 to October 8, 2003) and dry-II (October 10 to November 23 in 2002 and 2003). We covered approximately 156.35 km² in 2002 and 187.22 km² in 2003.

Food Habits

Black bear diets were determined by examining scats collected from the different trails during the two-year study period. As scats were collected, date and location were recorded. All droppings were washed, air dried, and analyzed in the laboratory. The scats were separated by year and season of collection. Food items were sorted and identified to the smaller taxonomic category. The relative frequency and the consumed biomass were determined for each food item for the two years and the three seasons within a year using the following methods.

Relative frequency (RF) was calculated using $RF = fi / F \times 100$ where: fi = number of scats where an item appears and F = number of total frequencies of all items in all scats (Martínez, 1994; Hidalgo, 1998). Biomass consumed (BC) was calculated using $BC = (RF_i \times CF) / \sum (RF_i \times CF) \times 100$ where RF_i = relative frequency of the item; CF = the correction factor of the item. The following correction factors were used according to Hewitt and Robins (1996): leaves, sprouts, and flowers = 0.26; roots and fruits = 0.93; hard mast = 1.5; insects = 1.1; small mammals and birds = 4; hair = 15; and bones and skin = 1.5.

We used Jaccard’s similarity index to determine how similar the diets between years and seasons were, $CC_j = c / s_1 + s_2 - c$ where s_1 and s_2 is the total number of items per year or season and c is the number of shared items (Brower et al. 1998).

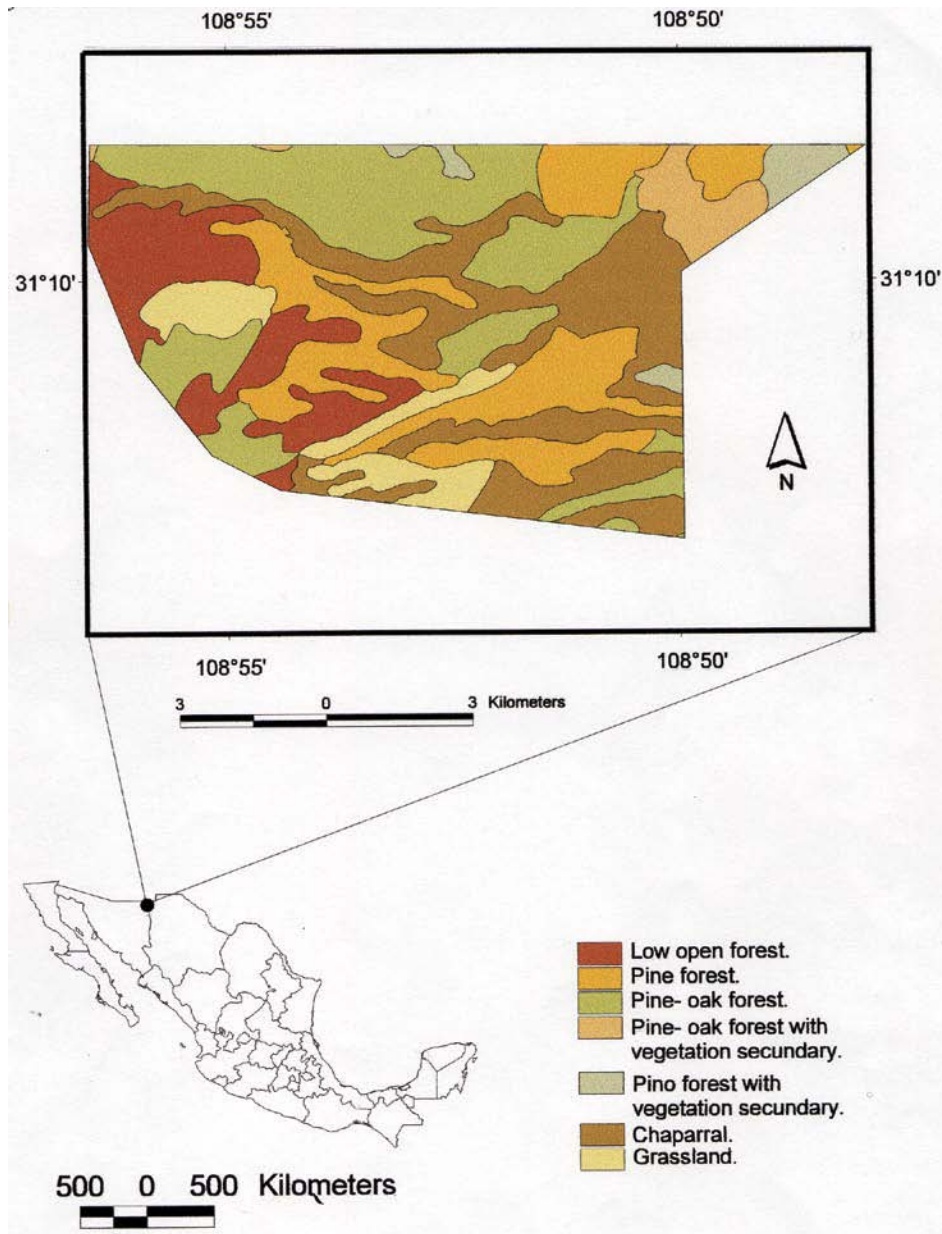


Figure 1—Vegetation types in the El Pinito ranch located in the Sierra San Luis Sonora, Mexico.

Habitat Use

For the habitat selection we combined spoor (scats and footprints) and photographic data gathered for the two years (and three different seasons) to determine use of different vegetation types. These data were plotted using ArcView v.3.2 (ESRI 1999) creating a Geographic Information System (GIS). We used the National Forestry Inventory classification layer to determine which plant associations were used each year and season. In order to determine significant differences between years we used Chi-square analysis and Bonferroni intervals to determine preference, no preference, or use as expected by chance (Byers et al. 1984).

Abundance and Density

We obtained two measures of abundance using camera trap data (24 hrs) within the seasons and the two years. The first

method uses the number of days of all cameras until the first photo is taken; for this data we use the equation $Y = 133.89 X^{-0.971}$ (Carbone et al. 2001) where Y is the number of trap days until the first photo was taken and X is the number of individuals in 100 km². The relative abundance was calculated as the number of total photographic records taken within a season divided by the total number of camera trap days times 100.

Results

Food Habits

During 2002 we analyzed a total of 180 scats (66 dry, 65 wet, and 49 dry-II), with a total of 24 prey items (12 animal items and 12 plant material), and 47 scats for 2003 (32 dry, 13 wet and 4 dry-II) for a total of 16 prey items (8 plants and 8 animals).

Table 1—Food items and the consumed biomass estimated for the study period.

Food items	Total		Dry		Wet		Dry-II	
	2002	2003	2002	2003	2002	2003	2002	2003
<i>Arctostaphylos pungens</i>	27.1	2.1	39.3	2.8	25.3		11.3	
<i>Juniperus deppeana</i>	34.0	22.8	10.9	18.6	32.9	42.0	71.2	20.0
<i>Dasyllirion wheeleri</i>	2.8	0.9	5.7	1.0	1.7	0.6	0.3	
Herb	1.8		1.7		1.8		1.8	
<i>Quercus</i> sp	8.2	1.7	6.9	2.2	10.7		6.1	
<i>Yucca bacata</i>	2.2	0.3	1.8	0.5	0.6		5.6	
<i>Nolina bigelovii</i>	0.4	0.8	0.7	0.9	0.3	0.6		
<i>Opuntia</i>		2.4		0.5		8.0		8.3
<i>Pinus</i> sp	0.3		0.7		0.2			
<i>Prunus persica</i>	0.9	0.3		0.5	2.2			
Seed 1	0.2		1.8					
Seed 2	0.7		0.6					
Seed 3	0.2		0.6					
<i>Odocoileus virginianus</i>	4.3	11.1	7.9	7.4	2.7		1.5	66.8
<i>Bos taurus</i>	1.4	50.0	4.0	59.6		32.3		
<i>Conepatus mesoleucus</i>	0.4		1.0					
<i>Spilogale putorius</i>	0.4		1.0					
Birds	1.9				4.7			
Opilionids	0.5		0.7		0.7			
<i>Diplocentrus peloncillensis</i>	1.8	0.4	0.7	0.5	3.3		1.1	
Formicidae	5.2	1.6	7.3	1.6	6.5	2.4		
Vespidae	2.6	0.4	3.6		3.3	2.4		
Apidae	0.3		0.7					
Orthoptera	1.3		0.7		2.0		1.1	
Coleoptera	1.0	0.8	1.5		1.3	4.7		
Homoptera		4.1		3.8		4.7		4.9
Molusca		0.4				2.4		
N/ period	24	16	22	13	17	10	9	4

For 2002, black bear diets were composed by vegetational items through the consumption of manzanita (*Arctostaphylos pungens*) and junipers (*Juniperus* sp.) representing 61.1% of the total BC. In contrast, consumption of manzanita and juniper in 2003 was drastically reduced by 92.6% and 33% respectively. Bears were more carnivorous by increasing the use of livestock by 97.3% and up to 61.1% in white-tailed deer, with these two species composing more than 60% of the total BC during that year. In addition, we report the consumption of scorpions (*Diplocentrus peloncillensis*), an item that has never been reported as having been eaten by bears. Jaccard's index was 0.48 confirming changes in the composition of the items used by black bears.

Dry Season

During 2002, the main items consumed by black bears were manzanita, junipers, white-tailed deer, and ants representing 65.4% of the total BC. In contrast, in 2003 bears fed mostly on livestock and white-tailed deer, adding up to 66.9% of the total BC for that season (table 1). During the dry season, the similarity index was 0.4.

Wet Season

For 2002, the most important prey items were junipers and manzanita representing 58.2% of the biomass, whereas during 2003 junipers and livestock accounted for 74% of the BC (table 1). For this season, the similarity index was 0.28 showing a very different diet for both years.

Dry-II Season

We found the least diverse diet for both years during this season (table 1). During 2002, junipers and manzanita accounted for 82.5% while in 2003, white-tailed deer accounted for 66.8% of the diet. The similarity index for this season was only 0.18 showing a dramatic change between prey items used by black bears in the different years.

Habitat Use

We obtained a total of 916 records (730 for 2002 and 186 for 2003). For 2003 we found a higher habitat use of oak-pine forest ($0.250 > P < 0.384$), pine forest with second growth ($0.054 > P < 0.139$), and grasslands ($0.063 > P < 0.152$) than

Table 2—Use of the communities in the study period where (+) = significantly higher use in 2003 compared to 2002; (-) = significantly lower use in 2003 compared to 2002; and (=) = proportional use in both years.

Community	General			Dry season			Wet season			After wet season		
	2002	2003	Use	2002	2003	Use	2002	2003	Use	2002	2003	Use
Low open forest	28.82	15.05	-	27.01	13.61	-	34.5	21.88	=	21.96	14.29	=
Pine forest	16.12	12.09	=	14.98	5.44	-	14.7	40.63	+	19.06	42.86	=
Pine forest with secondary vegetation	0	9.68	+	0	10.68	+	0	0	-	0	28.57	=
Pine-oak forest	14.98	31.72	+	10.92	40.14	+	11.5	0	-	23.36	0	-
Pine-oak forest with secondary vegetation	4.56	2.69	=	3.45	1.36	-	7.99	9.38	=	0.47	0	-
Chaparral	31.81	17.20	-	39.66	14.97	-	30.03	28.13	=	28.04	14.29	=
Grassland	3.71	10.75	+	4.02	13.61	+	1.28	0	-	3.71	0	-

in 2002. Open low forest and chaparral were less used in 2003 than in 2002 (table 2). During the dry season, we recorded an increase in the use of pine-oak forest, pine forest with second growth, and grasslands compared to 2002, where black bears used the other communities less than expected (table 2). For the wet season there was significant increase in the use of pine forest; as expected, bears used open low forest, chaparral, and pine-oak with second growth (table 2). For the 2003 dry-II season, black bears avoided pine-oak forest, pine-oak with second growth, and grasslands and used the remaining communities as expected (table 2).

Abundance and Density

We obtained a total of 134 photographs (96 in 2002 and 38 in 2003). For both years, we recorded a higher relative abundance during the dry season than either the wet season or the dry-II season (figure 2). The difference in abundance can be related to densities estimated per sampling period. For 2002, we determined a density of 6.9 (± 7) individuals/100 km², with a minimum density during the wet season (2.64 ind/100 km²) and an intermediate density during the dry-II

season (6.0 ind/100 km²) and the highest density during the dry season (8.91 ind./100 km²). For 2003, the overall density was lower with 4.15 (± 6.12) individuals/100 km², and no individuals recorded during the dry-II (figure 3).

Discussion

We found ample differences in black bear behavior during the two years of field work. During 2002 we found bears using a higher diversity of food items, concentrating on plant matter similar to that reported by other authors (i.e., Maehr and Brady, 1984; Leopold, 1985; Hellgren, 1993; Stubblefield, 1993; Beecham and Rohlman, 1994; Doan-Crider, 1995). Manzanita was gradually replaced by junipers in 2002 as the result of their respective fruiting period (USDA Forest Service 2003; Orth, 1995). Sotol is an important water source used in stressful months and appeared most frequently in scats from the dry period (Bolger, 1994; Hellgren, 1993). For 2003, junipers were used throughout the seasons. The low consumption of plant material was apparently related to low or no available resources produced during this year, due to El Niño, which exacerbated

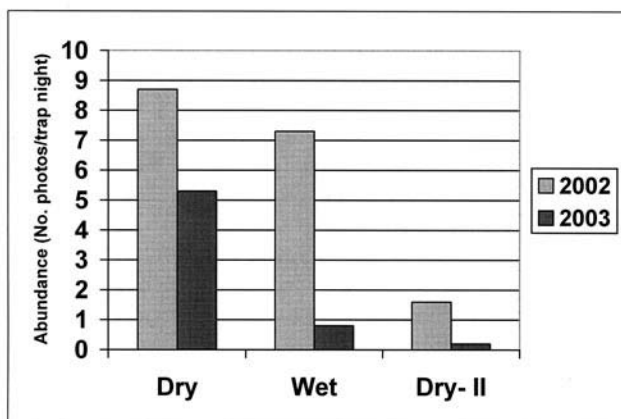


Figure 2—Black bear relative abundance index within different seasons.

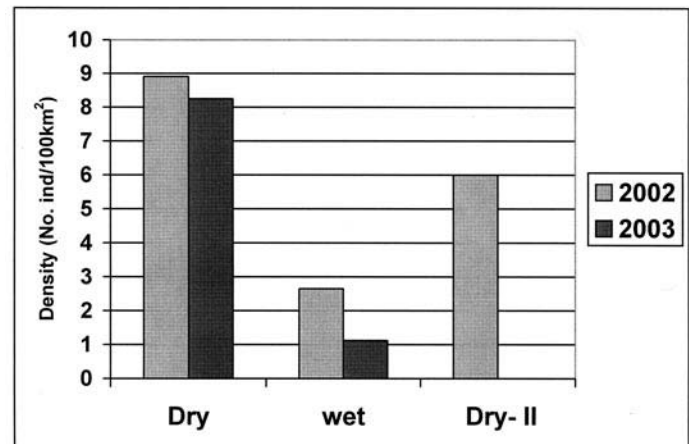


Figure 3—Black bear density estimates for the different sampling seasons.

drought (data on file, ranch owners of the region, Alfredo Varela and Manuel Gómez.). This drought was the probable cause of a higher ingestion of livestock, without a further distinction of scavenging or hunting. Doan-Crider (2002) noted a similar behavior during a year of low production of fruits. Finally, it is important to mention the presence of scorpions (*Diplocentrus peloncillensis*), as this is the first time it has been recorded as part of the diet of black bears.

We recorded changes in the utilization of habitat types by black bears during the two years, mainly attributed to fruit productivity and water availability, factors that are critical for black bear survival (Beecham and Rohlman, 1994, Hellgren, 1993). The most important category in terms of food production was the chaparral (LeCount, 1983; Stubblefield, 1993; Doan-Crider, 1995). Habitat use in the dry season of 2003 could be related to the presence of habitats adjacent to livestock production areas, concordant with an increase in livestock use. Similarly Beecham and Rohlman (1994) mention that black bears travel to new areas looking for complementary sources of energy. Pine forests were avoided in 2002, but they were highly used during 2003, probably related to water available in this habitat as there was no other source throughout the ranch. This factor has been characterized as a determining factor for bear productivity in other areas (Lyons et al. 2003).

A combination of low food productivity and drought apparently was reflected in the abundance and density having a reduction of 30% in relation to the first year of the study. Nevertheless our densities can be considered as relatively low compared to similar areas, such as Coahuila (Doan-Crider 1995, 72.46 ind/100 km²) or Arizona (96-200 ind/100 km², LeCount 1982 and 1990).

Conclusions

During 2002 the prevailing environmental conditions of the study area favored a high diversity diet, coupled with a higher density and abundance of black bears in the study area. During 2003, distinct climatic conditions modified black bear behavior in terms of habitat use and they became more carnivorous with a dispersed distribution to complement the lack of food and water resources.

Importantly, there were many complaints from ranchers about livestock depredation by black bears during 2002, when livestock ingestion was minimal. Although cattle consumption was significantly higher during 2003, ranchers filed no depredation complaints. Eradicating bears to solve a depredation problem is a misguided solution. It is necessary to determine real depredation rates and determine livestock mortality causes. We believe that increasing water sources for black bears in the prime habitat will reduce the number of bear-livestock incidents by dispersing black bears into neighboring areas.

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