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Crepuscular and Nocturnal Activity Patterns of Black Bears in the North Cascades of Washington

Abstract

The activity patterns of radio-collared black bears were monitored during 1996-1998 at two study areas in the North Cascades of Washington. Compositional analysis of activity patterns showed that black bears were not equally active across time periods and that they exhibited crepuscular activity patterns regardless of sex, season, or study area. The lowest level of activity consistently occurred during the 0201-0400 PST time period. In general, females were most active during the morning and males during the evening. The results of this study suggest that diurnal telemetry data would adequately describe black bear resource use.

Introduction

The activity patterns of animals are a result of the complex interactions between foraging efficiency, social activities, and environment (Aschoff 1964). An animal's pattern of activity and habitat use are adaptations to spatial and temporal variation in numerous environmental variables. The significance of these adaptations (Aschoff 1964, Neilsen 1983) makes it important to understand how diurnal, crepuscular, and nocturnal activities of animals influence habitat relationships. Most studies of space use by large carnivores use aerial telemetry because these species are wide ranging and often occupy rugged and remote areas. Habitat use estimates may be biased if sampling does not consider differences in a space use and activity patterns throughout a 24-hr period (Beyer and Haufler 1994).

Bear activity patterns have been determined by monitoring the integrity of radio-telemetry signals (Pockler and Hartwell 1973, Amstrup and Beecham 1976, Lindzey and Meslow 1977). Such determinations can be inhibited by radio interference, temperature fluctuations, and slight movements of bears (Garshelis and Pelton 1980, Garshelis et al. 1982). Theuerkauf and Jedrzejewski (2002) found that monitoring signal integrity alone overestimated the time wolves were active. However, using signal integrity, in combination with data on location changes obtained from triangulation, produced an accurate estimate of the activity patterns of wolves (Theuerkauf and Jedrzejewski 2002). This estimate was more accurate then activity sensors, which underestimated wolf activity (Theuerkauf and Jedrzejewski 2002).

Activity patterns have been reported for black bears on Long Island in southwestern Washington (Lindzey and Meslow 1977), on the Olympic Penninsula (Poekler and Hartwell 1973), and in west-central Idaho (Amstrup and Beecham 1976). In all of these areas bears have been reported as being the least active during the night. Lavivierc et al. (1994) offered a possible explanation of the diurnal activity patterns of black bears in areas with low levels of human activity. They suggested that their excellent vision for details at close range and discrimination of colors (Bacon and Burghardt 1976a) results in more efficient foraging during daylight hours. Visual cues represent the primary mechanism in searching for food (Bacon and Burghardt 1976b).

We monitored the crepuscular and nocturnal activity patterns of black bears to evaluate how well diurnal telemetry data would describe habitat use. The crepuscular and nocturnal activity patterns of black bears have not been described in the North Cascades of Washington, and may have important implications relative to their management. Our research questions included: (1) Are black bears equally active across all crepuscular and nocturnal time periods? (2) Do black bear activity patterns vary between study areas and seasons? (3) Are male and female black bear activity patterns similar?

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Study Areas

This study was conducted in the Okanogan Study Area (OSA) on the eastern side of the Cascade mountain crest and the Snoqualmie Study Area (SSA) on the western side (Figure 1). Elevations within the study areas ranged from 100 m in the valley bottoms to 2500 m at the ridge crests.

Precipitation on the OSA, falling mostly as snow, ranged from an average of 150-200 cm/yr on the ridge crests to 25-50 cm/yr in the lower elevations. Precipitation on the SSA, falling mostly as rain, ranged from 170-300 cm/yr. Vegetation conditions on the OSA varied from open bitterbrush *(Purshia tridentata)* slopes on the low elevation eastern portion of the study area, to Douglas-fir *(Pseudotsuga menziesii)* and ponderosa pine *(Pinus ponderosa)* forests at the lower and mid elevations, to montane and alpine vegetation beginning at about 1500 m. The SSA was composed of a mosaic of clearcuts and second growth western hemlock *(Tsuga heterophylla)* forests on the lower elevations, extending to montane and alpine vegetation above about 1200 m.

Methods

Black bears were captured and fitted with radio transmittters during April-July 1994-1997 (details described in Koehler et al. 2001). Each captured bear was ear-tagged and the upper lip was tatooed with an unique identifying number. Total body length, chest girth, and weight were measured. A premolar was extracted to determine age, and blood

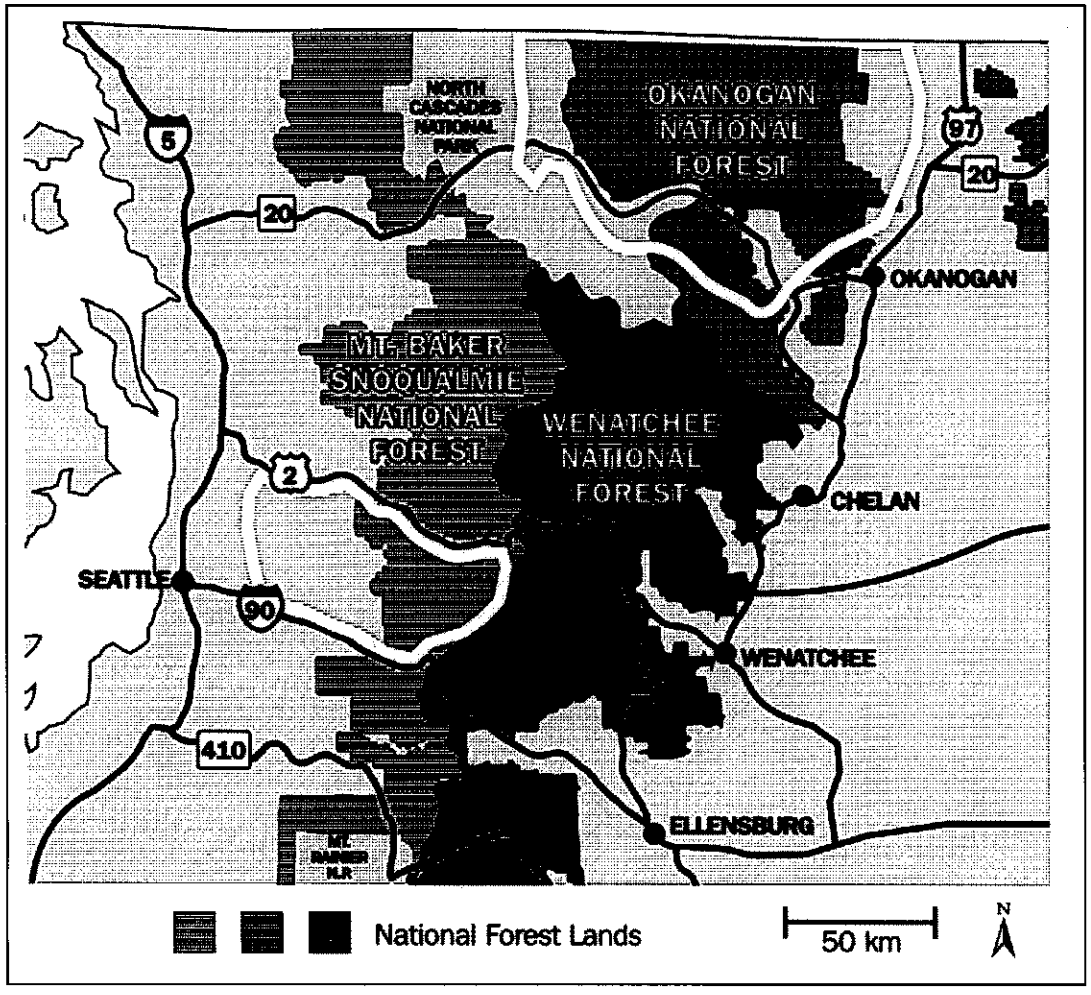

Figure 1. The Okanogan and Snoqualmie study areas are outlined in white.

was collected to assess disease and develop DNA profiles.

The crepuscular and nocturnal activities of radio-collared black bears were monitored using signal integrity and triangulation approximately one night per week, from den emergence to den entrance. On the OSA, bears were monitored during 1996 and 1997, and on the SSA during 1998. Bears were generally monitored from roads due to safety considerations. Each night from 1-4 bears were monitored at 2 hr intervals from 2000 PST to 0800 PST. Telemetry signals were monitored for 2-3 min from two locations for a total of 5-6 min/2 hr time period (Altmann 1974, Lariviere et al. 1994). Bearings to each bear were taken from 2-3 known locations along roads or trails within 10 min of each other to minimize bear movements. If there was any chance of disturbing the bear, only the signal integrity was monitored. Consecutive bearings between time periods were compared to determine if the bear had moved. A bear was considered active for a time period if the intensity of the signal was uneven or the bear had changed its location since the last radio location (Theuerkauf and Jedrzejewski 2002).

Data were analyzed by compositional analysis (Aebischer et al. 1993) using the computer program RESELECT. Compositional analysis uses multiple analysis of variance (MANOVA) to test the hypotheses, and paired t-tests to rank the relative levels of activities within each time period (Aebischer et al. 1993). Multiple pairwise comparisons were made to determine if any time periods were used significantly more than others. The significance level for all tests was set at $P = 0.05$. Seasons were determined by observed changes in bear diets and plant phenology. Seasons were divided into early-season (den emergence to 31 July), and late-season (1 August to den entrance).

We described activity patterns for 21 black bears (11 females and 10 males). Bears were monitored over 76 12-hr monitoring sessions, for a total of 912 hr between 1996 and 1998 (Table 1). Five tests using humans with radio collars were initially used to validate the results of the activity monitoring and none of these tests resulted in erroneous activity classifications.

Results

Annual Activity Patterns

Data from 21 black bears (11 females and 10 males) showed that their activities were not equally distributed across the time periods (Wilks lambda=0.11, $P<0.0001$) (Figure 2). Bears were the least active during the 0201-0400 time period and the most active during the crepuscular time periods (Table 2). Female black bears (6 from the OSA, 5 from the SSA) were least active during 0201-0400 and were most active during 0601-0800 (Wilks lambda=0.06, P<.0001, Table 2). Likewise, male black bears (8 from the OSA, 2 from the SSA) were least active during the same time period as the females (Wilks lambda=0.07, P<0.0001, Table 2). However, the highest level of activity for males occurred in the 2000-2200 time period. This information suggests that males were more active during the evening hours and females in the morning hours.

Okanogan vs Snoqualmie Study Areas

Black bears on the OSA (6 females and 7 males, Wilks lambda=0.09, $P<0.0001$) and SSA (5 females and 2 males, Wilks lambda=0.01, $P<0.0001$) exhibited crepscular activity patterns (Table 2). Black bears on the OSA were more active during 0601-0800 and 2000-2200 than during the other time periods, exhibiting a stronger crepuscular pattern than on the SSA. On the SSA, fewer sta-

TABLE 1. Summary information for crepuscular and nocturnal black bear activity pattern monitoring on the Okanogan and Snoqualmie study areas in the North Cascades, Washington.

Year	Study area	Total	No. Female	No. Male	Hours Monitored	Nights Monitored
1996	Okanogan	8	3	5	348	29
1997	Okanogan	14	7	7	360	30
1998	Snoqualmie	7	5	2	204	17
Totals		21	11	10	912	76

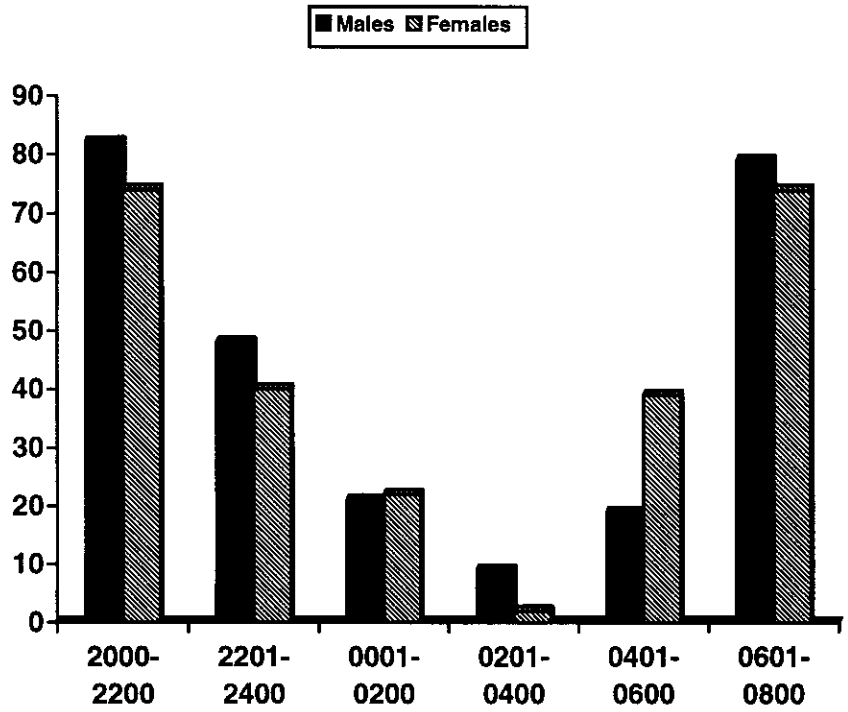

Figure 2. The proportion of radio-collared black bears active during the crepuscular and nocturnal time periods, North Cascades, Washington, 1996-1998.

tistically significant differences occurred between activity levels among time periods.

Seasonal Activity Patterns

Data from 19 black bears (9 females and 10 males) were used to investigate their activity patterns during the early-season. The activity patterns of black bears during the early-season indicated that bears were crepuscular (Wilks lambda=0.05, $P<0.0001$). During 0201-0400 black bear activity levels were lower than during any other time period (Table 3). The highest levels of activity occurred during 2000-2200 and 0601-0800.

The activity patterns of 14 black bears (10 females and 4 males) during the late-season showed that black bear activity was highest during crepuscular time periods (Wilks lambda=0.10, $P<0.0001$). However, during the late-season black bears were most active during the morning hours (Table 4), a shift from the early-season.

Male vs Female

Female activity levels (n=9, Wilks lambda=0.06, $P=0.0001$) were lower during 0001-0200 and 0201-0400 than other time periods. The highest levels of activity occurred during 0601-0800. Males were the least active during the nocturnal time periods and most active during the evening in the early-season (Wilks lambda=0.02, $P<0.0001$). While not a statistical relationship, this information suggests that black bears were segregated by gender at some level during the early-season.

Female black bears were most active in the late-season during 0401-0600 and 0601-0800 (n=10, Wilks lambda=0.01, $P<0.0001$). During both seasons, females were most active during the morning hours. Samples sizes for males during the late-season were too small for analysis.

Discussion

The annual and seasonal activity patterns of black bears in this study were similiar to those reported for black bears in other studies in the northwestern USA where bears have been reported as being generally diurnal, and most active during the morning and evening. (Amstrup and Beecham 1976, Lindzey and Meslow 1977, Poekler and Hartwell 1973). However, black bears may become

TABLE 2. Results of the multiple comparisons of annual black bear activity patterns among the six time periods, 1996-1998. + and – indicate that the time period on the left hand column had significantly higher or lower activity than the time period on the top row, $P = 0.05$. Rankings: 0 = least used time period, 5 = most used time period.

		Time Periods					
Rankings	Time Periods	2000-2200	2201-2400	0001-0200	0201-0400	0401-0600	0601-0800
Females (n = 11)							
4	2000-2200			+	+		
2	2201-2400				+		
1	0001-0200	–				–	–
0	0201-0400	–	–			–	–
3	0401-0600			+	+		–
5	0601-0800		+	+	+		
Males (n = 10)							
5	2000-2200			+	+	+	
4	2201-2400			+	+	+	
1	0001-0200	–	–				
0	0201-0400	–	–			–	–
2	0401-0600	–	–		+		
3	0601-0800				+		
Okanogan (7 females and 7 males)							
4	2000-2200		+	+	+		
3	2201-2400	–		+	+		–
1	0001-0200	–	–				–
0	0201-0400	–	–			–	–
2	0401-0600				+		–
5	0601-0800		+	+	+	+	
Snoqualmie (5 females and 2 males)							
4	2000-2200				+		
3	2201-2400				+		
1	0001-0200						
0	0201-0400	–	–				–
2	0401-0600						
5	0601-0800				+		

TABLE 3. Results of the multiple comparisons of early-season (den emergence to 31 July) black bear activity patterns among the six time periods, 1996-1998. + and – indicate that the time period on the left hand column had significantly higher or lower activity than the time period on the top row, $P = 0.05$. Rankings: 0 = least used time period, 5 = most used time period.

		Time Periods					
Rankings	Time Periods	2000-2200	2201-2400	0001-0200	0201-0400	0401-0600	0601-0800
Both Study Areas (9 females and 10 males)							
5	2000-2200		+	+	+		
3	2201-2400	–		+	+		
1	0001-0200	–	–		+		–
0	0201-0400	–	–	–		–	–
2	0401-0600	–			+		–
4	0601-0800			+	+	+	

TABLE 4. Results of the multiple comparisons of late-season (1 August-den entrance) black bear activity patterns among the six time periods, 1996-1998. + and – indicate that the time period on the left hand column had significantly higher or lower activity than the time period on the top row, $P = 0.05$. Rankings: 0 = least used time period, 5 = most used time period.

		Time Periods					
Rankings	Time Periods	2000-2200	2201-2400	0001-0200	0201-0400	0401-0600	0601-0800
Both Study Areas (10 females and 4 males)							
4	2000-2200		+	+	+		
2	2201-2400	–					–
1	0001-0200	–				–	–
0	0201-0400	–				–	–
3	0401-0600	–		+	+		
5	0601-0800		+	+	+		

nocturnal to reduce competition with grizzly bears (MacHutchon et al.1998) or when habituated to human activities (orchards, garbage dumps, campgrounds) (Ayres et al.1986). No evidence was available to suggest that black bears in this study were feeding on human foods, and grizzly bear numbers in the North Cascades are likely too low (Almack et al. 1993, Gaines et al. 2000) to influence black bear activity patterns.

The annual and seasonal activity patterns of black bears in this study suggested that males were more active during the evening and females during the morning. Garshelis and Pelton (1980) reported that adult males were overall more active than solitary adult females, but they did not describe any segregation of activity patterns by gender. Further research is needed to quantify this relationship.

Garshelis and Pelton (1980) reported nocturnal bear activity may increase during the fall. This was not the case in this study as black bears exhibited crepuscular activity patterns in both study areas, regardless of their sex or the season. Our research showed that black bears were relatively inactive during the night. Therefore, diurnal telemetry locations collected when bears are active should be used to evaluate their habitat use. Habitat managers should have confidence that habitat use analysis based on a diurnal telemetry dataset would identify all the important habitats for bears, thus addressing the issues raised by Beyer and Haufler (1994).

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