

BLACK BEAR HOME RANGE DYNAMICS AND MOVEMENT PATTERNS DURING A GYPSY MOTH INFESTATION

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Abstract: During 1985–89 in Shenandoah National Park (SNP), Virginia, a severe gypsy moth (*Lymantria dispar*) infestation resulted in widespread overstory canopy defoliation and a complete acorn crop failure in defoliated areas. We believed canopy opening and food supply alterations would lead to increased black bear (*Ursus americanus*) movements, especially in the fall as bears searched for acorns, and consequently, greater seasonal range sizes than prior to the infestation (1982–84). Female bear convex and concave polygon range areas determined with radio telemetry were not significantly different before and during defoliation in spring or summer. Fall range areas, however, were twice as large for bears in defoliated areas of SNP during infestation ($P = 0.025$ and 0.001 for convex and concave areas, respectively) and resulted in significantly larger annual areas used by bears (mean convex areas: 26.7 km^2 before versus 40.7 km^2 during infestation for solitary females and 14.6 before versus 34.2 km^2 during for females with cubs-of-the-year). Seasonal movements of females were consistent with range area data. Distances of shifts in seasonal geometric range centers were not different for spring to summer or early to late fall moves. However, summer to early fall shifts were twice as great ($P = 0.072$) during 1987–89 in defoliated areas than during 1982–84. Although acorn failure may have stimulated some bears to initiate fall moves, in 35 of 59 cases monitored bears remained in their traditional spring–summer ranges throughout the fall. Of those that did move, only 14 of 24 found acorns. Most females in this study successfully relied on soft mast fruits as alternative fall foods.

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Key words: acorn failure, black bear, defoliation, gypsy moth, home range, *Lymantria dispar*, movement, *Ursus americanus*, Virginia.

In 1987 the gypsy moth began to defoliate extensive portions of the oak–hickory (*Quercus* spp.–*Carya* spp.) dominated forest in Shenandoah National Park, Virginia. By 1991 approximately two-thirds of SNP had been defoliated to some degree. Gypsy moth defoliation results in summer canopy loss, increased forest temperatures (Kasbohm 1994), and most important, complete acorn production failure of heavily defoliated oaks (Fedde 1964, Liscinsky 1984, McConnell 1988, Gottschalk 1989, Kasbohm 1994, Kasbohm et al. 1996). Such effects can be manifest over thousands of hectares/year. In 1989 alone, 17,736 ha of SNP experienced greater than 60% canopy defoliation.

In the central and southern Appalachians, black bears are forest dwelling mammals adapted to habitats that provide essential over- and understory cover and hard and soft mast food supplies. Acorns are especially important fall bear food in SNP (Garner 1986) and have been implicated in influencing bear behavior and population dynamics (Beeman 1975, Garshelis and Pelton 1981, Wathen 1983, Eiler et al. 1989, Pelton 1989, Rogers and

Lindquist 1991). Responses to hard mast failures have included increased fall movements and home range expansions (Schorger 1946; Sauer et al. 1969; Beeman 1975; Amstrup and Beechum 1976; Rogers 1977, 1987; Garshelis and Pelton 1981; Carr 1983; Garris 1983; Clevenger 1986; Pelton 1989). Hence, an ecological disturbance such as gypsy moth infestation, which can modify wildlife habitats through forest micro-climate changes and yearly food supplies, may alter many aspects of bear behavior.

Prior to the gypsy moth infestation, Carney (1985) and Garner (1986) conducted an intensive radiotelemetry study of the SNP bear population. By 1987 a unique opportunity existed to document the effects of gypsy moth infestation and the resultant habitat defoliation on black bears. In this paper we discuss effects of gypsy moth-induced, short-term habitat changes on bear seasonal movements and home range dynamics in SNP through comparing predefoliation data (Garner 1986) and data collected during extensive gypsy moth infestation. We hypothesized that habitat and food supply alterations dur-

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ing years of heavy defoliation would lead to increased bear movements and, consequently, to larger home ranges, than in predefoliation years. Because defoliation causes the failure of acorn crops, we further hypothesized that movements during the fall would be affected more than during other seasons.

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STUDY AREA

The 522-km² study area encompassed the North and Central Districts of Shenandoah National Park in the Blue Ridge Mountains of north-central Virginia, approximately 120 km southwest of Washington, D.C. The park is narrow and irregularly shaped, 21 km at its widest point, oriented in a northeast to southwest direction and bisected by a 2-lane highway (Skyline Drive) with scenic overlooks, picnic areas, and campgrounds. Numerous foot trails and fire roads transected SNP and visitor traffic was often heavy in both the front and back country. Hunting was prohibited in SNP, but was allowed in all surrounding counties.

The park terrain is rocky and mountainous and varies in elevation from 270 to 1200 m. The primary vegetation was an oak-hickory forest, which is very susceptible to gypsy moth infestation. Dominant overstory species associations were chestnut oak (*Quercus prinus*, 41% of the study area); red oak (*Q. rubra*, 14%); yellow poplar (*Liriodendron tulipifera*, 20%); black locust (*Robinia pseudoacacia*), and black cherry (*Prunus serotina*, 4%); cove hardwoods (16%) including american basswood (*Tilia americana*), white ash (*Fraxinus americana*), red maple (*Acer rubrum*), black birch (*Betula lenta*), yellow poplar, and mixed oaks; pines (3%) such as white pine (*Pinus strobus*), pitch pine (*P. rigida*), table-mountain pine (*P. pungens*), and Virginia pine (*P. virginiana*); and eastern hemlock (*Tsuga canadensis*, 1%). Understory species common in SNP were flowering dogwood (*Cornus florida*), striped maple (*A. pensylvanicum*), mountain laurel (*Kalmia latifolia*), spicebush (*Lindera benzoin*), and witch hazel (*Hamamelis virginiana*). Other important species were apple (*Malus pumila*), sweet cherry (*Prunus*

avium), blackberry (*Rubus* spp.), blueberry (*Vaccinium* spp.), huckleberry (*Gaylussacia* spp.), grape (*Vitis* spp.), pokeweed (*Phytolacca americana*), and greenbriar (*Smilax* spp.).

The gypsy moth was first discovered in SNP in 1984 (Ravlin et al. 1990). Acreage of defoliation (>60% canopy loss) increased dramatically during the course of the study from almost none in 1985, to 546 ha in 1986 (1% of the study area), 2,304 ha in 1987 (4%), 6,227 ha in 1988 (12%), and 17,736 ha in 1989 (34%). Prior to 1989 defoliation was restricted primarily to the North District. In both 1988 and 1989, approximately 28% of the North District was completely stripped of overstory foliage. Chestnut oak and red oak habitats received the heaviest defoliation; 60% and 40% of these habitats suffered >60% overstory canopy loss in the North and Central Districts, respectively.

The Piedmont Plateau and Shenandoah Valley surround SNP to the east and west, respectively. Privately owned agricultural lands containing corn fields, apple orchards, and small livestock farms dominate non-park land. Limited bear habitat remains in the Shenandoah Valley; however, a mosaic of fragmented, forested "islands" provides additional bear habitat in the Piedmont Plateau.

Annual precipitation averaged 94–130 cm, depending on elevation (Conners 1988). Average annual snowfall ranged from 79–122 cm throughout SNP (Conners 1988). Average temperatures ranged from -3 C in the winter to 19 C in the summer. Higher elevations tended to be 5–10 C cooler than the surrounding lowlands (Heatwole 1978).

METHODS

Field work was conducted from December 1985 to March 1990 in the North District and northern half of the Central District of SNP. Bears were captured using spring-activated foot snares and culvert traps. Captured bears were immobilized with a 2:1 mixture of ketamine hydrochloride and xylazine hydrochloride at 300 mg/ml with a dose of 1 cc/45 kg (100 pounds) of estimated body weight. Drug was administered by a jab pole or CO₂-powered pistol. Immobilized bears were weighed, ear-tagged, and given a lip tattoo identification number. A premolar was extracted for aging using cementum annuli (Willey 1974).

Adult bears and selected subadult females were fitted with 164–165 Mhz radio transmitter collars (Telonics Inc., Mesa, Ariz.). Because of the small number of male bears radiocollared, only data for females were analyzed. Bears were located from fixed-wing aircraft with directional Yagi antennas mounted under each wing and by ground triangulation with hand-held Yagi antennas. Triangula-

tions were calculated with at least 3 bearings taken within a 20-minute time limit. However, close (<200 m), 2 bearing triangulations were obtained occasionally. Locations were plotted on U.S. Geological Survey 1:24,000 topographic maps and assigned universal transverse mercator (UTM) coordinates. Bears were located every 10 days from the air, with at least 2 ground triangulations between aerial locations. No telemetry data collected from December 1985–July 1987 were included in analyses because of the infrequency of relocations during this period.

The accuracy of telemetry locations was determined by (1) estimating the location of radiocollars placed at known sites throughout the study area, (2) locating collared bears in their winter dens, and (3) recovering dropped collars. Den sites and dropped collars were considered the most useful accuracy checks because they represented actual bear locations. Hence, they were not biased by transmitter placement. All test locations were typical of the locations and distances encountered during day-to-day tracking. Aerial and ground triangulation test locations were achieved with accuracies of 146 m (SE = 23.8; $n = 30$, range = 0–492 m) and 137 m (SE = 11.9; $n = 89$, range = 0–564 m), respectively.

Seasons were based on Garner (1986) and were defined by changes in plant phenology and bear denning chronology: spring (den emergence–15 Jun), summer (16 Jun–31 Aug), early fall (1 Sep–15 Oct), late fall (16 Oct–den entry or 1 Jan), and fall (early fall and late fall). Winter was not defined because most bears were denned by 1 January.

The effects of defoliation on bear seasonal movements and home range dynamics were examined by comparing seasonal and annual range areas and shifts in seasonal geometric range centers, respectively, between years of heavy gypsy moth defoliation (this study) and years before the infestation (1982–84, Garner 1986). Predefoliation data were taken or recalculated from Garner (1986). Telemetry and home range estimations were identical to Garner (1986) to allow direct comparison. Annual, spring, summer, and fall convex and concave polygon range areas were calculated using the Telem computer software program (Koeln 1980). Seasonal range centers were calculated as the mean UTM coordinate (Hayne 1949) for spring, summer, early fall, and late fall. Seasonal shifts were the distances between range centers of consecutive seasons (i.e., spring to summer, summer to early fall, and early fall to late fall). Only data from bears that were monitored for an entire year or season were used

in home range calculations for that year or season. Only data from bears monitored throughout both seasons of a seasonal shift were used in calculations for that seasonal shift. Data were pooled within the predefoliation and defoliation periods (1982–84 and 1987–89, respectively) because of small yearly sample sizes. Two reproductive classes, females with cubs-of-the-year and solitary females, were used. Analysis of variance (ANOVA) models of the general linear model (GLM) procedure (SAS Inst., Inc. 1985) were used to analyze the main effects of defoliation period and reproductive class and the defoliation period by reproductive class interaction on home range size and seasonal range center shifts. The proportion of locations of all females inside SNP boundaries was calculated seasonally and compared between defoliation periods with the *Z*-test for proportions.

Seven bears were monitored in nondefoliated areas of SNP during 1987–88. Data from these individuals were excluded from the above 2-way GLM procedure. However, sample sizes were large enough for solitary females for comparison of their fall range sizes and early fall to late fall range center shifts to preinfestation data, and data from bears in defoliated regions of SNP in 1987–89, with 1-way ANOVA.

Fall movements of all females monitored during years of gypsy moth defoliation also were examined independently from range center shift analyses. Bears were classified as having made fall moves if they left their traditional spring–summer ranges for >2 weeks. Presence or absence of acorns in fall ranges was determined during ground radiotracking by searching specific areas used by radiocollared bears for acorn bearing trees and the presence of fallen acorns. As determined by acorn collection plots placed in defoliated and nondefoliated stands, oaks in heavily defoliated areas suffered almost complete acorn production failures (Kasbohm 1994, Kasbohm et al. 1996). Consequently, bears in defoliated areas were believed to have insignificant quantities of acorns available. Inaccessibility of areas used by some collared bears prevented verification of acorn availability for specific individuals.

RESULTS

During preinfestation years, 2,804 locations were obtained for 25 females (Garner 1986). During years of defoliation, 43 females were located 3,193 times. The number of locations per bear/season ranged from 8–56 and 7–38 for 1982–84 and 1987–89, respectively.

Annually, 34–124 and 35–76 locations/individual were obtained.

Seasonal Range Areas

Convex (Table 1) and concave (Table 2) polygon area differences between 1982–84, prior to gypsy moth infestation, and during years of heavy defoliation (1987–89) followed similar trends. Annual range sizes of bears in defoliated areas during 1987–89 were larger than for bears prior to infestation in 1982–84 ($P = 0.054$ and 0.057 for convex and concave areas, respectively). No differences were apparent between defoliation periods in spring or summer. Mean fall range areas, however, were twice as large for bears in defoliated areas ($P = 0.025$ and 0.001 for convex and concave areas, respectively) than for bears prior to defoliation. These larger ranges were likely responsible for larger annual ranges.

During 1987–88, estimates of fall ranges were obtained for 7 solitary females in nondefoliated areas of SNP. Convex areas (Table 1) were greater for these individuals than for solitary females in defoliated areas ($P = 0.004$) and prior to infestation ($P < 0.001$). Concave areas (Table 2) also were larger, but were only significant when compared with those from 1982–84. Similar comparisons in other seasons were precluded because of the small ($n = 1$) number of bears radiocollared in nondefoliated areas of SNP in 1987–1989. The rapid southward spread of the gypsy moth

prevented radiocollaring of more individuals in nondefoliated areas of SNP.

Range use differed by reproductive class only during spring (Tables 1 and 2). Spring convex and concave use areas were smaller for females with cubs ($P = 0.013$ and 0.009 for convex and concave areas, respectively) than for solitary females. No significant differences were observed between reproductive class and defoliation periods in any season for convex or concave areas.

Seasonal Range Center Shifts

Spring to summer range center shifts did not differ between predefoliation and defoliation periods ($P = 0.151$, Table 3). Only 1 of 27 (4%) and 3 of 32 (9%) females made spring to summer shifts >2 km in 1982–84 and 1987–89, respectively. Summer to early fall shifts for bears living in defoliated areas, however, were 2 times greater during defoliation than prior to infestation ($P = 0.072$). Of females monitored in defoliated areas, 26% (11/43) exhibited summer-to-early fall range center shifts >4 km; 6% (2/32) did so prior to gypsy moth infestation. Distances of early fall to late fall shifts were not different in defoliated areas during 1987–89 and before infestation ($P = 0.364$). Only 5% (2/42) of females shifted range centers >4 km from early fall to late fall prior to infestation; similarly, in defoliated habitat only 14% (8/58) shifted. During 1987–1989, females in nondefoliated areas exhibited greater early fall to late fall shifts than they did prior to infestation

Table 1. Seasonal^a and annual^b mean convex polygon areas (km²) for female black bears by gypsy moth defoliation period and reproductive class, Shenandoah National Park, Virginia, 1982–89.

Female status/ season	1987–89								
	1982–84 ^c			Nondefoliated			Defoliated		
	Mean	SE	<i>n</i>	Mean	SE	<i>n</i>	Mean	SE	<i>n</i>
Solitary									
Spring	5.4	1.7	16	3.5		1	5.5	1.3	17
Summer	11.3	2.1	25	4.8		1	8.6	2.0	28
Fall	14.9	2.4	35	66.7	14.6	7	29.7	4.5	37
Annual	26.7	5.1	16	61.7		1	40.7	7.5	17
With cubs									
Spring	2.7	0.6	12			0	2.2	0.5	19
Summer	7.0	1.0	11			0	8.4	1.6	18
Fall	10.9	1.7	7	71.7		1	19.0	4.0	21
Annual	14.6	1.6	7			0	34.2	11.8	12

^a Calculated with 7–56 locations per season/bear.

^b Calculated with 34–124 locations per year/bear.

^c Data prior to gypsy moth infestation calculated from Garner (1986).

Table 2. Seasonal^a and annual^b mean concave polygon areas (km²) for radiomarked female black bears by gypsy moth defoliation period and reproductive class, Shenandoah National Park, Virginia, 1982–89.

Female status/ season	1987–89								
	1982–84 ^c			Nondefoliated			Defoliated		
	Mean	SE	<i>n</i>	Mean	SE	<i>n</i>	Mean	SE	<i>n</i>
Solitary									
Spring	0.7	0.2	15	0.2		1	1.0	0.4	17
Summer	2.3	0.4	24	0.3		1	1.6	0.3	28
Fall	2.2	0.4	34	7.8	2.1	7	5.9	0.8	37
Annual	7.9	0.8	15	19.0		1	11.9	1.7	17
With cubs									
Spring	0.1	0.1	12			0	0.3	0.1	19
Summer	1.6	0.4	11			0	1.6	0.3	18
Fall	2.4	0.6	7	14.2		1	4.6	0.8	21
Annual	6.1	0.8	7			0	9.1	2.4	12

^a Calculated with 7–56 locations per season/bear.

^b Calculated with 34–124 locations per year/bear.

^c Data prior to gypsy moth infestation calculated from Garner (1986).

($P < 0.001$) or in defoliated areas ($P = 0.011$); 43% (3/7) of these shifts were >4 km.

Distances of seasonal shifts were not different for solitary females and females with cubs of the year ($P > 0.30$ for all shifts). Shifts by reproductive class for defoliation periods were not significant for any seasonal period.

Use of Non-Park Land

The majority of radio locations of monitored females were within SNP boundaries before and during gypsy moth infestation (Table 4). In spring, $>90\%$ of locations were inside SNP before and during the infestation. In summer,

bears were located in the park less in 1982–84 than during years of heavy defoliation ($P < 0.001$). The percent of locations observed in early fall was not different between periods ($P = 0.142$), but in late fall, bears in defoliated areas in 1987–89 were located inside the park less than those in 1982–84 ($P = 0.005$). Females in nondefoliated areas in 1987–88 in late fall were found outside of the park more often than all other females ($P < 0.001$).

Fall Movements during Defoliation

In 1987, 1988, and 1989, 3 of 9, 10 of 20, and 11 of 30 females, respectively, monitored in defoliated areas made

Table 3. Mean seasonal range center shifts (km) for female black bears by gypsy moth defoliation period and reproductive class, Shenandoah National Park, Virginia, 1982–89.

Female status/ shift ^b	1987–89								
	1982–84 ^a			Nondefoliated			Defoliated		
	Mean	SE	<i>n</i>	Mean	SE	<i>n</i>	Mean	SE	<i>n</i>
Solitary									
SP-to-SM	0.66	0.13	16	0.96		1	1.48	0.61	17
SM-to-EF	1.66	0.43	25	1.26		1	3.65	0.82	26
EF-to-LF	1.50	0.18	35	6.00	2.15	7	2.43	0.43	37
With cubs									
SP-to-SM	0.55	0.07	11			0	0.85	0.19	14
SM-to-EF	1.23	0.39	7			0	3.39	1.67	17
EF-to-LF	1.83	0.90	7	9.38		1	1.77	0.32	21

^a Data prior to gypsy moth infestation calculated from Garner (1986).

^b SP = spring, SM = summer, EF = early fall, and LF = late fall.

Table 4. Percent of female black bear telemetry locations within the boundaries of Shenandoah National Park, Virginia, by defoliation period and season, 1982–89.

Season	1982–84 ^a		1987–89			
	%	<i>n</i>	Nondefoliated		Defoliated	
			%	<i>n</i>	%	<i>n</i>
Spring	90	189			92	391
Summer	79A ^b	361			88B	789
Early fall	84	176	85	40	79	641
Late fall	92A	183	67B	60	84C	798

^a Data prior to gypsy moth infestation from Garner (1986).

^b Percents with different letters within a season are significantly different ($P < 0.01$).

fall movements away from their spring–summer ranges. However, 10 of these 24 fall moves (42%) were to areas with insignificant acorn availability (i.e., to other defoliated portions of SNP). Only 8 (33%) were to areas known to contain available oak mast; of these, 5 were made in 1988 to a small area in the southwest portion of the North District that escaped defoliation that year. Six other females (25%) moved to areas where acorn availability was probable but could not be verified. In nondefoliated areas (1987–89), 7 of 8 females made fall moves. These individuals had available acorns in both their spring–summer ranges and in the areas to which they traveled.

Fall moves were initiated from early September to November each year. All but 3 individuals (all in defoliated areas) returned to their spring–summer ranges by mid-December. One female was legally killed by a hunter, 1 dispersed 19 km northwest of SNP, and 1 dened in her late fall range and returned to her traditional spring–summer range during the following spring. Females that did not move used their spring–summer ranges throughout the fall, and those in defoliated areas did not have significant quantities of acorns available.

DISCUSSION

Reproductive status had little effect on female bear movements or seasonal range sizes relative to gypsy moth infestation. Although females with cubs had smaller spring ranges than solitary females, presumably because of reduced mobility associated with young cubs, both reproductive classes responded similarly to decreases in overstory cover and acorn failure. Carr (1983) and Eveland (1973) also noted smaller ranges of females with cubs-of-the-year. In Idaho, cubs did not restrict female movements (Reynolds and Beecham 1980), and in Pennsylvania solitary females had smaller home ranges than females accompanied by offspring (Alt et al. 1980).

Severe gypsy moth infestation encountered in SNP during 1987–89 caused an immediate loss of overstory foliage from early June to August each year. Such cover loss was sufficient to significantly increase forest temperatures, altering the microclimate of defoliated stands (McConnell 1988, Kasbohm 1994). Nevertheless, bears did not respond to canopy opening by leaving defoliated regions or increasing their spring, or especially, summer movements. Consequently, bears had spring and summer range sizes equivalent to predefoliation years. Summer range sizes in both defoliation periods (before and during) were comparable to those estimated for other southern Appalachian bear populations (Carr 1983, Garris 1983, Brody 1984, Beringer 1986).

Females monitored in summer in defoliated habitat during infestation spent more time within SNP boundaries relative to females prior to infestation. This behavior kept bears within or in close proximity to heavily defoliated stands and prevented bears from using agricultural lands surrounding SNP. Only 1 radiocollared female was known to use a corn field during 1987–89. Habitat use analysis indicated a preference for defoliated stands in early summer (Kasbohm et al. 1994). Canopy opening and the resultant increased light penetration to the understory probably elicited increased soft mast production of a variety of important summer bear food producing species (Twery 1991), including sweet cherry and black cherry, blackberry, huckleberry, and blueberry. Although not directly measured, field observations indicated excellent production of fruit from these species. Increased soft mast availability probably prevented increased summer movements and larger summer range sizes.

Mast failures have been implicated in determining black bear fall movements and range sizes (Schorger 1946; Sauer et al. 1969; Beeman 1975; Amstrup and Beechum 1976; Rogers 1977, 1987; Garshelis and Pelton 1981; Carr 1983; Garris 1983; Clevenger 1986; Pelton 1989). Dur-

ing failures, especially of acorns, bears may travel long distances in the fall to areas with abundant mast crops. Pelton (1989) reported Tennessee bears moved 2–4 times farther in poor acorn years than in good ones. Similarly, Rogers (1977) documented increased numbers of bears moved during scarce food years. In defoliated areas of SNP comprising the majority of the study area, there was approximately a 99% acorn production failure compared to that in nondefoliated stands (Kasbohm 1994, Kasbohm et al. 1996). Hence, bears could have been forced to expand their ranges and make long distance moves to other areas in search of food. A greater number of females exposed to defoliation made fall moves, had significantly larger fall ranges, and exhibited increased summer to early fall range center shifts compared to females that experienced relatively abundant acorn production in years prior to gypsy moth infestation. Even so, only about 40% of monitored females made fall moves from their traditional spring–summer ranges, with the majority making no detectable excursions. In addition, bears that moved went to other areas of SNP. Before and during defoliation bears spent the majority of their time within park boundaries. Only in late fall were females located outside the park more often during defoliation, and then only 8% more locations fell outside SNP.

During defoliation female bears in infested areas of SNP used greater areas annually (38 km²) and in fall (26 km²) than in other southern Appalachian bear populations. In this region, use areas determined by convex polygons range from 5–17 km² annually (Beeman 1975, Quigley 1982, Villarrubia 1982, Warburton 1984, Beringer 1986, Seibert 1989, Reagan 1991) and 6–17 km² for fall seasons only (Carr 1983, Garris 1983, Brody 1984, Beringer 1986). Bears monitored prior to defoliation maintained greater mean annual use areas (23 km²) and intermediate mean fall use areas (14 km²) than did other bears in the mountains of the southeast.

Although bears may have been stimulated to make fall movements by the low availability of oak mast, they were only marginally successful in finding acorns in appreciable quantities. At best, only 14 of 24 individuals found acorns in the fall, with 5 traveling to the same local area. All bears that made fall moves exhibited distinct seasonal shifts. Those bears that didn't find acorns and those females that did not move at all (the majority of radiocollared individuals) successfully relied on soft mast fruits as alternative fall foods. In early and late fall, the primary foods consumed by bears during defoliation were fruits of grapes, pokeweed, and spicebush (Kasbohm et al. 1995). As with summer soft mast producers, defoliation appeared to induce increased berry production from

these species. Diet quality, physical condition, and reproductive and survival data indicated no declines relative to predefoliation years despite the soft mast-dominated fall diets (Kasbohm 1994, Kasbohm et al. 1996). Soft mast also was believed to alter bear movements in Great Smoky Mountains National Park, Tennessee, when bears remained in spring–summer ranges longer to feed on abundant black cherry until its depletion, rather than abandon an available food supply in search of acorns (Garshelis and Pelton 1981).

These conclusions are consistent with previous black bear research (Schorger 1946; Sauer et al. 1969; Beeman 1975; Amstrup and Beechum 1976; Rogers 1977, 1987; Garshelis and Pelton 1981; Carr 1983; Garris 1983; Clevenger 1986; Pelton 1989) and seem reasonable given the extreme oak mast failure in defoliated areas of SNP in 1987–89. However, behavior of bears monitored only throughout 1 fall ($n = 7$) in nondefoliated areas of SNP during the same years indicated that fall range size and at least early fall to late fall shifts were greater for all bears in 1987–89 regardless of gypsy moth infestation. These individuals exhibited the largest fall ranges, the greatest fall moves, and the highest proportion of time spent outside SNP in late fall of all bears radiocollared in SNP. Bears monitored prior to defoliation and those not exposed to defoliation in this study had fall acorns available in their spring–summer ranges. Predefoliation fall bear diets consisted primarily of acorns (Garner 1986), and the only scats collected in 1987–89 containing acorns were collected in nondefoliated habitat not yet affected by the gypsy moth. Perhaps local acorn crops differed between the 2 periods, with 1987–88 being poor years with respect to 1982–84, stimulating bears in nondefoliated habitat to seek areas with greater food availability. These individuals would not have benefitted from enhanced soft mast production in response to defoliation and likely would have needed to locate hard mast had local acorn crops in their spring–summer ranges been insufficient. Unfortunately, no reliable data are available to assess past mast crops in SNP. Past acorn surveys were performed by the Virginia Department of Game and Inland Fisheries (VDGIF) on National Forest and state-owned lands near SNP. Although these surveys indicated average production in 1982–84 and 1988 and below average in 1987 (D. Martin, VDGIF, Verona, pers. commun., 1994), they did not encompass SNP nor areas directly adjacent to the park. Furthermore, no one has examined the biomass of acorns that is needed to support bear populations or to induce or suppress

movements. It is possible, of course, that factors other than food availability also may have influenced fall bear movements.

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