# Black Bear Harvest and Nuisance Behavior in Response to Gypsy Moth Infestation

**John W. Kasbohm,**[1] *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0321*

**Michael R. Vaughan,** *Virginia Cooperative Fish and Wildlife Research Unit, National Biological Survey, Blacksburg, VA 24061-0321*

**James G. Kraus,**[2] *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0321*

*Abstract:* Yearly food supplies influence black bear (*Ursus americanus*) harvest and nuisance behavior. During 1987–1990, gypsy moth (*Lymantria dispar*) infestation in northwestern Virginia, especially in Shenandoah National Park (SNP), resulted in widespread defoliation, acorn failure, and subsequent alterations in bear behavior. We believed canopy opening and especially acorn failure would lead to increased hunter harvest and nuisance behavior in defoliated regions of Virginia. In the defoliated region of Virginia, 138 ± 12 bears/yr and 220 ± 12 bears/yr were harvested before (1980–1986) and during infestation, respectively ($P = 0.03$). In addition, proportion of females harvested in this region increased from 34% to 40% ($P = 0.09$). These increases may have resulted from increased bear movements in fall and, hence, greater bear susceptibility to hunting during infestation. Significant differences in harvest or harvest sex ratios before and during infestation could not be demonstrated in regions of Virginia not experiencing defoliation. Number of nuisance bears captured near SNP during 1987–1990 was twice that during 1981–1986, but the increase may have been unrelated to gypsy moth infestation; fall nuisance activity showed little increase despite acorn failure. Nuisance behavior within SNP was not affected by canopy loss or acorn failure. Defoliation enhanced soft mast production and may have allowed bears to avoid turning to higher levels of nuisance activity that might be expected during more conventional hard mast failures.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 48:261–269

[1] Present address: United States Fish and Wildlife Service, Suwannee River Management District, Route 3, Box 64, Live Oak, FL 32060.

[2] Present address: United States Fish and Wildlife Service, 6620 South Point Dr. S., Suite 310, Jacksonville, FL 32216.

Throughout its range, the black bear often comes in contact with humans. In Virginia, bear-human contacts can involve bear damage to agricultural crops (especially corn), orchards, livestock, and apiaries; legal and illegal harvest; aggressive behavior by bear toward campers and hikers; and road kills (Garner and Vaughan 1989, Vaughan et al. 1990). Such contacts are especially important to tourism in and around Shenandoah National Park (SNP) (Garner and Vaughan 1989, Vaughan et al. 1990). Natural food abundance often influences bear-human interactions (Carpenter 1973, Rogers 1976, Beeman and Pelton 1980, Garshelis 1989), with increased nuisance or damage problems occurring in years of scarce natural food supplies (Rogers 1976, 1977, 1989; Elowe 1984; Garshelis 1989; Stiver 1991). However, conflicting reports exist as to the effects of food shortages on hunter harvest (Carpenter 1973, Lindzey et al. 1976, Beeman and Pelton 1980).

During 1987–1990 the gypsy moth defoliated 307,900 ha of Virginia's primary black bear range (C. Dull, U.S. For. Serv., unpubl. data), in some cases resulting in extensive canopy cover loss, forest microclimate changes (McConnell 1988, Kasbohm 1994), and alterations in wildlife food supplies (Gottschalk 1989, Twery 1991, Kasbohm 1994). Hard mast crops in defoliated areas were especially devastated, with defoliated oak trees (*Quercus* spp.) producing essentially no acorns (McConnell 1988, Kasbohm 1994). Hence, these habitat changes may have substantially altered bear behavior, including bear-human interactions. We hypothesized that annual bear harvest and nuisance activity would increase during years of heavy defoliation and acorn failure relative to years prior to gypsy moth infestation. We examined effects of gypsy moth infestation on annual bear harvest and nuisance and/or damage problems in Virginia during a severe defoliation event from 1987–1990.

Funding for this study was provided by the National Park Service, the U.S. Fish and Wildlife Service, Virginia Cooperative Fish and Wildlife Research Unit, the Virginia Department of Game and Inland Fisheries (VDGIF), and the Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University. We thank D. Martin, G. Blank, Jr. (Va. Dep. Game and Inland Fish.), and C. Dull (U.S. For. Serv.) for the use of their data. We also acknowledge T. Gerlach, B. Greenewalt, R. Hughes, L. Kasbohm, and the many SNP employees who provided field assistance.

## Methods

This study was conducted in Virginia's primary black bear range including Shenandoah National Park (SNP). Most of this area was mountainous with oak-hickory forest interspersed with agricultural lands. Prominent oaks were chestnut oak (*Quercus prinus*), northern red oak (*Q. rubra*), and white oak (*Q. alba*). Park land was essentially 100% forested, but was surrounded by corn fields, fruit orchards, and small livestock farms. Hunting was allowed throughout, except in SNP. Important understory species included sweet and black cherry (*Prunus avium* and *P. serotina*), blackberry (*Rubus* spp.), blueberry (*Vac-*

*cinium* spp.), huckleberry (*Gaylussacia* spp.), grape (*Vitis* spp.), pokeweed (*Phytolacca americana*), and spicebush (*Lindera benzoin*).

Yearly bear harvest and nuisance data in Virginia were compared between years of heavy gypsy moth infestation (1987–1990) and years prior to the infestation (1980–1986). Virginia harvest data were obtained from the Virginia Department of Game and Inland Fisheries (D. Martin, VDGIF, unpubl. data). Number of bears captured following nuisance or damage complaints was determined by month and year from VDGIF state trapper's records. These bear capture incidents represented verified nuisance and damage reports all made by a single VDGIF trapper, so trapping effort and methods were consistent between years with and without defoliation.

Harvest and nuisance data were tallied for counties grouped into 3 regions of Virginia (Fig. 1) based on defoliation histories (C. Dull, U.S. For. Serv., unpubl. data) and probable extent of influence of the SNP bear population on yearly harvest and nuisance problems; the population in SNP is high density (0.67–1.0 bears/km$^2$, Carney 1985), with roughly 50% of Virginia's annual harvest coming from the 8 counties containing SNP (Martin 1993). The defoliated region was defined as those counties incorporating and directly surrounding SNP, and experiencing significant gypsy moth defoliation from 1987–1990 (2%, 8%, 17%, and 48% of the total forested land in 1987, 1988, 1989, and 1990, respectively). The intermediate region was composed of 3 counties experiencing only slight defoliation in 1990 (4% of the total forested land), but still near or containing SNP. Counties not receiving any measurable gypsy moth defoliation

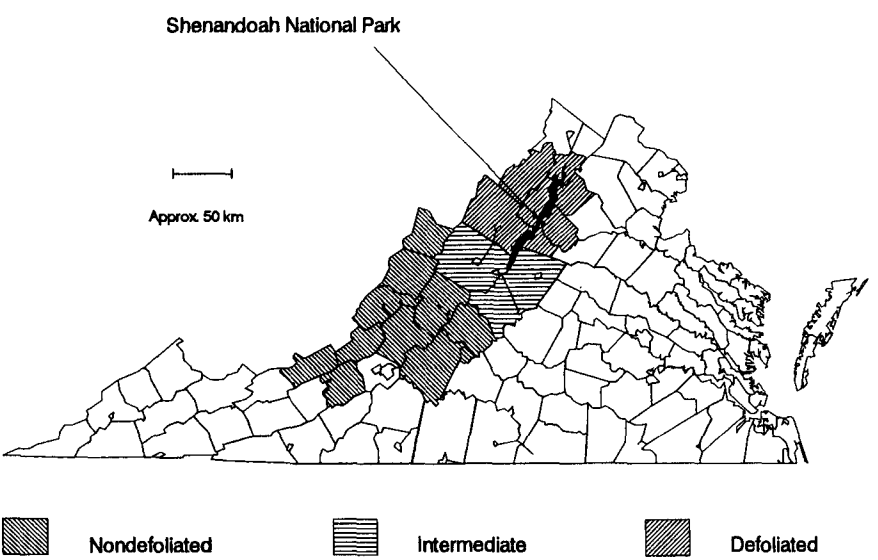


**Figure 1.** Location of defoliation regions: nondefoliated, intermediate, and defoliated, in Virginia for analysis of hunter harvest and nuisance capture data, 1980–1990.

from 1980–1990, maintaining a yearly bear harvest, and which were only minimally influenced by SNP were defined as the nondefoliated region.

Each region likely had different bear densities, hunter effort, and hunting restrictions. Thus, direct comparisons among regions were not meaningful. To examine effects of defoliation, hunter harvest and captures of nuisance bears were compared between predefoliation (1980–1986) and defoliation (1987–1990) periods within a defoliation region. Similar comparison results in all regions would imply the gypsy moth had no observable effect on harvest or nuisance captures. We could not define a post defoliation period because defoliation and its effects continued after the study.

The Wilcoxon Rank Sum test was used for all comparisons and $P < 0.10$ was considered significant. Legal harvest and nuisance bear captures were examined separately for males, females, and all bears. Sex ratio differences between defoliation periods also were examined by comparing percentage of females in total yearly harvests.

We determined nuisance behavior of female bears in SNP by monitoring radio-collared individuals from 1986–1989, we captured too few adult males to examine male behavior. Bears were captured using Aldrich foot snares and culvert traps in the North District and northern half of the Central District of SNP. All adult and selected subadult female bears were fitted with 164–165 Mhz radio collars (Telonics Inc., Mesa, Ariz.). Bears were located every 10 days from fixed-wing aircraft with directional yagi antennas mounted under each wing, and at least 2 times between aerial locations by ground triangulation with hand-held yagi antennas. Accuracy of telemetry locations was determined by estimating locations of radio collars placed at known sites, from collared bears in their winter dens, and from dropped collar recoveries. Aerial and ground triangulation test locations were accurate to 148 m ± 28.6 SE ($N = 30$) and 137 m ± 11.9 ($N = 89$), respectively.

## Results

### Virginia Hunter Harvest

Change in hunter harvests from predefoliation years (1980–1986) to years of heavy gypsy moth infestation (1987–1990) differed among the 3 regions (Table 1). Numbers of bears killed/year in the nondefoliated ($P = 0.45$, 0.85, and 0.39 for males, females, and total kill, respectively) and intermediate ($P = 0.34$, 0.57, and 0.45, respectively) regions remained relatively constant. However, mean annual kill was 1.5, 1.8, and 1.6 times greater during infestation years in defoliated counties for males, females, and total kill, respectively ($P = 0.07$, 0.01, and 0.3, respectively). Changes in sex ratios of harvested bears also varied by region (Table 1). Proportion of females in the annual harvest in nondefoliated and intermediate regions remained unchanged ($P = 0.57$ and $P = 0.13$, respectively); whereas proportion of females harvested in the defoliated region increased during years of defoliation ($P = 0.09$).

**Table 1.** Mean (SE) annual black bear harvest and percentage female bears in annual harvest by defoliation region, before and during gypsy moth infestation, northwest Virginia, 1980–1990.

| | Legal harvest | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | | Female | | Total | | Percentage female | |
| Region | Before | During | Before | During | Before | During | Before | During |
| Defoliated | 90(8)A[a] | 134(18)B | 47(5)C | 86(10)D | 138(12)C | 220(12)D | 34(2)A | 40(3)B |
| Intermediate | 50(5) | 65(12) | 44(6) | 41(3) | 93(11) | 105(15) | 46(2) | 40(4) |
| Nondefoliated | 89(9) | 101(17) | 56(7) | 57(9) | 145(15) | 158(25) | 38(2) | 36(2) |

[a]Harvest of bears within a sex grouping and/or percentage females with different letters differ between defoliation periods, A – B = $P < 0.10$, C – D = $P < 0.05$.

### Virginia Nuisance Bear Captures

Average numbers of nuisance bears captured per year in the intermediate and defoliated regions during gypsy moth infestation (13 ± 3 and 45 ± 4, respectively) were greater ($P = 0.03$ and 0.01, respectively) than before defoliation (6 ± 2 and 24 ± 5, respectively). Only 3 bears were captured following nuisance or damage complaints in the nondefoliated region during 1981–1990. This region of Virginia apparently does not experience many bear nuisance problems. Too few individuals were captured each year in any region to confidently examine data for males and females separately or to determine trends in nuisance bear sex ratios.

In the defoliated region and during years of defoliation, nuisance problems were greater from May-August and slightly greater in October and December (Fig. 2). In the intermediate region, increased nuisance activity occurred mainly in August and September during defoliation years; small increases were evident in June and October.

### Nuisance Behavior in Shenandoah National Park

Only 2 (4%) of 44 radio-collared females from SNP exhibited nuisance behavior during 1986–1989. One adult was removed from a cornfield by the VDGIF, and a subadult frequently rummaged through trash at Skyland Lodge in SNP in August 1989 before she was removed. Bears were frequently located near campgrounds and picnic areas, but no collared bear ever entered a campground or "panhandled" for food in a picnic area. Only 1 instance of an unmarked bear in a campground was encountered in defoliated areas of SNP during the study. All of these nuisance incidents occurred during summer. The frequency of these events indicates nuisance activity in SNP as at an extremely low level despite high bear density.

## Discussion

Legal harvest appeared to be influenced by gypsy moth infestation, i.e., annual kill was greater during infestation only in the defoliated region. Both

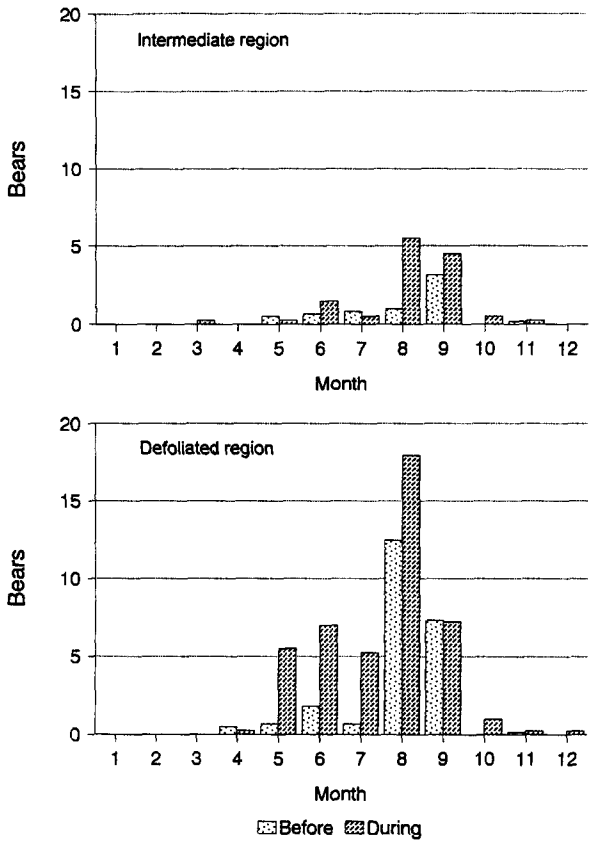


**Figure 2.** Mean number of nuisance bears captured by month and defoliation region in Virginia, before (1981–1986) and during (1987–1990) gypsy moth infestation. Only 3 bears were captured in the nondefoliated region during these years.

regions with essentially no defoliation did not experience increased mean annual kill. Similarly, Beeman and Pelton (1980) observed a 4-fold increase in hunter harvest around Great Smoky Mountains National Park, Tennessee, during a poor acorn year. Conversely, Carpenter (1973) and Lindzey et al. (1976) in Virginia and Pennsylvania, respectively, noted a direct relationship of hunter harvest and mast availability. In Virginia, gypsy moth infestation resulted in widespread acorn crop failure (McConnell 1988, Kasbohm 1994); defoliated oak stands produced only 1.6 kg acorns/ha versus 118 kg/ha in nondefoliated stands (Kasbohm 1994). This stimulated increased fall bear movements (Kasbohm 1994), possibly increasing hunter-bear encounters and, thus, bear vulnerability to hunting.

Females apparently were more seriously affected than males by gypsy moth infestation. During the hunting season (i.e., late fall), females were outside the protective boundaries of SNP more during defoliation years (16% of 1987–1989 late fall locations, Kasbohm 1994) than before infestation (8% in 1982–1984,

Garner 1986), increasing their likelihood of encountering a hunter. Males generally make significantly greater fall moves (Garshelis and Pelton 1981) and are outside SNP more than females in most years; Garner (1986) found males were twice as likely to be located outside SNP in fall as females. Therefore, males already were more vulnerable to hunting relative to females regardless of defoliation.

Other factors could have been responsible for differential changes in hunter harvest along with or instead of gypsy moth defoliation. Changes in hunter effort or methods could influence number of bears killed. However, no significant changes in yearly regulations occurred from 1980–1990. Restrictions on hunting methods, especially hunting with dogs, also did not change. We could not determine if bear hunter effort changed throughout the decade. In Virginia, legal hunters must purchase a big game license, but there is no license specific to bear hunting. Hence, numbers of hunters pursuing bears was not known. Nevertheless, if changes in hunter effort did occur, similar trends might have been expected in all 3 regions.

Nuisance activity, depredation complaints, and numbers of bears handled or killed following complaints usually increase during years with low mast productivity (Schorger 1946; Rogers 1976, 1977, 1989; Beeman and Pelton 1980; Elowe 1984; Garshelis 1989; Stiver 1991). Many have noted more bears feeding in cornfields when natural food sources are limited (Lindzey et al. 1976, Elowe 1984). Although nuisance and/or damage captures doubled in the defoliated region, a similar increase also was observed in the intermediate region, implying gypsy moth infestation may not have been responsible for greater nuisance incidents. Most captures occurred in summer; absence of substantial numbers of nuisance captures from September to December, when acorns would normally be available, clearly indicate nuisance behavior in fall was not a function of gypsy moth-induced acorn failure. Defoliation influences on bear behavior in summer, however, are uncertain. Because nuisance activity increases were prominent from May to August in the defoliated region, and only in August in the intermediate region, canopy loss and its associated effects on bear habitat may have played a role. Nevertheless, radio-collared females remained inside SNP boundaries more than before infestation (88% of summer locations in SNP 1987–1989 vs. 79% in 1982–1984, Garner 1986, Kasbohm 1994). In addition, because defoliation was not noticeable until early June, at least in May, no affect of defoliation on bear nuisance behavior was possible. Although reporting rates of nuisance bears may vary among years, VDGIF's nuisance bear program has been in place since the mid-1960s (D. Martin, VDGIF, pers. commun.), minimizing any chance of an increasing reporting rate from 1980–1990.

Soft mast production likely alleviated some of the detrimental effects of defoliation (e.g., acorn failure). Defoliation appeared to stimulate increased soft mast fruit production of important summer and fall bear foods. Although we did not measure production, field observations indicated sweet and black cherry, blueberry, grape, pokeweed, and spicebush all produced highly abundant crops (Twery 1991, Kasbohm 1994). Scat analysis revealed bears relied heavily on

these fruits during defoliation (Kasbohm 1994) instead of on acorns as they had before infestation (Garner 1986). Hence, defoliation may have allowed bears to feed on abundant soft mast instead of turning to higher levels of nuisance activity that might be expected during more conventional hard mast failures.

An increasing population size from 1980–1990, especially in the defoliated region, could also explain increasing trends in both hunter harvest and nuisance behavior. However, population estimates from SNP in 1982–1984 revealed a very dense (0.67–1.0 bears/km$^2$) and probably stable population (Carney 1985); our estimates during 1985–1989 also are high (0.41–0.72 bears/km$^2$), but are somewhat lower and do not support the hypothesis that population size increased. Although population sizes could have increased in other regions of Virginia, such increases have not translated into increased harvest or nuisance behavior.

Clearly, the low incidence of bear nuisance problems within SNP (at the heart of gypsy moth infestation and with the highest bear density in Virginia) during years of heavy canopy defoliation (up to 84% for some bears) does not imply any increase in bear-visitor conflicts. SNP maintains records of bear-human conflicts. However, extremely variable reporting rates among years (e.g., inconsistency in reporting all incidents or multiple reporting of the same incident) due to constant turnover of seasonal employees, precluded use of SNP bear incident reports to evaluate effect of gypsy moth infestation. Nevertheless, Garner and Vaughan (1989) reported that bear incidents in SNP from 1970–1986 steadily declined. This trend appeared to continue through 1987–1990 without change in SNP bear management policies.

Traditional understanding of black bear biology suggests our 2 hypotheses, i.e., increased hunter harvest and increased nuisance behavior, would be realized during a severe gypsy moth infestation. Harvest did appear to be influenced by defoliation and subsequent acorn failure. However, effects on nuisance behavior were not pronounced, and in fall, were not apparent at all. It would be desirable to determine whether harvest and nuisance behavior return to predefoliation levels in the future. Unfortunately, because the gypsy moth continues to defoliate Virginia forest and has inflicted long-term habitat alterations (Kasbohm 1994) this seems impossible. Managers and biologists, especially in the southeast, should be aware of the possible and far-reaching effects of the gypsy moth on not only bears, but also on other game and nongame species. In addition, this study emphasizes the importance of soft mast production to bears and stresses the need to monitor annual availabilities of all important bear food producing species, hard and soft mast alike. More research is warranted on the effects of gypsy moth defoliation and its consequences to wildlife populations.

## Literature Cited

Beeman, L. E. and M. R. Pelton. 1980. Seasonal food habits and feeding ecology of black bears in the Smoky Mountains. Internatl. Conf. Bear Res. and Manage. 4:141–147.

Carney, D. W. 1985. Population dynamics and denning ecology of black bears in Shenandoah National Park, Virginia. M.S. Thesis, Va. Polytech. Inst. and State Univ., Blackburg. 84pp.

Carpenter, M. 1973. The black bear in Virginia. Va. Comm. Game and Inland Fish., Richmond. 22pp.

Elowe, K. D. 1984. Home range, movements, and habitat preferences of bears (*Ursus americanus*) in western Massachusetts. M.S. Thesis, Univ. Mass., Amherst. 112pp.

Garner, N. P. 1986. Seasonal movements, habitat selection, and food habits of black bears (*Ursus americanus*) in Shenandoah National Park, Virginia. M.S. Thesis, Va. Polytech. Inst. and State Univ., Blacksburg. 104pp.

——— and M. R. Vaughan. 1989. Black bear-human interactions in Shenandoah National Park, Virginia. Page 155–161 *in* Bear-people conflicts—Proceedings of a symposium on management strategies. Northwest Territories Dep. Renewable Res.

Garshelis, D. L. 1989. Nuisance bear activity and management in Minnesota. Pages 169–180 *in* Bear-people conflicts—Proceedings of a symposium on management strategies. Northwest Territories Dep. Renewable Res.

——— and M. R. Pelton. 1981. Movements of black bears in the Great Smoky Mountains National Park. J. Wildl. Manage. 45:912–925.

Gottschalk, K. W. 1989. Gypsy moth effects on mast production. Pages 42–50 *in* C. E. McGee, ed. Proceedings of the workshop on southern Appalachian mast management. Knoxville, Tenn.

Kasbohm, J. W. 1994. Response of black bears to gypsy moth infestation in Shenandoah National Park, Virginia. Ph.D. Diss., Va. Polytech. Inst. and State Univ., Blacksburg. 219pp.

Lindzey, J. S., W. S. Kordek, G. J. Matula, Jr., and W. P. Piekielek. 1976. The black bear in Pennsylvania status, movements, values and management. Internatl. Conf. Bear Res. and Manage. 3:215–224.

Martin, D. 1993. Virginia status report. East. Black Bear Res. and Manage. 11:82–86.

McConnell, S. P. 1988. Effects of gypsy moth defoliation on acorn production and viability, literfall, and litter layer depth and biomass in North-central Virginia and western Maryland. M.S. Thesis, Va. Polytech. Inst. and State Univ., Blacksburg. 124pp.

Rogers, L. L. 1976. Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. Trans. North Am. Wildl. Nat. Resour. Conf. 41:431–438.

———. 1977. Social relationships, movements, and population dynamics of black bears in northeastern Minnesota. Ph.D. Diss., Univ. Minn., Minneapolis. 194pp.

———. 1989. Black bears, people, and garbage dumps in Minnesota. Pages 43–46 *in* Bear-people conflicts—Proceedings of a symposium on management strategies. Northwest Territories Dep. Renewable Res.

Schorger, A. W. 1946. Influx of bears into St. Louis County, Minnesota. J. Mammal. 27:177.

Stiver, W. H. 1991. Population dynamics and movements of problem black bears in Great Smoky Mountains National Park. M.S. Thesis, Univ. Tenn., Knoxville. 134pp.

Twery, M. J. 1991. Effects of defoliation by gypsy moth. Pages 27–39 *in* K. W. Gottschalk, M. J. Twery and S. I. Smith, eds. Proceedings, U.S. Department of Agriculture interagency gypsy moth research review 1990. For. Serv. Gen. Tech. Rep. NE-146. 152pp.

Vaughan, M. R., P. F. Scanlon, S. P. Mersmann, and D. D. Martin. 1990. Black bear damage in Virginia. Fourth East. Wildl. Damage Control Conf. 4:147–154.