Wildlife Session

Deer Movements in Relation to Food Supplies in the Southern Appalachians

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Abstract: We studied seasonal movements of white-tailed deer (*Odocoileus virginianus*) in northeast Georgia in relation to agricultural food plots during years of varying oak (*Quercus* spp.) mast production. In total, 2,381 radio telemetry locations were collected from 12 does from 1987 through 1989. Fall and winter home ranges were larger ($P < 0.1$) during a high oak mast productivity year compared to a low productivity year. There were no differences ($P > 0.1$) in spring home range sizes under 3 different oak mast conditions. All radio-collared does had ranges which included 1 or more food plots. Most deer were located within 800 m of a food plot during all years and all seasons. Distances does were located from food plots were not different ($P > 0.1$) during fall and spring regardless of mast conditions; however, during the winter of low mast productivity deer were located closer, 177.5 m vs 289.9 m, to food plots than they were during the winter of high mast productivity ($P < 0.1$).

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The Chattahoochee National Forest provides 296,400 ha of public hunting land within 2 hours driving distance of approximately 50% of Georgia's deer hunters, yet it is lightly hunted for deer. The principle reason for low use is lower deer densities in the Blue Ridge Mountain Region (4 to 10 deer per km^2) versus the Piedmont Region (15–20 per km^2) (Kammermeyer et al. 1989). Mountain deer populations fluctuate widely and depend heavily upon mast (Johnson et al. 1986).

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Mast fluctuations and low populations cause lower public satisfaction with the deer resource, and hunters are less willing to accept either sex hunting or greater harvest because of a desire to stockpile deer. The management goal is to stabilize or improve mountain deer populations so that a large public land base will attract and satisfy more of Georgia's demand for public deer hunting.

Low deer densities that are influenced by varying mast supplies do not respond well to management by harvest regulation and often are controlled by density independent factors (Wentworth et al. 1992). Recent studies (Kammermeyer et al. 1984, Vanderhoof and Jacobson 1988, Vanderhoof 1989, Kammermeyer and Moser 1990) have suggested that agricultural wildlife openings be used to increase deer harvest, quality, and population size, and may be valuable in reducing population fluctuations (Rogers 1980). Deer occupying large forested areas without agricultural openings may move to peripheral fields and pastures in search of food during mast shortages (Downing et al. 1969). Data from heavily forested Georgia wildlife management areas (WMA's) show low hunter success during mast failures (Kammermeyer et al. 1984). Additionally, low deer populations with poorer physical condition follow poor mast years (Wentworth et al. 1992). Deer movements off forested WMA's, behavioral changes, high non-harvest mortality rates, and low recruitment during mast failures may explain low harvests in the current year and reduced populations in subsequent years. However, these explanations are largely speculative because little data exists to describe the reaction of deer to varying mast supplies. The objectives of this study were to determine if white-tailed deer home range size was independent of annual hard mast production and if white-tailed deer use of agricultural wildlife openings was independent of annual hard mast production.

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Methods

The study was conducted on the 5,101-ha Lake Burton WMA, in the Blue Ridge Mountain Physiographic Region of northeast Georgia. Elevations range from 550–1,280 m. Major forest types are oak-hickory (*Q.* spp.-*Carya* spp.), oak-pine (*Q.* spp.-*Pinus* spp.), northern red oak (*Q. rubra*), and yellow poplar (*Liriodendron tulipifera*) (Braun 1950). Forest composition is 79% upland hardwoods, 6% yellow pines, 3% white pine (*P. strobus*), 9% hardwood-pine, 3% yellow poplar; 1% of the various forest types are in the 0–10 year age class. Much of the area has a well developed heath layer with *Rhododendron* spp., *Kalmia* spp., *Vaccinium* spp., *Leucothoe* spp., and *Gaylussacia* spp. often abundant (Braun 1950). Annual precipitation is 187 cm. The WMA is part of the Chattahoochee National Forest and is jointly managed for wildlife by the Georgia Department of Natural Resources, Wildlife Resources Division, and the U.S. Forest Service.

Fifty-five agricultural openings (24.6 ha) averaging 0.5 ha were maintained as wildlife food plots on the study area. Four of these openings (2.0 ha) were planted to annual (corn, sorghum) mixes with the rest (41 openings, 22.6 ha) planted to perennial (clover, ryegrass, orchardgrass, fescue) mixes. Road access to the interior of the WMA is poor with approximately 1 km of access road per km^2. Openings were located across the area. Distances between openings varied from 105 m to 2,100 m and averaged 578 m.

White-tailed deer is the primary game animal on the area; black bear (*Ursus americanus*), wild turkey (*Meleagris gallopavo*), and feral hog (*Sus scrofa*) are also present. The deer population was estimated by Deer Camp population model (Moen et al. 1986) to be 10 per km^2 (Kammermeyer et al. 1989). The average annual harvest for the past 10 years has been 1.75 per km^2 (32% does).

Eleven adult (≥ 2 years) does and 1 doe fawn (7 months old) were captured using succinylcholine chloride delivered via capture rifle at the rate of 0.09–0.15 mg/kg body mass. Captured deer were aged by tooth wear and replacement, and were fitted with 150-Mhz transmitting collars equipped with either movement or mortality sensors (Telonics, Inc., Mesa, Ariz.).

One hundred and twenty-three telemetry stations were located on the study area and marked with numbered stakes. Fixes were taken with a hand-held 2-element Yagi antenna and measured with a hand-held compass. Topographic maps (1:24,000) were marked with telemetry stations and used to plot triangulated locations of telemetered deer in the field. Preliminary fixes were taken to allow observers to move to the known stations closest to the individual deer. Only compass bearings that formed angles exceeding 30° were recorded. Initial bearings were discarded if a second was not completed within 10 minutes. Field data were transferred to database files containing station number, time, and compass bearing. Station and agricultural food plot locations were identified by UTM grid coordinates and entered into computer data files.

Radio-collared deer were located 2 to 3 days per week during 6-hour periods (0600 – 1200, 1200 – 1800, 1800 – 2400). One to 3 locations were taken on each deer during a tracking period. Data were entered into TELEM, a telemetry software program (Koeln 1980), for analysis.

Seasonal home ranges for all 12 deer were calculated through the TELEM softward program using the 95% minimum convex polygon method. Distances from food plots were measured for each deer location collected during the season.

Three mast survey lines (16.1 km each) were examined annually in early September to quantify oak mast abundance (Whitehead 1969). The survey involved visually estimating acorn production at 10 stations approximately 1.6 km apart. Observers, using binoculars, estimated percent of crown bearing acorns, percent of twigs bearing acorns, and the number of acorns per twig. These data were stratified into red oak and white oak groups. Data from these 2 groups were combined to analyze overall oak mast availability. A mast availability index, ranging from 0 – 10, was computed from these data. The indices were interpreted as low (<2.0), medium (2.1 – 3.0), or high (>3.0) (Wentworth 1989).

Statistical Analysis

A minimum of 2 hours was allowed between telemetry locations on any individual deer, and each instrumented deer represented a separate family unit. As such, locations for individual deer were assumed to be independent observations. Home range sizes and the average distances deer were located from food plots were assumed to be distributed normally because Kolmogorov-Smirnov and Kniper tests failed to indicate otherwise ($P < 0.1$).

The influence of hard mast production (low, medium, and high) and season (fall, winter, and spring) on home range size was tested with a randomized block 2-way Analysis of Variance (ANOVA) (Ott 1988). A second 2-way ANOVA was used to evaluate distance deer were located from food plots by season. Pairwise comparisons were conducted with Duncan's multiple range tests. Home range of the fawn was not different from the adults ($P > 0.1$), thus the fawn home range was pooled with adults for statistical analysis.

Since experimental units were home ranges and the average distance from food plots (both composites of individual locations), the data were not time trend data. Additionally, all known sources of variation in deer movement (primary foods, season, and food by season interactions) were included in statistical models. As such, auto correlation of error terms was not a factor in either ANOVA.

Results

Home ranges for all does ($N = 12$) varied from 49.9 – 183.8 ha ($\bar{x} = 112.7 \pm$ 11.8 SE). Seasonal ranges varied from 9 to 148.2 ha, but generally were smallest during the fall (21 Sep – 20 Dec) of 1987 ($\bar{x} = 25.1$ ha $\pm$ 3.6 SE) and winter (21 Dec – 20 Mar) of 1988 ($\bar{x} = 31.5$ ha $\pm$ 5.9 SE) (mast rating 0.66) and the summer (21 Jun–20 Sep) ($\bar{x} = 30.6$ ha $\pm$ 5.1 SE) and fall of 1989 ($\bar{x} = 35.3$ ha $\pm$ 9.5 SE) (mast rating 2.41). Spring (21 Mar – 20 Jun) ranges (1987 $\bar{x} = 51.3$ ha $\pm$ 5.9 SE, 1988 $\bar{x} =$ 44.4 ha $\pm$ 5.6 SE, 1989 $\bar{x} = 51.7$ ha $\pm$ 8.1 SE) were larger ($P < 0.1$) than summer ranges (1987 $\bar{x} = 36.3$ ha $\pm$ 7.8 SE, 1988 $\bar{x} = 37.6$ ha $\pm$ 7.1 SE, 1989 $\bar{x} = 30.6$ ha $\pm$ 5.1 SE) and similar in size to fall ($x = 58.9$ ha $\pm$ 14.9 SE) and winter ranges ($\bar{x} = 66.5$ ha $\pm$ 11.7 SE) when acorns were abundant (Fig. 1). Mast availability was low in 1987 (0.66 rating), medium in 1989 (2.41 rating), and high in 1988 (5.18 rating) when compared to a 12-year history of mast production on the study area. During the 12 years index values varied from 0.66 to 5.18 ($\bar{x} = 2.73$). Fall home ranges were larger ($P < 0.1$) when mast availability was high ($\bar{x} = 58.9$ ha $\pm$ 14.9 SE) than when mast availability was low ($\bar{x} = 25.1$ ha $\pm$ 3.6 SE). There were no differences ($P > 0.1$) in fall range sizes between years of high and medium ($\bar{x}$ 35.3 ha $\pm$ 9.5 SE) mast availability, or years of medium and low mast availability. Winter home range size was larger ($P < 0.1$) during the year of high mast availability ($\bar{x} = 66.5$ ha $\pm$ 11.7 SE) than during the winter of low mast availability ($\bar{x} = 31.5$ ha $\pm$ 5.9 SE). There were no differences between spring home ranges with varying mast availability ($P > 0.1$).

Deer were located farther from food plots during the summer and fall of 1988 and winter and spring of 1989, and closest to the food plots during the fall of 1987

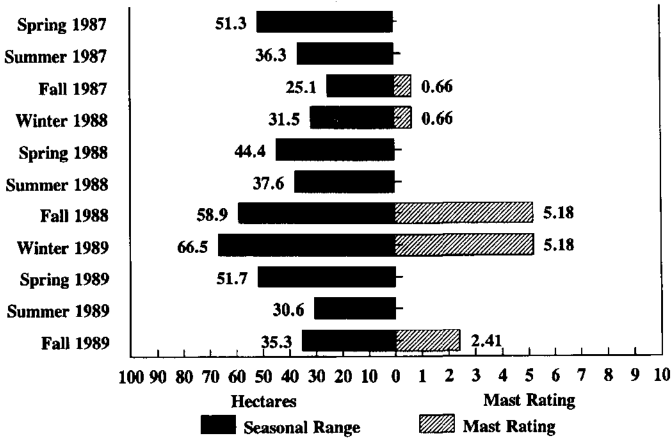

Figure 1. Comparison of mast index *vs* average seasonal ranges of 12 does radio-collared on Lake Burton WMA, Georgia, 1987–1989.

and subsequent winter (low mast) and the fall of 1989 (medium mast). There were no differences ($P > 0.1$) in the distance deer were located from agricultural food plots during fall for high ($\bar{x}$ = 258.6 m ± 53.9 SE), low ($\bar{x}$ = 187.2 m ± 21.9 SE), or medium ($\bar{x}$ = 198.3 m ± 29.2 SE) mast years or spring for high ($\bar{x}$ = 251.1 m ± 41.0 SE) or low ($\bar{x}$ = 216.1 m ± 35.8 SE) mast years. Deer were located closer ($P < 0.1$) to food plots during the winter of low mast ($\bar{x}$ = 177.5 m ± 16.7 SE) availability than during the winter of high mast availability ($\bar{x}$ = 289.9 m ± 63.2 SE).

Discussion

Long range movements of deer in mountain habitats have been documented to a limited extent in the Southeast (Downing et al. 1969, Kammermeyer and Marchinton 1975). Downing et al. (1969) noted large numbers of deer feeding on a small grass plot and stated that deer may move to a choice food supply and that such movements may be more common than generally is recognized. Kammermeyer and Marchinton (1975) noted 3 movement patterns of deer associated with a refuge in northwestern Georgia: (1) sedentary movement of resident refuge deer, (2) dispersal of bucks from the refuge coincident with the rut, and (3) migration of deer onto the refuge coincident with opening of hunting season. Such observations have been common in the mountain regions of Georgia and led to the hypothesis that substantial movements of deer may occur from large forested blocks of habitat to wildlife openings, road sides, and agricultural crops in response to mast failures. However, this hypothesis was not supported by our study since home ranges and movements were reduced during winters of low mast availability. Long distance movements of does were usually of short duration and may have been associated with chases by domestic dogs.

Nichols (1978) mentioned that deer stocked in east Tennessee in the late 1940s and early 1950s were expected to expand and repopulate large areas. Expansion did not occur and deer restoration was delayed for 10 years. Moreover, on the Cumberland Plateau, of > 400 deer tagged on the Catoosa WMA during a 6-year period, none were recovered > 3.22 km from the WMA boundaries (Nichols 1978). This suggests small home ranges of deer, low dispersal rates, and no long distance movements. However, Nichols (1978) also reported that 2 radio-monitored does on the Cumberland Plateau had average home ranges of 691 ha. In our study in the north Georgia mountains, total home range size of does averaged 112.7 ha.

Our data indicated that deer were located closer to food plots within their home range during winters of low mast production when compared to winters of high mast production. This may be due to the fact that our study animals had food plots within their normal ranges. We observed no shifts from established home ranges to agricultural openings when oak mast was scarce; however, some occasional sallies carried deer through distant high quality openings. These deer always returned quickly to their original home range. Studies in Mississippi (Burns 1988) and Virginia (Scanlon and Vaughan 1985) suggest that deer utilize wildlife plantings or road sides within their home ranges but do not shift their ranges to take advantage of distant food sources. Our data support those findings.

Instead of making long movements to alternate food supplies, our deer restricted their ranges during a fall and winter of low mast availability. Deer were located closer to food plots during the winter of low mast production than during the winter of high mast production. The largest seasonal ranges occurred when mast ratings were the highest.

Based on seasonal home range sizes and distances from food plots, deer in our study were much less dependent on food plots during the fall with high mast availability than during any other season-mast combination. Wentworth et al. (1990*a*, 1992) found that deer in the southern Appalachians use oak mast heavily when available. When acorn supplies were limited, greater use of grasses and woody twigs was evident both in early and late winter. In an earlier related study, Wentworth et al. (1990*b*) found that food plots were an important source of food in winter and spring following poor mast years.

The seasonal variation in home range size we found is consistent with results from other studies. Cartwright (1975) reported most home ranges of < 259 ha during winter, spring, and early summer. Home ranges of the same deer from July through November were usually > 259 ha. Although none of the home ranges in northeast Georgia were as large as 259 ha they did vary with season and mast production. Corbett et al. (1971) recorded small seasonal ranges for deer in the North Carolina mountains as part of a study of the effects of dogs on radio-equipped deer. Although their study was not designed to address the question of seasonal deer movements in relation to food supplies, seasonal home range extremes (9–50 ha) probably were most affected by season and food availability.

Some of the variations in home range size reported in the literature may be due to different techniques of range estimation, availability of food supplies, or to the length and intensity of tracking.

Heavy use of acorn mast as a fall and winter energy source has been well documented (Harlow and Hooper 1971). Mass, antler development, and population dynamics of deer herds in the Southern Appalachians are significantly affected by the size of the acorn crop (Wentworth et al. 1990*a*, 1992). Supplemental food plantings can provide an alternate food source (Halls and Stransky 1968). In the Arkansas Ozarks, Rogers (1980) reported that drastic population fluctuations associated with acorn production were dampened with the addition of forage openings. With the addition of 2% openings in their enclosure, cultivated forages comprised approximately 97% of the deer diets in March of a year with a poor mast crop. In another study, grasses made up about 17% of the late winter diet in years of poor mast years (Wentworth et al. 1992) even though food plots were < 0.2% of the area.

The literature clearly indicates a dependence of mountain deer herds on hard mast and points out that food plots are an important means of providing alternative foods during mast shortages. Based on our findings, it seems unlikely that deer occupying large forested areas in the Southern Appalachians will move substantial distances to use pastures, crops, road sides, or even wildlife plantings during shortages of natural foods.

In areas managed for deer in the Southern Appalachians, agricultural plantings, representing at least 0.5% of the area, should be provided in a systematic fashion to be available to a large segment of the population. Relatively small home ranges recorded in our study indicated planted openings may be needed in each 100- to 200-ha unit.

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