Mortality of Maturing White-tailed Deer in Coastal South Carolina

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Abstract: A better understanding of population dynamics leads to more informed wildlife management decisions. Investigations of mortality rates and their causes for maturing white-tailed deer (*Odocoileus virginianus*) are lacking in the Coastal Plain of the Southeast. We captured 36 (18 male and 18 female) fawns with rocket nets and radio-collared them on Westvaco's North Whitener tract in Jasper County, South Carolina, from October through December 1992. We radio-tracked these deer during the 1993 calendar year to investigate mortality rates in a coastal area under a quality deer management program. Calendar year mortality rates, estimated with the Kaplan-Meier product limit method, were 0.389 (SE = 0.115) for females and 0.410 (SE = 0.119) for males. Sex-specific survival functions did not differ within the year ($P = 0.906$) or within either age-period analyzed (fawn period, 1 Jan–31 May, $P = 0.300$; yearling period, 1 Jun–31 Dec, $P = 0.229$). However, sources of mortality appeared to differ by sex-class. All 7 female mortalities were from non-hunting mortality factors, whereas 5 of 7 male mortalities were attributable to off-site hunter harvest of dispersing yearling bucks. Non-hunting mortality (9 of 14) was highest from January to May (7 of 9), which coincided with a time of heavy flooding. Hunting mortality (5 of 14) occurred from October to December as bucks dispersed from the study site. The maturing segment of the study site deer population (0.5 year olds to 1.5 year olds) is primarily controlled by non-hunting mortality in association with seasonal stress and off-site hunting mortality associated with fall movement patterns.

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Currently, South Carolina has the most liberal deer hunting regulations in the United States. Yet, in coastal South Carolina, as in many other parts of the southeastern United States, deer densities have reached levels that potentially conflict with human interests and economic concerns (Smith and Coggin 1984). For populations subject to hunter pressure, legal deer harvest is a major cause of mortality. However, deer mortality rates are constantly affected by many interrelated factors, including poaching, predators, disease, parasites, nutrition, weather, and accidents (Matschke et al. 1984). Halls (1984) asserted that impact of non-hunting mortality on deer populations remains unknown.

Klein and Olson (1960), Nelson and Mech (1986, 1990), Holzenbein and Marchinton (1992), and others have reported diverse age-, and sex-specific mortality rate estimates throughout the United States. In the southeast, Blanton and Hill (1989) and Epstein et al. (1983, 1985) investigated neonatal mortality rates. Demarais et al. (1988) and DeYoung (1989) studied mortality rates among mature bucks in Texas. However, information concerning mortality rates and causes of mortality is lacking for maturing white-tailed deer across the southeast. To more clearly describe and manage local deer populations, accurate estimates of mortality rates affecting local herds are necessary (Huegel et al. 1985, Nelson and Woolf 1987, Dusek et al. 1992).

Our objectives were to estimate annual and "seasonal" mortality rates and identify cause-specific mortality factors from 1 January 1993 to 31 December 1993 for maturing deer in a coastal South Carolina white-tailed deer population subject to hunter harvest under a quality deer management plan.

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Methods

The study was conducted on Westvaco's North Whitener Tract located southwest of Tillman, South Carolina, which occupies approximately 32.4 km^2 and lies in the Southern Flood Plain Forest Region of the South Atlantic Coastal Plain (Newsom 1984). Elevations range from 3.5 to 11 m above sea level. Seasonal winter flooding occurs annually in the lowest areas. Lower elevations are characterized by bottomland hardwood and cypress (*Taxodium distichum*)/tupelo (*Nyssa aquatica*) wetlands. Higher elevations are characterized by northwest/southeast sand ridges planted with loblolly pine (*Pinus taeda*) and typically bordered by mature bottomland hardwoods. Additional hardwood areas have been retained in upland areas as wildlife travel corridors. The pattern of alternating bottomlands and upland ridges (and the contrasting habitats associated with each area) produces a patchy matrix of habitats and a large amount of edge habitat.

Approximately 0.2 km^2 of wildlife food plots are planted annually in winter rye (*Lolium perenne*) and roughly 76,200 kg of corn (*Zea mays*) is distributed as supplemental wildlife feed. A quality deer management program was adopted in 1984 and continues through the present. Hunters are expected to harvest only bucks with antlers that equaled or exceeded 4 points on 1 side and a spread of 30.5 cm (12 inches) and large does presumed to be mature animals. From 1986 to 1993, average annual harvest was 110 deer/year (SE = 22.4) (66 does, SE = 21.2; and 44 bucks, SE = 7.8). In 1993, 134 deer (41 bucks and 93 does; 1 deer/24 ha) were harvested on the North Whitener Tract. Spotlight surveys conducted in January and February of 1994 estimated a post hunt deer population density of 1 deer/2 ha.

Deer were captured with rocket nets (Hawkins et al. 1968, Swayngham 1988, Boller 1992) between 1600 and 0200 hours at 20 different trap sites on Westvaco's North Whitener Tract. Night vision goggles (U.S. Army, model AN/PVS-7B) were used to facilitate night trapping. Trap sites were selected to: 1) maximize potential of capturing young deer, 2) minimize recaptures, and 3) minimize impact of deer trapping on normal hunt club activities. Captured animals were blindfolded and restrained by members of the capture crew while the deer remained in the net. Each deer was aged by tooth replacement (Severinghaus 1949) and marked with 2 numbered metal ear tags. Fawns were fitted with radio transmitter collars equipped with a motion/mortality sensor (Wildl. Materials, Carbondale, Ill). Transmitters had a projected battery life of 3 years within the 150 to 151 MHz range. Injured deer were treated with penicillin and/or topical antibiotics. Collared deer were only treated for minor injuries that occurred during capture. All animals were released as quickly as possible to reduce potential for injury or capture myopathy.

Radio-collared deer were monitored daily and relocated once every 2 days using the loudest signal method (Springer 1979). Homing was used to locate animals when a transmitter pulse rate indicated a probable mortality. Mortality sites and remains were photographed and examined for clues to cause of mortality. Carcasses found in good condition were transported to the Southeastern Cooperative Wildlife Disease Study (SCWDS) in Athens, Georgia, for necropsy and clinical determination of cause of death.

Sex-specific mortality functions were estimated using the Kaplan-Meier product-limit method and were compared using log rank and Chi-square test statistics (Pollock et al. 1989, Kurzejeski et al. 1987). Time zero for mortality rate analysis was 2 January 1993. Calendar year mortality analysis was conducted for 2 January to 31 December 1993. Fawns were considered yearlings after 31 May. Therefore, sex-specific functions were analyzed within each age-period (fawn period, 2 Jan–31 May; and yearling period, 1 June–31 Dec). Deer were censored when collars were lost or transmitters malfunctioned.

Results

Thirty-six (18 female and 18 male) fawns were captured and radio-collared between 2 October and 12 December, 1992. Of these 36, 21 (58%) survived to 1 January, 1994. Between 2 January 1993 and 1 January 1994, 14 collared deer died (Table 1, Fig. 1). One male was censored due to transmitter malfunction. Female and male calendar year mortality rate estimates (1 − survival rate) were 0.389 (SE = 0.115) and 0.410 (SE = 0.119), respectively (Table 2). Calendar year rate estimates did not differ significantly between females and males (P = 0.906). Fawn period sex-specific mortality rate estimates were 0.278 (SE = 0.106) for females and 0.115 (SE = 0.076) for males. Yearling period mortality rate estimates were 0.154 (SE = 0.100) for females and 0.333 (SE = 0.122) for males. We found no significant differences between sex-specific mortality functions within either age-period (fawn period, $P = 0.300$ and yearling period, $P = 0.229$).

Main sources of mortality for North Whitener study deer during 1993 included bobcat predation, malnutrition, parasitism, or disease (5 of 14, 36%) and fall hunting (5 of 14, 36%). Lesser sources of mortality included vehicle/deer collision (2 of 14, 14%) and unknown natural causes (2 of 14, 14%). All cases of bobcat predation, malnutrition, parasitism, and disease occurred early in 1993 during a period of high seasonal flooding (Nov 1992 to May 1993). Greatest flooding occurred between 13 and 22 January when the Savannah River crested above 5.5 m flooding > 70% of the study site. Bobcat predation was the proximate cause of mortality for 3 deer (Table 1). Two of these were sent for necropsy, and SCWDS found that the deer were predisposed to predation by malnutrition, parasitism, or disease. Malnutrition, parasitism, and disease were the proximate cause of death for 2 additional deer (Table 1). All 5 hunting mortalities occurred among males that dispersed from the study area as yearlings in fall (Oct to Nov 1993) and were harvested off-site. Distances from geometric center of home range to off-site harvest location ranged from 4.1 to 21.6 km.

Discussion

Sex-specific mortality rates do not differ for maturing deer in the North Whitener herd. However, all female mortalities (5 as fawns in the early part of the year and 2 as yearlings in the fall) were attributable to non-hunting mortality factors, whereas 5 of 7 male mortalities (71%) were from off-site hunter harvest of yearling bucks. Only 2 male mortalities (29%) were attributable to non-hunting mortality factors, both were fawns at time of death. Klein and Olson (1960) described the pattern of higher "natural" mortality among fawns than for deer from 1.5 to 5.5 years old in a study of mortality induced by winter stress in southeast Alaska. Nelson and Mech (1986) noted cause-specific differences in a Minnesota herd subject to wolf predation and exploitative buck/restrictive

Table 1. Sex-specific mortality for fawn and yearling periods for radio-collared white-tailed deer captured in fall 1992 on Westvaco's North Whitener Tract, Jasper County, South Carolina

Sex	Malnutrition/ parasitism/disease		Predation		Vehicle/deer collision		Unknown natural		Hunting		Total	
	Fawn[a]	Yearling[b]	Fawn	Yearling	Fawn	Yearling	Fawn	Yearling	Fawn	Yearling	Fawn	Yearling
Female	1		2		1	1	1	1			5	2
Male	1		1							5	2	5
Total	2		3		1	1	1	1		5	7	7

[a]Fawn period = 2 Jan–31 May [b]Yearling period = 1 June–31 Dec.

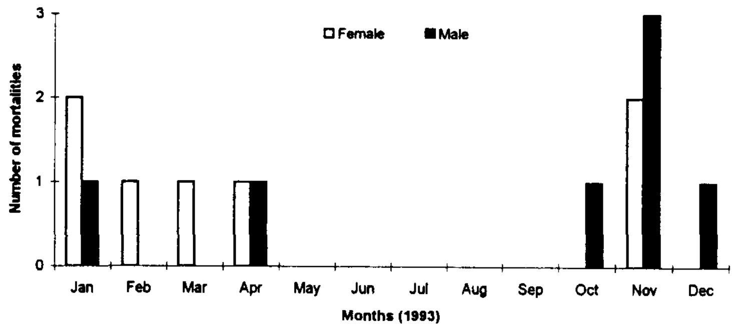

Figure 1. Monthly sex-specific mortality of radio-collared white-tailed deer captured in fall 1992 on Westvaco's North Whitener Tract, Jasper County, South Carolina.

doe harvest. In that study, maturing males suffered from high rates of hunting mortality and younger deer experienced high rates of non-hunting mortality.

In areas where harvest is restricted to mature animals as part of a program of quality deer management, it should be expected that young deer will suffer lower rates of hunting mortality than older deer. Losses of yearling males from North Whitener to off-site hunting during fall dispersal is substantial. Similar patterns of high hunting mortality among male yearlings during fall dispersal have been reported by Hawkins et al. (1971) at the Crab Orchard National Wildlife Refuge in Illinois and by Kammermeyer and Marchinton (1975) at the Berry College Refuge, Georgia. In both cases deer herds were at high densities, and hunting pressure was greater on young males in the dispersal areas than in the study areas. In a study of age- and cause-specific mortality among male deer in an area managed for quality deer in south Texas, DeYoung (1989) concluded that "managing for mature males can be inefficient because 25%–29% of males/year will die before reaching mature age."

Management Implications

Our results indicate that hunting and non-hunting mortality factors play important roles in controlling total deer numbers. While selective harvest strategies can remove hunting pressure from a significant portion of the deer population (typically does and immature deer), mortality rates among these reserved segments of the population can be substantial. Deaths from predation, malnutrition, parasitism, and disease occurred in association with severe environmental stress resulting from severe flooding on the study site. It is doubtful that these factors have as great an impact in years of less severe flooding. The study sample represents only one portion of the maturing segment of the population (deer 6 months old to 1.5 years old). It is unlikely that older segments of the population are affected by these factors to the same extent. However, given the high population density, an increased annual harvest, particularly doe harvest,

Table 2. Calendar year and period-specific Kaplan-Meier rate estimates for radio-collared white-tailed deer captured in fall 1992 on Westvaco's North Whitener Tract, Jasper County, South Carolina

	N			Mortality rate[a] (SE)			95% Confidence limits		
Sex	Fawn[b]	Yearling[c]	Calendar year[d]	Fawn	Yearling	Calendar year	Fawn	Yearling	Calendar year
Female	18	13	18	0.278 (0.106)	0.154 (0.100)	0.389 (0.115)	0.071–0.485	0.000–0.350	0.164–0.614
Male	18	15	18	0.115 (0.076)	0.333 (0.122)	0.410 (0.119)	0.000–0.264	0.095–0.572	0.176–0.643

[a]Mortality rate = (1 − survival rate) [b]Fawn period = 2 Jan–31 May [c]Yearling period = 1 June–31 Dec. [d]Calendar year = 2 Jan–31 Dec.

may serve to maintain the herd at a healthier level by reducing population numbers and mortality from malnutrition, parasitism, and disease. Van Etten et al. (1965) reported that for a closed population, an average annual removal of 44% of the fall herd materially reduced herd size while "limitation to a one-third harvest would have maintained the original herd numbers."

Further study of the affect of fall movement patterns is needed to assess potential impact of off-site hunting on the North Whitener herd. While estimates of on-site recruitment resulting from immigration (permanent movements from adjacent properties to North Whitener) were beyond the scope of this study, it is conceivable that fall recruitment of yearling bucks approximates fall loss from off-site harvest. However, high fall emigration rates among bucks generally indicate high population density and high social pressures (Marchinton and Hirth 1984). Holzenbein and Marchinton (1992) suggested that emigration rate of young males can be reduced by "adequately controlling" the female segment of the population.

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