Virginia Journal of Science
Volume 43, Number 1B
Spring 1992

White-Tailed Deer as Keystone Species within Forest Habitats of Virginia

William J. McShea and **John H. Rappole**
National Zoological Park, Conservation & Research Center
Front Royal, Virginia, 22630

ABSTRACT

The 2 potential pathways by which deer may influence the abundance and distribution of other vertebrate species are, first, directly by competing for limited resources; and second, indirectly by altering habitat features that determine the distribution of other species. Evidence for direct competition may be consumption of mast by deer, while evidence for habitat alteration may be reduced understory vegetation densities within mature forests. Preliminary data indicate small mammal densities in the spring are limited by the size of the mast crop the previous autumn and composition of the understory bird community is correlated with the density of understory vegetation. The selected exclosure of deer from 4 study areas within the Shenandoah National Park and the National Zoo's Conservation and Research Center in Front Royal, Virginia will allow deer impacts along both these pathways to be assessed.

Key Words: White-tailed deer, *Odocoileus virginianus*, mast crop, forest understory, forest birds, small mammals

INTRODUCTION

Managing for the conservation of species on public lands is a primary policy concern (Johnson and Agee, 1988; Salwasser et al., 1984; Salwasser, 1988; Thomas and Salwasser, 1989). Within Virginia, both state and federal lands are set aside for the conservation of endangered and endemic species. Although the ultimate goal of conservation is relatively straightforward, problems arise for land managers when determining how best to meet this goal. With respect to the National Park Service, its mandate from Congress is to maintain the abundance, diversity and ecological integrity of native plants and animals (16 USC 1, 2-4). This mandate has been interpreted as allowing "nature to take its course", except when native species reach "unnaturally high densities" owing to human activities, and these densities have a negative impact on the historical or biological integrity of the park (National Park Service, 1988). White-tailed deer are presently at historically high densities within most of the eastern U.S. (McCabe and McCabe, 1984), but there is no firm evidence for stating that these high densities are negatively affecting the integrity of the biotic community within National Parks (Warren, 1991). The question of whether to manage white-tailed deer within public lands has been the focus of symposia by the National Park Service (Atlanta 1988), The Wildlife Society (Denver 1990) and USDA Forest Service (Warren, Pa. 1987). However, discussion of managing white-tailed deer within public lands set aside for conservation is prema-

ture without a better data base to determine the actual impact of this species on its community.

The potential role of white-tailed deer in forest communities expands the concept of "keystone" predator (Paine, 1974) to "keystone" species, i.e., species which by their behavior, and sometimes sheer numbers, have a significant impact on the diversity of species within ecosystems (Paine, 1980; Krebs, 1988; Terborgh, 1988). Large herbivores are frequently cited as keystone species because of their potential for alteration of habitat (Laws et al., 1975; Mack and Thompson, 1982; Krebs, 1988); thus white-tailed deer should be studied as a keystone species in eastern North America. White-tailed deer cause significant habitat alteration (Leopold, 1933; Hough, 1965; Alverson et al., 1988) and consume limited food resources (Pekins and Mautz, 1987); yet, beyond interactions with other large herbivores (Ludewig and Bowyer, 1985), their influence on vertebrate species composition within forest ecosystems has not been studied. It is necessary to test the hypothesis that white-tailed deer affect the composition of bird and mammal communities *indirectly* through altering habitat features, and *directly* through the consumption of shared food types (e. g. mast).

Mast is an important food resource for many forest mammals (Martin et al., 1951); reproduction and overwinter survival of both sciurids (Elliot, 1978; Nixon and Hanson, 1987) and white-footed mice (Miller and Getz, 1977; Gashwiler, 1979) are influenced by the size of the mast crop. Deer consume a significant portion of the mast crop within this study area (McShea and Schwede, 1992). This study showed that rapid declines in acorns on the ground occurred regardless of the size of the mast crop, and that deer increased their home range to incorporate mast producing areas and consumed approximately 50% of marked acorns placed out during the mast fall (McShea and Schwede, 1992). If the abundance of mast-consuming small mammals is positively correlated with the size of the mast crop, then high densities of white-tailed deer may restrict the ability of more mast-dependent species to survive low or moderate mast crop years.

The diversity of bird communities is influenced by both vertical (MacArthur and MacArthur, 1961) and horizontal (Roth, 1981) structural complexity. Within forests, the heterogeneity of understory vegetation is positively correlated with bird species diversity (Lynch and Whigham, 1984). Increased understory vegetation may increase the number of foraging niches available (MacArthur and MacArthur, 1961; Blake, 1983), and reduce the rate of nest predation by better concealing nests (Wray and Whitmore, 1979; Redmond et al., 1982; Martin and Roper, 1988) or hindering the movement of predators (Bowman and Harris, 1980).

It is well documented that white-tailed deer reduce understory density and diversity (Alverson et al., 1988; Hough, 1965; Tilghman, 1989), and circumstantial evidence indicates deer foraging may alter the bird community dependent on that understory. A 42% decline over a 50 year period in the number of bird species which nest within 2 m of the forest floor in a western New York preserve has been attributed to high deer densities (Baird, 1990), as have low ovenbird densities within a preserve in western Maryland (Boone and Dowell, 1986). In Pennsylvania, a forest enclosure with artificially high densities of ungulates had a lower diversity of bird species and was composed of more "field" species relative to a control area (Casey and Hein, 1983). Also in Pennsylvania, forest areas with logging activity

maintained a more diverse bird community than areas with high densities of white-tailed deer (Dessecker and Yahner, 1987).

Over a long period, reduced deer densities may have wide ranging effects on the small mammal and bird communities within mature forests, possibly by changing the diversity and density of overstory vegetation. However, we predict that, if deer affect the vertebrate community, the initial response to lower deer densities will be increased understory vegetation and increased mast crop availability. Therefore, we will examine 2 subsets of the vertebrate community which should respond to these environmental changes; mast-dependent small mammals and forest interior birds that nest and/or forage within 2 m of the forest floor.

The objective of this paper is to examine the vertebrate community within a tract of continuous forest in the southern Appalachian region of Virginia for evidence that present densities of deer have a negative impact on select vertebrate communities within this region. We are addressing 2 potential effects (indirect and direct) and focusing on specific portions of the vertebrate community which would best test each effect (mast consuming small mammals and forest understory birds).

METHODS

Study sites are located in mature, Appalachian oak forest on the premises of the Conservation and Research Center (CRC) and Shenandoah National Park (SNP) in northern Virginia. The CRC is a 1,200-ha research facility located 2 km SE of the town of Front Royal, Warren County. The SNP is a component of the national park system that stretches along the Appalachian Mountain chain from Front Royal south almost to Waynesboro, Virginia, a distance of approximately 160 km. Deer densities within the CRC and sections of the SNP are high (0.3 deer/ha) (Seidensticker, 1983), and have been at these levels for at least the last 5 years. This high deer density is comparable to other state and federal lands (Wilcox, 1976; Healy et al., 1987).

Five study sites are located in the northern section of SNP and 3 sites are located within the adjacent CRC. The sites are located more than 1 km apart, in mature (>40 years), hardwood forest with mast producing trees in overstory, and not within designated wilderness areas of SNP or captive breeding areas at CRC. Each site is 4 ha, and composed of 100 small mammal trapping stations at 20-m intervals. Two sites, both in CRC, have been monitored since 1986, the remaining sites were established in 1990.

In order to estimate mast production at each grid, every other station has a mast collector (230 cm circumference wire-mesh funnel), which was examined weekly during September and October. All acorn and hickory nuts were removed, air dried for a month, separated from their caps or shells, and weighed to the nearest gm (See McShea and Schwede, 1992, for more details).

To assess the impact of mast crops on small mammal populations, overwinter survival, as measured by population densities in late March, was compared to size of the mast crop the previous autumn. Small mammal density was estimated by trapping for 72 h at each site; 2 Sherman traps (23 cm) were placed at each station (200 total) and checked every 12 h. To monitor squirrel densities, 10 Tomahawk traps (40 cm) were placed on each site at 50-m intervals. All captured animals were uniquely marked, weighed, and examined for evaluation of reproductive condition.