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Seasonal Forage Availability and Diet of Reintroduced Elk in the Cumberland Mountains, Tennessee

Jason Lee Lupardus

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To the Graduate Council:

I am submitting herewith a thesis written by Jason Lee Lupardus entitled "Seasonal Forage Availability and Diet of Reintroduced Elk in the Cumberland Mountains, Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

Lisa Muller, Major Professor

We have read this thesis and recommend its acceptance:

David Buckley, Joe Clark, John Wilkerson

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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SEASONAL FORAGE AVAILABILITY AND DIET OF REINTRODUCED ELK IN THE CUMBERLAND MOUNTAINS, TENNESSEE

A Thesis
Presented for the
Master of Science Degree
The University of Tennessee, Knoxville

Jason Lee Lupardus
December 2005

DEDICATION

I dedicate this thesis to all who strive to make a difference in the understanding and conservation of our natural resources. This small piece of the puzzle is for those in the past, present, and future who share this great passion for the natural world.

ACKNOWLEDGEMENTS

Words can't describe the sensation of hearing the sweet sounds of elk bugling in the mountains of Tennessee for the first time in over 150 years. I feel grateful that I was involved with the Tennessee elk restoration. I would like to thank everyone who helped me along the way with this project. First and foremost I want to thank my major professor, Lisa Muller. I am grateful to her for giving me the opportunity to be here. I appreciate all of her guidance, knowledge, encouragement, and support. Most of all, I want to thank her for being such a good friend and listener through all the good and bad times.

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Finally, elk restoration in the Cumberland Mountains has required a collaborative effort from many groups and individuals. I thank the Rocky Mountain Elk Foundation, University of Tennessee, and Tennessee Wildlife Resources Agency for funding and support.

ABSTRACT

The Tennessee Wildlife Resources Agency (TWRA) reintroduced elk (*Cervus elaphus manitobensis*) into the Cumberland Mountains, Tennessee over a 3-year period beginning in December 2000. We radio-collared 160 elk and monitored them by aerial telemetry from February 2001 to June 2003. Locations (n = 1450) were used in a geographic information system (GIS) to develop a core herd home range (789-ha sampling area) to assess elk seasonal forage use and availability. We monitored diet and resource availability from November 2003 to October 2004 by vegetation sampling and microhistological analysis of feces. Tall fescue (*Festuca arundinacea*; 35.1%) dominated the winter grass diet composition (65.9%). The diet shifted in the spring to a mixture of woody plants (28.1%), forbs (19.4%), and grasses (38.4%). The highest seasonal use of forbs (45%) and legumes (23%) occurred during summer, with jewelweed (*Impatiens* spp.; 27%) as the dominant plant in the diet. The dominant fall forage class was woody plants (37.4%). Oaks (*Quercus* spp.; 14.3%) were the most used woody plant and oak acorns comprised 9.7% of the elk diet. Elk herbivory, interspecific competition for key resources (e.g., acorns), and landscape-level changes (e.g., mining) should be monitored. Short-term detrimental effects from mining could be severe for a small, growing elk herd, and demographic effects could affect reintroduction success. We suggest that historic evidence, native grasses, and the elk diet indicate that oak savannas would be an ideal habitat type to manage for on the Royal Blue Wildlife Management Area. Further research will be needed to

determine the effects of elk upon the flora and fauna in deciduous forests of eastern Tennessee.

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PART I

INTRODUCTION

BACKGROUND

The eastern subspecies of North American elk (*C. elaphus canadensis*) once ranged throughout the Southeast; however, that subspecies is now considered extinct. The last remaining elk reported in east Tennessee was shot in 1849, and the final elk reported statewide was in Obion County in the 1860s (Ganier 1928). Hunting and the loss of habitat were considered the major contributing factors for the extinction of the subspecies (O'gara and Dundas 2002).

In the early 1900s, reintroduction of elk began in many eastern states from Louisiana to New Hampshire. Most elk reintroductions were considered failures because of problems with crop depredation, disease, and poaching (O'gara and Dundas 2002). Recent elk reintroductions have occurred in Arkansas, Michigan, Pennsylvania, Wisconsin, Tennessee, North Carolina, and Kentucky.

One of the most notable and successful repatriation efforts occurred in Kentucky, where 1,044 elk were released during 1997-2001. Elk were obtained from Arizona, Kansas, New Mexico, North Dakota, Oregon, and Utah for stocking in Kentucky (Larkin et al. 2003). In 2005, officials estimated 4,700 elk existed in the 1.04 million-ha restoration zone in Kentucky (C. Logsdon, Kentucky Department Fish and Wildlife, personal communication).

Based on the success of the Kentucky restoration program, Tennessee Wildlife Resources Agency (TWRA), Rocky Mountain Elk Foundation, Tennessee Conservation League, Campbell Outdoor Recreation Association, Elk

Island National Park (EINP), U.S. Department of Agriculture Forest Service at Land Between the Lakes (LBL), and the University of Tennessee worked together to facilitate elk restoration in Tennessee. The Tennessee repatriation area was located directly southwest of the elk zone in Kentucky. Large continuous forests, low human population densities, and lack of production agriculture were the primary factors considered in the identification of a restoration zone suitable for elk (TWRA 2000). The restoration zone (271,145 ha) was located in the Cumberland Mountains of East Tennessee (Anderson, Campbell, Claiborne, Morgan, and Scott counties). A "no elk zone" was designated beyond the restoration zone in which animals were considered incompatible with human pursuits and available habitat (TWRA 2000).

Elk (*C. e. manitobensis*; n=167) were released onto the Royal Blue Wildlife Management Area (RBWMA), Tennessee. Elk from EINP were selected for reintroduction because they were an intensively monitored herd with a disease-free history. All elk were tested for diseases prior to importation and were treated for liver flukes (*Fascioloides magna*) and other endoparasites before transportation. The first release of 50 elk occurred on 19 December 2000 on Horsebone Ridge with a subsequent release of 36 elk on 28 February 2001 near Puncheon Camp Creek. Fifty more elk were released at Puncheon Camp Creek on 14 February 2002. All elk from these releases came from EINP in Alberta, Canada. The fourth release of 31 elk occurred on 22 February 2003 near Clay Gap on the adjacent Sundquist Wildlife Management Area, Tennessee. Elk were translocated from LBL, but they originated from EINP stock.

JUSTIFICATION

Elk behavior, population growth rates, and fecundity are influenced by diet and relative nutrition (Cook 2002). Elk diets have been extensively studied in the western U. S. where vegetation consists primarily of coniferous forests, shrublands, and grasslands (Kufeld 1973, Korfhage et al. 1980, Johnson et al. 2000). Thus, it is essential to understand the seasonal diet composition of elk in eastern forest types to ensure long-term sustainability of newly repatriated populations. The importance of the deciduous forest in a habitat dominated by grasslands has been described by Clutton-Brock et al. (1982) for red deer (*Cervus elaphus*) in Europe; however, elk dietary and habitat use of deciduous forests is not clearly understood in the eastern U.S.

OBJECTIVES

This study was designed to assess the seasonal diets of elk in the deciduous forest of the eastern U. S. The primary objectives were to:

1. Develop a sampling area within the RBWMA for microhistological analysis of feces and vegetation measurements.
2. Examine the seasonal availability and use of plant species foraged by elk, from November 2003 to October 2004.
3. Test the hypothesis that elk consumed vegetation in direct proportion to relative forage availability.

LITERATURE REVIEW

Factors Affecting Elk Food Habits

Elk diets have been extensively documented in the western U.S. for a variety of habitat types (Kufeld 1973). Elk are often classified as grazers because they are associated with large grasslands like those of the central plains and western states. Elk have been classified as intermediate feeders due to their body size, rumination, and morphological characteristics (Hofmann 1989). Perhaps the most accurate description of elk food habits is opportunistic (Hofmann 1989).

Ruminant diet preferences have been described as hedyphagic or euphagic (Provenza 1995). Hedyphagia was defined as animals having an innate preference for foods that are nutritious. Initially animals determine nutritional quality through olfactory, site, tactile, texture, and taste to actively select forage items (Owen 1992); however, this theory has little scientific validity. Euphagia was defined as a hunger for specific nutrients. The animal actively seeks forages to balance nutrient deficiencies (Provenza 1995). Euphagia was found in rats (Rozin 1976) and sheep (Provenza et al. 1994) when given food in controlled settings.

Elk diets also involve multi-generational processes of adaptive learning. Offspring watch adults and learn what forage to select. A history of food preference is transmitted to younger cohorts each year. Learned behaviors increase the foraging efficiency and the overall nutritional benefits over time, such that a wealth of nutritional wisdom is developed over multiple generations.

Diet development may also include active learning through postingestive feedback (Provenza 1995). Animals feel satiety or malaise after feeding on different forages. Consequently, preferences are developed to maintain homeostatic regulation. Nutrition and palatability of plant species combinations affects the feeling of satiety or malaise, with more nutritious and highly digestible forages promoting satiety (Provenza 1995). Ruminants can quickly learn to be selective of particular forages in the environment. Provenza (1995) found that lambs introduced to a new environment initially sampled all forages equally, but changed their consumption levels to optimize their nutrition.

Optimal foraging theory developed by MacArthur and Pianka (1966) described the balance between costs and benefits of foraging as essential to survival and reproduction. Elk develop food preferences based on characteristics of available forages that maximize fitness and minimize costs. The nutritional level and location of forages directly affect elk feeding habits. Wickstrom et al. (1984) found that travel rates or energetic costs for elk were directly related to forage availability. Increased quantities of available forage in one area would cause increased time foraging in that same area.

Breeding, dispersal, social interaction, and harem formation also relate to feeding strategies of elk. Seasonal nutrition levels have been related to pregnancy rates and fetal survival. Clutton-Brock et al. (1982) found that female nutrition levels for red deer foraging in the spring were much more important than winter foraging to birth weights of young. Robbins (1993) found protein, fat, and water levels increased for pregnant females, and energy requirements were 17 to 32%

higher during pregnancy. Lack of adequate nutrition to meet these higher demands during gestation caused abortion or lower birth weights. Thorne et al. (1976) found that abortion occurred in captive elk when body mass loss was >17% from winter until parturition and that elk calves weighing <11.4 kg had a 50% survival rate. Also, foraging in poor quality habitat could lower fecundity because of the need to utilize energy for survival. Thus, elk foraging in high quality habitat where all nutritional needs were met or exceeded resulted in increased birth weights, reduced parasite loads, and increased disease resistance (Cameron et al. 1993, Cook et al. 2001).

External environmental factors could also influence elk foraging selection and behavior. Morgantini and Hudson (1985) reported that elk moved to forested areas during the hunting season and diet composition changed. After the hunting season, elk returned to original areas and resumed diet preferences of pre-hunt conditions. Other disturbances that influenced elk foraging behavior were mining (Kuck et al. 1985), logging (Skovlin et al. 2002), all-terrain vehicle (ATV) use, mountain bike riding, horseback riding, and hiking (Wisdom et al. 2004).

Forage selection may also differ by sex. Sexual differences in foraging by red deer in Europe were possibly related to nutritional requirements and intraspecific competition (Clutton-Brock et al. 1982). Female elk used higher quality habitat because of increased nutritional demands from pregnancy and calf-rearing (Robbins 1993, Cook 2002). Female red deer formed closely matrilineal bonded groups that worked dynamically to protect key resources within their ranges from members outside of their matriarch (Clutton-Brock et al. 1982).

Thus, female red deer could keep males from feeding within the same areas resulting in differences in foraging between the sexes.

Collection Methods for Elk Diet Analysis

North American elk diets vary widely amongst habitat types. Researchers have documented elk diets by visual feeding observations, pen or restricted feeding, browse surveys, stomach contents, and microhistological analysis. Visual feeding observations required researchers to watch and note each plant species consumed and the number of bites taken (Baker and Hobbs 1982, Clutton-Brock et al. 1982). This method worked well if the observer could be close to the animal for an accurate account of foraging activity and was only possible if animals are tame or trained to feed in close proximity to observers. However, observer effects on the behavior of animals could bias foraging activity. Also, this method would be difficult to conduct in most areas with free-ranging elk and is limited to daylight hours. Nocturnal feeding bouts could be different than daylight feeding regimes.

Researchers have also investigated elk diets by using pens or restricted feeding trials that provide an assortment of food choices within an enclosed area. Food choices may be in the form of natural or planted pastures, hay, or pelletized rations. Cannon et al. (1987) used tame elk in 2-ha enclosures to determine food preferences by measuring the quantity of forage eaten. Inferences can only be made for forage items offered to elk, and the method was limited for understanding the diet of free-ranging elk.

Browse surveys measure browsed plant species in areas or plots. Exclosures or use of fencing to exclude elk from an area can be used to measure unbrowsed plants within the exclosure area to browsed plants outside where elk have access. Baker et al. (1997) used exclosures to determine foraging effects of elk upon aspen (*Populus tremuloides*). Although, browse surveys were considered non-invasive techniques that do not directly influence elk foraging behavior, bias may occur when other species (e.g., deer (*Odocoileus* spp.)) utilize the same resources as elk (Hobbs et al. 1983, Gogan and Barrett 1995, Kirchhoff and Larsen 1998).

Stomach analyses from live or dead animals have also been used to determine elk diets. Holechek et al. (1982) described fistulation techniques for live animals where a cannula was surgically placed on the rumen or esophagus so that samples could be directly collected. Although this technique was usually limited to penned animals, Wickstrom et al. (1984) harnessed elk with a head halter to allow active movement for forage selection. Baldwin and Patton (1938) had the first published study in the eastern U.S. using elk rumen contents collected from hunter harvest to identify diet composition. This process required skill in identifying all plant parts, and rumen fluids may degrade plant species beyond recognition.

Microhistological analysis utilized fecal pellets to understand diet composition. Microhistological analysis began with grinding pellets and examining plant material at the cellular level (Davitt and Nelson 1980). Reference slides from available plant species found within the research area were used to verify plant species found within feces. However, rumen fluid breaks down plant species at different rates thus affecting diet composition. Dearden et al. (1975) developed correction factors using rumen fluid from domestic ruminants for *in vitro* digestion to adjust diet composition. Microhistological analysis can be compared with *in vitro* digestion to see possible changes between plant composition in the original and adjusted diets. A disadvantage to microhistological analysis was that forb estimates may be lower and grass and woody species estimates may be higher when correction factors were not applied (Gill et al. 1983, Hanley et al. 1985). The major advantage was that microhistological analysis is a non-invasive technique that captures the entire feeding cycle of elk. Chapuis et al. (2001) found microhistological analysis was quantitatively and qualitatively similar to rumen analyses, but microhistological analysis appeared to identify a larger number of forage items in the diet.

Review of Pre-Columbian Diets of Elk

The eastern subspecies of elk was known to inhabit all eastern states except for Florida (O'gara and Dundas 2002). Elk remains have been found in archaeological sites throughout the eastern U.S. dating back several thousand years (McCabe 2002). Little is known about the diet and habitat-use characteristics of elk in the pre-Columbian era, but some insight has been gained from records of early explorers.

Ramsey (1853:501) gave one of the earliest written descriptions of elk in the Cumberland Mountains, Tennessee from 1783 as, "The top of the mountain is described as being then, a vast upland prairie, pastured over as far as the eye could see, with numerous herds of deer, elk and buffalo, gambooling in playful security over these secluded plains." This description provides insight to the type of environment that was once present, but it does not tell what was important for elk survival.

Native elk in Tennessee foraged in a completely different type of habitat than what is found today. The environment described by early European explorers was possibly influenced by aboriginal activities. Aboriginals manipulated much of the landscape by fire. Fire was a prevalent tool used by Native Americans to help control woody vegetation, maintain grasslands, and keep the understory clear of woody debris for ease of movement (Van Lear and Waldrop 1990). The quantity of native forbs and grasses was probably much greater in burned areas. These fires may have been essential for providing adequate habitat for elk. Habitat manipulation by fires may have created immense grasslands, some were described as oak savannas located in forested areas.

Elk may have relied heavily upon the mast crop from the forested areas in the eastern U.S. The most important mast-producing species of that time was the American chestnut (*Castenea dentata*). These trees were the stable, predominant mast crop producers in the deciduous forest each year (Diamond et al. 2000), and they provided an important food source for many mammals (Lindenmayer et al. 2000). This forage may have been important for overall weight gain and fat reserves essential to winter survival especially in areas where other food sources were limited. Diamond et al. (2000) suggested that the loss of American chestnuts to the chestnut blight (*Cryphonectria parasitica*) decreased overall mast production by 34% in deciduous forests. American chestnut loss greatly reduced the forest carrying capacity for wildlife species. The historical extent of American chestnut use by elk is not known; however, chestnuts were likely a part of the diet. Oak acorns were another possible food source. Oak trees were important mast producers for eastern forests; however, oak mast production fluctuated yearly. Baldwin and Patton (1938) found American chestnut leaves and oak acorn parts in the stomachs of elk in Virginia.

Review of Post-Columbian Diets of Elk

Elk diets have been grouped into the following seasons: winter (December-February), spring (March-May), summer (June-August), and fall (September-November). Seasonal forage use by elk was highly variable due to geographic location and relative availability of plant species. Furthermore, environmental factors influence elk diet compositions seasonally and yearly. Unique forage compositions were found for each elk diet reviewed.

Winter–Kufeld (1973) reviewed literature on seasonal forage selection by elk and found primarily grasses (e.g., bluestem (*Andropogon* spp.), brome grass (*Bromus* spp.), sedge (*Carex* spp.), fescue (*Festuca* spp.), and cat's tail (*Phleum* spp.)) and shrubs (e.g., birch (*Betula* spp.), cedar (*Juniperus* spp.), aspen (*Populus* spp.), and blueberry (*Vaccinium* spp.)). Sedges were consistently found. Grasses (e.g., brome grass, fescue, rush (*Juncus* spp.), and blue grass (*Poa* spp.)) dominated the winter diet of elk in California (Gogan and Barrett 1995), Colorado (Hobbs et al. 1983), and New Mexico (Rowland et al. 1983). Forbs (e.g., wort

(*Artemisia* spp.) and sweet clover (*Melilotus* spp.)) comprised 56% of the diet in South Dakota (Wydeven, and Dahlgren 1983). The winter diet was often influenced by snow depth which shifts forage selection from grasses to shrubs (Cook 2002). Kirchhoff and Larsen (1998) found that shrubs (e.g., lemonleaf (*Gaultheria shallon*) and blueberry) and conifers (e.g., western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*)) comprised 59.6% of the elk diet in southeast Alaska.

Spring–Elk diets shifted to newly emerging growth of grasses and forbs. Kufeld (1973) reviewed 8 elk diet studies in Montana and found 87% use of grasses (e.g., bluestem, sedge, fescue, and cat's tail). The diet composition of grasses (e.g., brome grasses) for elk in southcentral Wyoming was 84% (Ngugi et al. 1992). Sedges (39.6%) dominated the grasses (73.1%) eaten by elk in South Dakota (Wydeven and Dahlgren 1983); however, 25.4% use of forbs (e.g., worts) was also reported. Elk in coastal California preferred forbs (e.g., miner's lettuce (*Montia perfoliata*) and narrowleaf plantain (*Plantago lanceolata*)) to grasses (Gogan and Barrett 1995).

Summer–Forbs occurred most frequently in elk diets (Kufeld 1973). The forb composition was 48% (e.g., Engelmann's aster (*Aster engelmannii*) and sticky geranium (*Geranium viscosissimum*)) in southeastern Idaho (Cannon et al. 1987) and 62% (e.g., narrowleaf plantain) in California (Gogan and Barrett 1995). Other studies found forbs in the summer diet, but they were not the dominant forage type. Grasses were found most frequently in the diet of elk in northern Idaho (Kingery et al. 1996), South Dakota (Wydeven and Dahlgren 1983), and

Colorado (Baker and Hobbs 1982). Big bluestem was the most important grass found by Wydeven and Dahlgren (1983), and Kentucky bluegrass (*Poa pratense*) was frequently found by others (Kufeld 1973).

Fall–The review by Kufeld(1973) on Montana elk food habits studies found the mean grass composition was 73%. Ngugi et al. (1992) reported brome grasses, sedges, rushes, and blue grasses in elk diets for southcentral Wyoming. A foraging shift from forbs to grasses in the fall was detected by Gogan and Barrett (1995) in California; however, the inverse effect was found in South Dakota (Wydeven and Dahlgren 1983) and northern Idaho (Kingery et al. 1996). The woody species composition was 62% (e.g., serviceberry (*Amelanchier alnifolia*) and mountain-lover (*Pachystima myrsinites*)) for the elk diet in southeastern Idaho (Cannon et al. 1987).

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PART II

MANUSCRIPT

This part will be lightly revised and submitted for publication to the *Journal of Wildlife Management*. The use of "we" in this part refers to my co-authors (Lisa Muller and Jason Kindall) and myself. I am the primary contributor to the research and authorship of this paper. My co-authors aided me with consultation, development, and editing.

INTRODUCTION

The eastern subspecies of North American elk (*Cervus elaphus canadensis*) once ranged throughout the Southeast; however that subspecies is now considered extinct. The last remaining elk reported in Tennessee was in the 1860s (Ganier 1928). Hunting and loss of habitat were the major contributing factors for the extinction of the subspecies (O'gara and Dundas 2002), and in the early 1900s, reintroduction of elk began in many eastern states from Louisiana to New Hampshire. Most elk reintroductions were considered failures because of problems with crop depredation, disease, and poaching (O'gara and Dundas 2002). More recent elk reintroductions have occurred in Arkansas, Michigan, Pennsylvania, Wisconsin, Tennessee, North Carolina, and Kentucky to restore native elk populations.

Tennessee Wildlife Resources Agency (TWRA) established a 271,145 ha-area (Figure 1) for elk restoration in the Cumberland Mountains of eastern Tennessee. Large continuous forests, low human population densities, and lack of production agriculture were primary factors evaluated in the identification of a restoration zone suitable for elk (TWRA 2000). Subsequently, elk (*C. e. manitobensis*; n=167) were released onto the Royal Blue Wildlife Management

Area (RBWMA), Tennessee over a 3-year period beginning in December 2000. Elk were translocated from Land Between the Lakes (LBL), Kentucky and Elk Island National Park (EINP), Alberta, Canada. All elk originated from the source herd at EINP.

Elk behavior, population growth rates, and fecundity were important for determining the success of reintroduction efforts and were, in turn, influenced by diet and relative nutrition (Cook 2002). Diets of elk have been extensively studied in the western U. S. where vegetation primarily consists of coniferous forests, shrublands, and grasslands (Kufeld 1973, Korfhage et al. 1980, Johnson et al. 2000). However, little information exists on elk diets and habitat use in the deciduous forest of the eastern U.S. Therefore, our objectives were to 1.) develop a sampling area within the RBWMA for microhistological analysis of feces and vegetation measurements, 2.) examine the seasonal availability and use of plant species foraged by elk from November 2003 to October 2004, 3.) and test the hypothesis that elk consumed vegetation in direct proportion to relative forage availability.

STUDY AREA

The RBWMA (20,235 ha) was located in Scott and Campbell Counties, Tennessee in the southern part of the Cumberland Mountain region (Smalley 1984). The RBWMA was established in 1992 when TWRA purchased the surface rights over Koppers Coal Reserve. Tennessee Valley Authority owns the mineral rights (Jackson 2003). Strip, bench, and deep mining have been the predominant means of coal extraction, which has left RBWMA with a latticework of shelves or benches across the landscape. The RBWMA was a multiple-use area that received a large volume of traffic from all-terrain-vehicles (ATV).

The area consisted of 86% deciduous forest, 12% openings (primarily pasture and reclaimed coal strip mines), and 1% cropland (TWRA 2000). Cabrera (1969) described the major community types found within the deciduous forest of the RBWMA as sugar maple (*Acer saccharum*)-yellow poplar (*Tulipifera liriodendron*)-basswood (*Tilia americana*)-buckeye (*Aesculus flava*) in north-facing coves, sugar maple-northern red oak (Quercus rubra)-yellow poplar-black locust (*Robinia psuedoacacia*) on north and west-facing ridges and coves, and chestnut oak (*Quercus montana*)-black locust on west and southwest-facing ridges and coves. Most openings created by mining have been reclaimed with tall fescue (*Festuca arundinacea*) and serecia lespedeza (*Lespedeza cuneata*). Other openings are seasonally planted with mixtures of rye grass (*Lolium* spp.), wheat (*Triticum* spp.), and legumes (*Trifolium* spp.).

Elevations in RBWMA ranged from 400 to 800 m. The soils were developed from bedrock, shale, and siltstone, and they were classified as acidic, loamy, and well drained (NRCS 2003). The climate was temperate, with temperatures ranging from a mean daily low of 0.8^{o} C in January to a high of 24.2^{o} C in August. The mean temperature was 13.1^{o} C in 2003. Extreme freezing temperatures seldom fell below -8.9^{o} C (NOAA 2003). The mean annual precipitation for 2003 was 172 cm, approximately 40 cm over the average for the area (NOAA 2003). Flooding and landslides were common for this area due to mining, steep gradients, long slopes, ground saturation, freezing conditions, or frozen ground that increased subsurface water flow rates. Most slopes were 40% to 60%, but range from 10% to 100% (Smalley 1984). Montgomery Fork, located in the center of the RBWMA, flows into the New River which has been reported to have an acidic pH (6.0) and high levels of pathogens (reviewed in Jackson 2003).

METHODS

Radiotelemetry

Elk (n = 160) were fitted with VHF radio transmitters prior to release. We used aerial telemetry techniques described by White and Garrot (1990) to determine elk locations at various times during the day and on different days of the week from February 2001 to June 2003. Fixed-wing aircraft were equipped with dual wing-strut mounted, 2 element, H-antennas for aerial telemetry. A Lotek Suretrack 1000 receiver (Lotek Wireless, Inc., Newmarket, Ontario, Canada) was used to detect each elk transmitter. A handheld Garmin GPS unit (Garmin International, Olathe, Kansas, USA) was used to record geographic coordinates when the aircraft was directly over each elk.

Sample Area Delineation

A sample area (Figure 1)[a] was delineated within RBWMA using location points (n = 1,450) of radio-collared elk gathered through aerial telemetry from February 2001 to June 2003 to develop a herd home range (Edge et al. 1987). All [a]location points for individual animals were censored from analyses if radio contact was lost, the collar was found dropped, or if the collar was found on a

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[a] All tables and figures are located in the Appendix.

dead elk. Also, due to surrounding private lands, we were restricted to developing a sampling area within the RBWMA boundaries. Therefore, points (n = 321) found exclusively within the boundary were analyzed to determine a core home range for elk only inhabiting the RBWMA. The core sampling area was chosen because of the size, abundant elk activity, and concentration of data points needed for effective habitat sampling (Worton 1989). We estimated 95% and 50% kernel group home ranges using the Animal Movement Extension in Arc View 3.2® (ESRI, Redlands, California; Hooge and Eichenlaub 1997).

Vegetation Sampling

Forage availability was developed from vegetation sampling. We determined major habitat types in the core area using 1995 land cover maps developed by TWRA. The major cover types located within the core group home range were deciduous forest and grassland. An additional cover type called "edge" was added. The importance of elk use of edge areas has been documented (Harper 1971, Witmer and deCalesta 1983, Skovlin et al. 2002, Larkin et al. 2004). Kufeld (1973) listed many important plants utilized by western elk that were classified as disturbance or edge species.

Delineating edge width is difficult due to vegetative structure, topography, and path connectivity, but edges can be functionally defined by wildlife use (Yahner 1988, Lidicker 1999). Preliminary data, edge forage species (Kufeld 1973), and on-site plant inspections were used to determine edge width. A buffer distance of 10-m around fields, both sides of unimproved roads and improved roads, and grasslands was used as the edge-cover type.

We conducted preliminary sampling in summer 2003 to determine the necessary sample size to distinguish differences at $p \leq 0.05$. Square 1-m^2 samples were taken 5 m from plot center in the 4 cardinal directions at each randomly placed preliminary plot (n = 23; $\sigma^2 = 34.51$). We recorded all forbs, grasses, and seedlings within each 1-m^2 sample. Preliminary data, logistical constraints, and sampling costs were used to determine the quantity of vegetation plots (n=150). We randomly placed these points throughout the three major cover types using Random Point Generator 1.28 (Jenness Enterprises, Flagstaff, Arizona, USA) Extension for Arc View 3.2®. The proportional area of each cover type was used to derive the distribution of sampling points. Deciduous forest (n = 123), grassland (n = 14), and edge (n=13) plots were randomly placed throughout each cover type for the sampling area (Figure 2), and GPS coordinates were assigned to each plot center.

We conducted vegetation sampling seasonally from November 2003 until October 2004. Sampling occurred in 4 major time periods as described by Kufeld (1973): summer (June-August), fall (September-November), winter (December-February), and spring (March-May). We sampled each plot once per time period.

Major habitat assessments were conducted at each plot as described by Nixon et al. (1970). All species were identified and percent cover was determined for saplings and shrubs (1-m to 2-m height) in a 10-m^2 square plot surrounding plot center. In the deciduous forest and grassland area, square 1-m^2 samples were taken 5 m from plot center in the 4 cardinal directions. We recorded all forbs, grasses, and seedlings within each 1-m^2 sample. Edge sample plots (1 m^2) were taken at 5 m and 10 m from plot center in each linear direction parallel to adjacent roads or fields (Figure 3). Ocular estimates for percent cover of each plant species was conducted by only one person for all samples.

We used a 10-factor prism at each plot center for measuring basal area for all trees over 10 cm diameter breast height to determine the tree canopy composition and estimate hardwood mast yields. We identified and recorded the number of tree species at each plot. We used methods described by Whitehead (1969) to estimate the available acorn crop based on basal area, data from the mast crop survey (TWRA 2005), and mean acorn mass compiled from 14 oak species in the southeastern U.S. (Long and Jones 1996).

Fecal Sampling

We collected fresh elk scat when traveling between vegetation plots in the core area from November 2003 to October 2004. Scat was considered fresh on the basis of rich color, moist consistency, and strong odor (Kirchhoff and Larsen 1998, Weckerly and Ricca 2000). We collected 30 pellet groups during each season (120 samples per year), consisting of a minimum of 5 individual pellets from each scat was needed for adequate analysis (Kirchoff and Larsen 1998). Pellets were not collected if they were touching surrounding plant tissues. The pellets were then placed in a plastic bag and frozen.

All pellet samples were sent to the Washington State Habitat Lab (Pullman, Washington, USA) for microhistological analysis of plant cells (Davitt and Nelson 1980). All plants in the diet were described to species if possible. Due to cellular similarities, some specimens were only classified to genera. Plant identification and percent composition were determined by examining 1 slide of 50 field views per fecal sample. All plants viewed microscopically were compared to reference slides. The Washington State Habitat Lab prepared reference slides for this geographical area from previous studies (Castleberry et al. 2002) and from collected plant species in the RBWMA.

Data Analysis

All data analyses were performed using SPSS version 12.0 (SPSS Inc, Chicago, Illinois, USA). All vegetation plots within the 3 cover types for the core sampling area were pooled to determine the seasonal relative availability of individual plant species (% cover). We used analysis of variance for a repeated measures design to test the relative availability of individual plant species (independent variable) against the relative percent of plant material found in fecal samples (n = 30) to determine disproportionate use ($p \leq 0.05$). Tests between forage availability and diet composition were based on linearly independent pairwise comparisons among the estimated means each season. Positive mean differences represented plants used in less proportion to availability. Forages were not considered as preferred when the significant mean difference (smd) was positive. A negative smd represented plants used in greater proportion to availability and was considered as elk forage preferences. The word "preference" described disproportionate use of plant species, and it was only relevant to what forages were available at our site.

RESULTS

Radiotelemetry

Mean location frequency per elk was twice per month. Telemetry error was determined by locating collars (transmitters) that were randomly placed throughout the RBWMA by other personnel. Mean telemetry error was 261m (n = 30, SE = 24.5). The 95% and 50% kernel home ranges covered 7,100 ha and 789 ha, respectively. The 50% kernel home range was located in the southern part of RBWMA, encompassing the Montgomery Fork Creek area; it represented a statistical center of activity for the elk. The 50% kernel home range included 70% (n = 63; 17 males and 46 females) of the current monitored elk herd (n=114).

Winter

The lowest diversity of plants found within the diet for all seasons was winter (n=45; Table 1). Grasses (65.9%) were the dominant forage class (Figure 4) with the most frequently consumed being tall fescue (*Festuca arundinacea*; 35.1%). Christmas fern (*Polystichum acrostichoides*) was 12% of the diet composition. The largest negative smd (-7.82) found in the diet was big bluestem (*Andropogon gerardii*), and other preferred grasses were tall fescue, little bluestem (*Schizachyrium scopariu)*, barnyard grass (*Echinochloa crusgalli)*, Johnson grass (*Sorghum halepense*), and orchard grass (*Dactylis glomerata*). Briars (*Rubus* spp.) were used little when tested against availability (smd = 21.17).

Spring

The highest diversity of plants found within the diet for all seasons was spring (n=57). Although, the diet shifted in the spring to a mixture of woody plants (28.1%) and forbs (19.4%), grasses (38.4%) remained the dominant forage class. Autumn olive (*Elaeagnus* spp.) was the most highly preferred woody plant (smd = -10.06). Other woody plants preferred were eastern red cedar (*Juniperus virginiana)*, oaks (*Quercus* spp.), and pines (*Pinus* spp.). Sedges and rushes (*Carex* spp. & *Juncus* spp.) were the most frequently used (12.7 %) and preferred (smd = -8.36) grasses. Jewelweed (*Impatiens* spp.) was the only forb preferred (smd = -4.56). Maples (*Acer* spp.) were the least preferred (smd = 5.47) overall.

Summer

Forb use increased to 45% in the summer. Jewelweed constituted 27% of the diet and was the most preferred forage (smd = -24.15). Legumes (23%) were a large forage component of the diet, and clovers (*Trifolium* spp.; *Melilotus* spp.) were a highly preferred forage (smd = -12.16). Big bluestem was the only grass to be preferred (smd = -2.35). Autumn olive, oaks, and spice bush (*Lindera benzoin*) were preferred woody plants. Briars (smd = 10.88) and maples (smd = 6.18) were the least preferred of all used forages.

Fall

Oak acorn availability was estimated from oak basal area mean (7.21 m^2/ha) and the mast crop survey (5.3 out of 10) rating (Whitehead 1969). A conservative estimate of viable acorns (52%) was determined from Whitehead (1969); however, acorn loss from acorn weevils (*Curculio* spp.), diseases, and wildlife can range from 10%-100% for white oak (*Quercus alba)* and 2%-92% for southern red oak (*Quercus rubra*; Gibson 1972, 1982). We estimated 17 viable acorns for each square 1-m^2 sample.

The dominant forage class was woody plants (37.4%). Oaks (14.3%) were the most used woody plant with acorns comprising 9.7% of the oak composition. Another highly used (8.7%) and preferred woody plant (smd = -7.73) was autumn olive. Tall fescue was 10.8% of the diet composition and constituted nearly ½ of the overall grass forage class (24%); however, tall fescue was not preferred (smd = 8.82). Big bluestem was the only grass preferred (smd = -2.48). The combined legume diet composition was 19.3% for clovers and lespedezas (*Lespedeza* spp.). Briars were the least preferred forage overall (smd = 10.16).

DISCUSSION

Microhistological analysis of feces provides an efficient and less biased method to determine diet composition. Dearden et al. (1975) developed correction factors using rumen fluid from domestic ruminants for *in vitro* digestion to adjust diet composition because minute plant fragments might be overestimated in the actual diet. Forb estimates may be lower and grass and woody species estimates may be higher when correction factors are not applied. However, other researchers found that correction factor application may introduce bias because digestion rates differed among individuals, plants species, and plant growth stages (Gill et al. 1983, Hanley et al. 1985, Barker 1986, Alipayo et al. 1992, Bartolome et al. 1995). Therefore, we chose not to apply correction factors in our study.

All grassland areas in the study site developed as a result of past mining activities. Tall fescue, lespedeza, and autumn olive were the top 3 species used for reclamation of mined areas and roads in the RBWMA (TVA 1981). Fescue was highly preferred during winter because it was the only species available in large quantities. Fescue has been considered valuable forage for elk in some areas (Kufeld 1973, Cook 2002); however, the nutritional content of fescue may be limited. The importance of fescue and other grasses in the winter diet may be related to costs and benefits of travel to more nutritious forage (Wickstrom et al. 1984). Elk utilized areas where the greatest benefits could be obtained with minimum costs. Many preferred grasses (e.g., big bluestem, sedges/rushes, orchard grass, little bluestem) in the diet were available in lower quantities, but they were found in juxtaposition to fescue. Christmas fern was a substantial component (12%) of the winter diet, but it was not preferred when compared to its widespread availability. Thus, we believe that elk were using any available green forage in the area.

Jost et al. (1999) reported that elk in the Burwash region of Ontario ate jewelweed in relative proportions to what was available. White-tailed deer (*Odocoileus virginianus*) in Pennsylvania highly preferred jewelweed (Williams et al. 2000). Jewelweed plants are succulent, and they are primarily found in cool, damp, closed-canopy areas. Cook (2002) stated that succulent and nutritious vegetation was highly used by elk during calving and subsequent neonatal period, and Korfhage et al. (1980) suggested that elk in Oregon preferred succulent plants. Peak lactation for elk yielded up to 4 L of milk per day (Cook 2002), and water comprised 81% of milk (Robbins 1993). Thus, the need for nutritious plants with high water contents suggests the importance of jewelweed in the elk diet. We believe that jewelweed was a highly valuable plant used by elk during summer in the RBWMA. More research into the nutritional components of native plants will be fundamental to understanding how elk and other herbivores utilize plant species for homeostatic regulation.

We classified clovers and lespedezas as legumes rather than simply as forbs to better understand the dynamics of artificially planted forages in the elk diet. However, these items were classified broadly as forbs in other diet studies (Kufeld 1973, Cook 2002). The forb composition in the diet would have been substantially higher in the summer (45% to 68%) and fall (10.0% to 29.3%) if we had categorized legumes as forbs. Significant findings of clovers in the summer and fall were similar to other reports (Kufeld 1973, Cook 2002). Legumes were located along roadsides, reclaimed mines, and artificially placed food plots (TVA 1981).

Elk viability in deciduous forests may be somewhat dependent upon the hard mast crop. Acorns composed only 9.7% of the fall diet, but the nutritional value from this food source was probably substantial. Mast dependent species utilize acorns to increase body fat reserves for the winter. The hard mast crop has been shown to significantly impact natality, mortality, and overall population dynamics for white-tailed deer (Wentworth et al. 1990) and black bears (*Ursus americanus*) in the southern Appalachians (Pelton 1989). Interspecific competition for acorns may influence populations of other species. Forage consumption for 1 adult elk is equivalent to 3 white-tailed deer (HMC 1996). Resource competition and dietary overlap has been noted between deer (*Odocoileus* spp.) and elk (Hobbs et al. 1983, Gogan and Barrett 1995, Kirchhoff and Larsen 1998). More research is needed to understand how the elk population will affect other species that compete for the same resources in deciduous forests.

Plant community changes may occur as a result from elk herbivory (Hobbs 1996, Ripple and Beschta 2003). High densities of elk may reduce habitat quality for other species (Lindzey et al. 1997). One plant group of concern was oaks. We found that elk used oaks in all seasons. It has been noted that oak regeneration has been limited by the lack of fire regimes (Van Lear and Waldrop 1990) and from deer herbivory (Buckley et al. 1998). We may now have another large competitor that could further impact oak community dynamics.

Some forage items in the diet were not expected. Elk use of lichens and mosses has been found in Alaska (Kirchoff and Larsen 1998); however, we believe that the low levels of lichens, mosses, and insects found in the diet were arbitrarily eaten when elk were foraging upon more important food classes. We found only one crop item in the diet composition, corn (*Zea mays*). Corn was not planted on the study site or in nearby areas ($\geq$8 km). The RBWMA is a large area that receives hunting pressure throughout the year. We believe that corn found in the elk diet was from baiting and artificial feeding of deer and turkey on our study area.

MANAGEMENT IMPLICATIONS

Dietary shifts may occur rapidly due to landscape-level changes occurring in RBWMA. Mining activities began in summer 2005 and will alter approximately 30% (6,900-ha) of RBWMA (S. Stooksbury, TWRA, personal communication). Kuck et al. (1985) found that mining disturbances caused elk calves to move into poorer habitat. However, the long term effect of mining often leaves reclaimed areas that provide optimal foraging for elk (Wood et al. 1995, Cogan 1996). Management should focus on coupling population dynamics with diet information. Short-term detrimental effects from mining could be severe for a small, growing elk herd. Demographic effects could affect reintroduction success. We must establish a census for monitoring population trends and floral changes to address mining effects. Post-mining reclamation will be necessary to ensure that quality forages are replaced with native grasses, forbs, and woody plants. Practices utilizing non-native, poor quality species (e.g., tall fescue, sericea lespedeza) should be avoided.

The importance of maintaining a mature oak forest component was evident from diet preferences. Ramsey (1853) described portions of the Cumberland Mountains as oak savannas enriched with deer, elk, and buffalo (*Bison bison*) in 1783. We found native warm season grasses throughout the study site where an arson fire burned nearly 5 years ago. We believe that these grasses developed from the remnant seed bank. We suggest that the historic evidence, native grasses, and the elk diet indicate that oak savannas would be an ideal habitat type to manage for on the RBWMA. Periodic fires, grazing, or drought normally maintained oak savannas. Management of existing oak stands will be an important community dynamic. Ecologically, oak savannas most likely occurred on the drier southern slopes and mountaintops. Prescribed burning and silvicultural techniques should be used to promote oak regeneration and other beneficial forages. Prescribed burning would potentially enhance the quantity and quality of native grasses and forbs (Van Lear and Waldrop 1990). Further monitoring is needed to fully understand elk foraging dynamics in oak communities.

Much emphasis is placed upon intensively managing small food plots to provide additional sources of nutrition for animals in the winter, but our findings show that the legume-dominated plots were most readily used before winter. We suggest that a diversity of annual and perennial grasses and forbs be used to optimize the overall value of these small food plots. Thus, elk can benefit from food plots throughout the year. Cook (2002) suggested that spring and fall forages are more important nutritionally than winter forages for elk. Forages should be managed for all seasons over a broader scale using landscape level techniques (e.g., silviculture, prescribed burning, herbicide treatment). The conversion of monocultures of tall fescue and lespedeza to more diverse, palatable, and nutrient rich forages is desirable.

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PART III

CONCLUSIONS

DIETARY IMPLICATIONS

The use of telemetry locations was an effective method for developing a sampling area. We were able to find adequate fresh scat groups for sampling. The analysis could be repeated to understand how elk have interacted within the floral and faunal communities. Future research efforts should focus on monitoring and reassessing elk habitat. Elk herbivory and interspecific competition for key resources may have long-term effects on communities. Ripple and Beschta (2003) found community level changes in the flora and fauna in Yellowstone National Park from elk herbivory. Resource competition has been found between deer (*Odocoileus* spp.) and elk (Hobbs et al. 1983, Gogan and Barrett 1995, Kirchhoff and Larsen 1998). Monitoring may be necessary to understand the effects of reintroduced elk on surrounding communities.

Elk were found to use many plant species disproportionately to their relative availability. We believe that some of the highly used plants in the diet could be indicative of nutritional needs. The dynamics of the oak forest community may be important for the viability of elk. We believe that oak savannas would benefit the future elk herd, and that it would provide another unique habitat type for the Royal Blue Wildlife Management Area (RBWMA). Knowledge of the seasonal elk diet in eastern forests can be used to better assess potential elk habitat and understand how future elk populations will disperse and inhabit new areas. Elk diets can be coupled with population dynamics to evaluate the habitat carrying capacity. Management to promote and sustain elk populations should be partially based upon dietary information.

LANDSCAPE LEVEL CHANGES AFFECTING ELK

Landscape level changes to RBWMA and surrounding areas are occurring. Past operations classified as strip or contour mining in RBWMA have left a series of benches and shelves along the mountain with high walls consisting of steep gradient slopes (Jackson 2003). Future mining activities will potentially alter the environment on a large-scale basis. A new type of mining, cross ridge mining, will soon occur in RBWMA. Approximately 30% of the RBWMA will be permanently altered by cross ridge mining beginning in summer 2005 (S. Stooksbury, Tennessee Wildlife Resources Agency, personal communication). Nearly 6,900-ha scattered throughout the RBWMA will be directly affected. Cross ridge mining incorporates the removal of upper sections of mountains to obtain coal. The coal operator attempts to put the remnants from the upper sections of the mountains back to the approximate original contour of the land (OSMRE 2005). Kuck et al. (1985) found that mining disturbances caused elk calves to move into poorer habitat. However, the long term effect of mining often leaves reclaimed areas that provide optimal foraging for elk (Wood et al. 1995, Cogan 1996). Mining could influence foraging behavior of elk on RBWMA. Short-term detrimental effects from mining could be severe for a small, growing elk herd.

Mountaintop removal mining has been used extensively in Kentucky, where upper mountain sections were mined and the remnants were pushed over into the adjoining valleys to form large flat areas (OSMRE 2005). These flat areas have been reclaimed in grasses that essentially provide a large grazing habitat for elk. Larkin et al. (2004) reported that translocated elk in eastern Kentucky experienced similar site fidelity between forested areas and artificial herbaceous openings (up to 5,000 ha) developed from mountaintop removal mining. These large herbaceous openings may be a contributing factor to the growing population of elk in Kentucky. Elk dietary shifts could occur in RBWMA if large areas are converted to grasslands, and elk in RBWMA could respond similarly to the Kentucky herd.

Active forestry occurring in the area will be another source of habitat change. Fountain Forestry is logging approximately 1,200 ha of forest each year in the adjacent Sundquist Wildlife Management Area. Clear-cutting is occurring in large blocks up to 300 ha in size (J. Elkins, Tennessee Wildlife Resources Agency, personal communication). Large areas of mature forest are being changed to early successional habitat. Skovlin et al. (2002) found high elk use of early successional habitat created from logging or fires within the first 5 years; however, Lyon (1979) found that elk abandoned logging areas because of the initial disturbance and from ongoing human activity (>4 years) in these areas. Elk in our area have been using the early successional areas developed from logging (J. Elkins, Tennessee Wildlife Resources Agency, personal communication). Logging may encourage potential forage benefits for elk, but the increased human activity into previously undisturbed areas may counterbalance any positive effects on a broader landscape level.

The RBWMA is a multiple-use area that provides access to recreation users of all types, and people travel from all over the U.S. to use over 1,000 km of off-road trails that extend throughout the RBWMA and other surrounding public properties (S. Stooksbury, Tennessee Wildlife Resources Agency, personal communication.). Many of these trails are highly eroded and cause major disturbance to the soils, surrounding plants, and the aquatic environment. Wisdom et al. (2004) compared the effects of ATV riding, mountain biking, horseback riding, and hiking to elk flight responses and movements and found that ATV riding had the greatest negative effect. More research is needed to understand how ATV's will affect elk in RBWMA.

The large contiguous forest is slowly being diminished in the region of the Cumberland Mountains. Floral and faunal shifts will be occurring such that species composition will be much different with these disturbance factors. Shifts in elk foraging and population dynamics could change quickly due to current and future landscape level alterations. These landscape alterations may influence the small elk population. Thus, demographic effects could affect reintroduction success in the RBWMA. Monitoring will be necessary to understand the interactions between elk and the environment.

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APPENDIX

Table 1. Availability (% cover) of forages from plot samples (n=150) tested against mean percentage of elk diet ($\bar{x}$ % $\pm$ SE) to determine mean differences. Diet composition determined from microhistological analysis of plant material in feces in 789-ha core area (50% kernel home range), November 2003 to October 2004, Royal Blue Wildlife Management Area, Tennessee, USA.

	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
Plant Taxa	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Woody Plants												
Acer spp.	0.2	0.1	3.3 *	0.4	0.1	5.5 *	0.2	0.0	6.2 *	0.7	0.5	5.3 *
Aralia spinosa	0.1	0.1	-7.8 *	0.2	0.2	-0.2	0.0	NA	NA	0.0	NA	NA
Betula lenta	0.0	NA	NA	1.0	0.4	-1.0	1.0	0.7	-0.7	0.0	NA	NA
Carya spp.	0.5	0.3	-1.9 *	0.3	0.1	0.3	0.2	0.1	0.4	0.1	0.1	1.3
Ceanothus americanus	0.3	0.1	-0.3	0.6	0.3	-0.2	0.0	NA	NA	0.2	0.1	0.4
Celtis spp.	0.1	0.0	-0.3	0.0	NA	NA	0.0	NA	NA	0.0	NA	NA
Cercis canadensis	0.2	0.2	-0.6	0.4	0.1	0.5	0.3	0.3	0.3	0.7	0.3	-0.5
Cornus florida	0.1	0.0	-0.1	0.0	NA	NA	0.8	0.5	-0.8	0.6	0.3	-0.5

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Woody Plants												
Elaeagnus spp.	1.7	0.7	-1.8 *	9.7	1.8	-10.1 *	2.3	0.5	-2.4 *	8.7	2.5	-7.7 *
Fagus grandifolia	0.0	NA	NA	0.1	0.1	0.0	0.0	NA	NA	0.1	0.1	0.1
Fraxinus americana	0.0	NA	NA	0.0	NA	NA	0.0	NA	NA	0.3	0.3	-0.1
Ilex opaca	0.0	NA	NA	0.0	NA	NA	0.0	NA	NA	0.1	0.1	0.0
Juniperus virginiana	0.0	NA	NA	3.2	1.1	-3.5 *	0.0	NA	NA	0.3	0.2	-0.3
Lindera benzoin	1.3	0.7	-1.5	0.3	0.2	-0.4	1.5	0.5	-1.6 *	3.9	1.0	-4.3
Liriodendron tulipifera	0.0	NA	NA	0.0	NA	NA	0.1	0.1	2.6 *	0.0	NA	NA
Magnolia spp.	0.0	NA	NA	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.2	-0.2
Oxydendrum arboreum	0.0	NA	NA	0.0	NA	NA	0.5	0.3	0.8	0.0	NA	NA
Pinus spp.	0.9	0.4	-1.0	2.0	0.7	-2.1 *	0.1	0.1	-0.1	0.3	0.2	-0.4

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Woody Plants												
Prunus spp.	0.4	0.1	-0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	-0.8
Quercus acorns	0.0	NA	NA	0.0	NA	NA	0.0	NA	NA	9.7	2.6	-6.7 *
Quercus spp.	2.1	0.4	-0.8	3.4	0.9	-2.5 *	3.1	0.5	-1.6 *	4.6	0.9	-3.3 *
Rhododendron spp.	0.1	0.1	-0.4	0.9	0.4	-0.6	0.0	NA	NA	0.7	0.4	0.5
Rhus spp.	2.6	0.8	-1.3	0.1	0.1	3.0 *	0.0	NA	NA	3.5	1.0	-4.0 *
Rosa spp.	1.5	0.3	-1.2	1.8	0.7	-1.7	0.0	NA	NA	0.1	0.0	0.0
Sambucus canadensis	0.1	0.1	0.1	0.0	NA	NA	0.0	NA	NA	0.5	0.2	-0.5
Sassafras albidum	0.1	0.1	0.5	0.0	NA	NA	0.5	0.3	1.2	0.0	NA	NA
Tilia americana	0.0	NA	NA	0.7	0.3	-0.7	0.0	NA	NA	0.0	NA	NA
Tsuga canadensis	0.0	NA	NA	0.1	0.1	0.0	0.0	NA	NA	0.0	NA	NA

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Woody Plants												
Vaccinium spp.	0.5	0.1	1.2	2.5	0.5	-1.2	0.5	0.2	0.6	0.7	0.2	0.7
Viburnum acerifolium	1.0	0.2	-0.6	0.1	0.1	0.3	0.0	NA	NA	1.0	0.4	-1.0
Unknown woody species	1.3	0.2	NA	2.2	0.3	NA	2.0	0.3	NA	3.1	0.3	NA
Total Woody Species	*15.1*			*28.1*			*13.3*			*37.4*		
Forbs												
Allium spp.	0.0	NA	NA	0.1	0.1	0.0	0.3	0.2	-0.3	0.0	NA	NA
Ambrosia spp.	0.0	NA	NA	0.1	0.1	-0.1	0.3	0.1	1.3	0.1	0.0	0.1
Antennaria spp.	0.0	NA	NA	0.2	0.1	-0.1	0.6	0.2	-0.6	0.1	0.1	0.0
Arisaema triphyllum	0.0	NA	NA	0.0	NA	NA	0.7	0.2	0.1	0.0	NA	NA
Aster spp.	0.0	NA	NA	1.2	0.4	-0.6	0.9	0.2	-0.4	0.3	0.1	0.6

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Forbs												
Centrosema virginianum	1.1	0.3	-1.0	1.1	0.5	-0.2	2.6	0.7	-0.6	1.4	0.4	-0.1
Chamaecrista fasciculata	0.0	NA	NA	0.8	0.3	0.1	0.0	NA	NA	0.0	NA	NA
Chenopodium album	0.0	NA	NA	0.1	0.1	-0.1	0.0	NA	NA	0.2	0.2	0.1
Erigeron annuus	0.0	NA	NA	0.2	0.1	-0.1	0.6	0.2	-0.4	0.0	NA	NA
Euonymus americana	0.2	0.1	0.7	0.7	0.4	0.0	0.7	0.2	0.0	0.5	0.3	0.2
Galium spp.	0.0	NA	NA	1.0	0.4	1.3	0.9	0.3	-0.3	0.1	0.1	0.2
Geranium maculatum	0.0	NA	NA	0.9	0.3	0.2	1.5	0.3	-1.5	0.1	0.1	-0.1
Helianthus spp.	0.0	NA	NA	0.0	NA	NA	0.8	0.2	4.3 *	0.0	NA	NA
Heuchera spp.	0.0	NA	NA	0.0	NA	NA	0.1	0.1	1.1	0.0	NA	NA
Impatiens spp.	0.0	NA	NA	7.9	2.6	-4.6 *	27.0	3.7	-24.2 *	0.0	NA	NA

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Forbs												
Ipomoea spp.	0.2	0.2	-0.4	0.1	0.1	-0.1	0.0	NA	NA	0.1	0.1	-0.1
Lathyruss pp.	0.6	0.2	-0.5	0.0	NA	NA	0.5	0.2	0.1	0.1	0.1	0.3
Mitchella repens	0.9	0.3	-1.0	0.0	NA	NA	0.2	0.1	-0.1	0.9	0.4	-3.3 *
Monarda spp.	0.0	NA	NA	0.0	NA	NA	0.2	0.2	0.0	0.0	NA	NA
Phytolacca americana	0.2	0.2	0.0	0.0	NA	NA	0.5	0.3	0.7	0.0	NA	NA
Potentilla spp.	0.0	NA	NA	0.5	0.2	0.8	1.0	0.5	0.0	0.2	0.1	0.6
Rubus spp.	0.5	0.3	21.2 *	1.0	0.2	3.0 *	1.3	0.4	10.9 *	1.4	0.2	10.2 *
Smilacina racemosa	0.0	NA	NA	0.6	0.3	1.3	0.1	0.1	0.9	0.0	NA	NA
Smilax spp.	0.1	0.1	6.6	0.3	0.2	3.1 *	1.0	0.4	1.4	0.3	0.2	3.1 *
Solidago spp.	0.1	0.0	0.1	0.2	0.1	2.3 *	0.6	0.2	4.0 *	0.8	0.3	3.6 *

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Forbs												
Vicia spp.	0.1	0.1	-0.1	0.3	0.1	-0.2	0.4	0.2	-0.4	0.0	NA	NA
Unknown forbs	0.6	0.2	NA	2.1	0.4	NA	2.5	0.3	NA	3.4	0.4	NA
Total Forbs	*4.6*			*19.4*			*45.0*			*10.0*		
Ferns												
Athyrium filix	0.5	0.2	-1.1	0.4	0.2	2.9 *	0.3	0.2	2.0 *	0.0	NA	NA
Polystichum acrostichoides	12.0	2.1	7.9 *	2.5	1.0	4.4 *	0.2	0.2	5.1 *	0.6	0.4	7.6 *
Unknown ferns	0.6	0.2	NA	4.3	2.0	NA	0.6	0.1	NA	0.4	0.2	NA
Total Ferns	*13.1*			*7.2*			*1.1*			*1.0*		
Grasses												
Andropogon gerardii	8.5	1.2	-7.8 *	4.6	1.1	-4.9 *	2.3	0.6	-2.4 *	2.4	0.7	-2.5 *

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Grasses												
Carex spp. & *Juncus* spp.	1.4	0.2	2.8 *	12.7	3.1	-8.4 *	1.3	0.4	1.3	2.0	0.4	1.3
Dactylis glomerata	3.3	0.6	-3.0 *	2.5	0.6	-2.6 *	1.1	0.4	-1.2	1.2	0.5	-1.3
Echinochloa crusgalli	0.2	0.2	-3.8 *	0.0	NA	NA	0.4	0.4	-0.1	0.0	NA	NA
Festuca arundinacea	35.1	2.8	-5.6 *	10.7	1.9	2.8 *	5.0	1.2	4.7 *	10.8	2.3	8.8 *
Microstegium japonicum	0.0	NA	-0.4	0.0	NA	NA	0.0	NA	NA	0.1	0.1	3.3 *
Panicum spp.	3.9	0.5	-1.5	1.0	0.3	1.6	0.5	0.2	2.7 *	1.0	0.3	2.4 *
Phleum pratense	2.3	0.6	-0.4	1.8	0.9	-1.8	0.5	0.3	1.1	0.9	0.3	0.4
Schizachyrium scoparium	4.9	0.8	-4.9 *	1.4	0.4	-1.3	0.2	0.1	-0.1	1.1	0.4	-1.0
Setaria spp.	0.5	0.2	-0.7	0.2	0.1	-0.2	0.0	NA	NA	0.3	0.2	-0.3
Sorghum spp.	0.7	0.3	-0.9	0.9	0.2	-0.7	0.1	0.1	0.1	0.8	0.4	-0.9

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Grasses												
Triticum spp.	3.5	0.7	-3.0 *	1.0	0.4	-0.6	0.9	0.4	-0.7	1.5	0.6	-1.3
Unknown grasses	1.6	0.2	NA	1.6	0.2	NA	1.7	0.3	NA	1.9	0.3	NA
Total Grasses	*65.9*			*38.4*			*14.0*			*24.0*		
Crops												
Zea mays	0.0	NA	NA	0.2	0.1	-0.2	0.6	0.3	-0.7	0.6	0.3	-0.7
Total Crops	*0.0*			*0.2*			*0.6*			*0.6*		
Legumes												
Lespedeza spp.	0.2	0.1	-0.2	1.6	0.7	2.6 *	7.5	1.4	-0.9	12.8	3.5	-5.7 *
Trifolium & *Melilotus* spp.	0.3	0.1	4.0 *	2.4	0.8	0.7	15	2.7	-12.2 *	6.5	1.3	-5.0 *
Total Legumes	*0.5*			*4.0*			*23.0*			*19.3*		

Table 1. Continued.

Plant Taxa	Winter (n=30)			Spring (n=30)			Summer (n=30)			Fall (n=30)		
	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]	$\bar{x}$ (%)	SE	$\bar{x}$ difference [a]
Other												
Lichen/Moss	0.1	0.1	NA	0.2	0.1	NA	0.2	0.1	NA	0.4	0.1	NA
Insect	0.1	0.1	NA	0.1	0.1	NA	0.7	0.2	NA	0.2	0.1	NA
Unknown	0.6	0.2	NA	0.2	0.1	NA	2.5	0.3	NA	4.0	0.1	NA
Number of plants	45			57			55			54		

NA Not applicable because items were not in the diet, unknown, or considered to be arbitrarily eaten ("other" category).

a Positve numbers represent plants used in lesser proportion to availability, and negative numbers represent plants used in greater proportion to availability.

* Significance ($p \leq .05$).

Table 2. Basal area (10-factor prism) determined for trees >10 cm diameter breast height in 789-ha core area (50% kernel home range) for reintroduced elk, November 2003 to October 2004, Royal Blue Wildlife Management Area, Tennessee, USA.

Tree Species	Basal Area ft^2/ac (n=137)
Apple (*Malus* spp.)	0.07
Hackberry (*Celtis* spp.)	0.07
Striped Maple (*Acer pensylvanicum*)	0.07
Virginia Pine (*Pinus virginiana)*	0.07
Eastern White Pine (*Pinus strobus)*	0.07
Black Oak (*Quercus velutina*)	0.15
Cucumber Tree (*Magnolia acuminata*)	0.15
Yellow Buckeye (*Aesculus flava*)	0.22
Sassafras (*Sassafras albidum)*	0.29
Southern Red Oak (*Quercus falcata*)	0.29
European Alder (*Alnus glutinosa*)	0.44
Sourwood (*Oxydendrum arboreum)*	0.44
Elm spp. *(Ulmus* spp.)	0.51
Sugar Maple *(Acer saccharum)*	0.58
Red Mulberry (*Morus rubra*)	0.66
Sweet Birch (*Betula lenta*)	0.66
American Sycamore (*Platanus occidentalis*)	0.73

Table 2. Continued.

Tree Species	Basal Area ft^2/ac (n=137)
Bitternut Hickory (*Carya cordiformis*)	0.80
Hickory spp. (*Carya* spp.)	0.88
Scarlet Oak (*Quercus coccinea*)	0.95
White Ash (*Fraxinus americana)*	1.09
Eastern Hemlock (*Tsuga canadensis)*	1.17
American Basswood (*Tilia americana)*	1.24
American Beech (*Fagus grandifolia)*	1.31
Blackgum (*Nyssa sylvatica)*	1.46
Shagbark Hickory (*Carya ovata*)	1.82
Mockernut Hickory (*Carya tomentosa*)	1.97
Black Locust (*Robinia pseudoacacia)*	2.04
Pignut hickory (*Carya glabra*)	2.12
Black Cherry (*Prunus serotina)*	3.58
White Oak (*Quercus alba*)	4.53
Northern Red Oak (*Quercus rubra*)	9.49
Chestnut Oak (*Quercus montana*)	15.99
Red Maple (*Acer rubrum)*	16.93
Tulip Poplar (*Liriodendron tulipifera)*	23.36
Total	96.20

Table 3. Plot center locations (n = 150) developed from Random Point Generator 1.28 (Jenness Enterprises) Extension for Arc View 3.2 (NAD83 map datum) for vegetation sampling plots in 789-ha core area (50% kernel home range) of reintroduced elk, November 2003 to October 2004, Royal Blue Wildlife Management Area, Tennessee, USA.

		GPS Coordinates	
Cover Type	Plot #	Longitude	Latitude
Deciduous Forest	1	-84.3042021	36.2872949
Deciduous Forest	2	-84.2993174	36.2832642
Deciduous Forest	3	-84.2983465	36.2834043
Deciduous Forest	4	-84.3020419	36.2838558
Deciduous Forest	5	-84.3019085	36.2848578
Deciduous Forest	6	-84.3011068	36.2854271
Deciduous Forest	7	-84.3006163	36.2850455
Deciduous Forest	8	-84.3056043	36.3127885
Deciduous Forest	9	-84.2956367	36.3065199
Deciduous Forest	10	-84.2896079	36.3009648
Deciduous Forest	11	-84.2966748	36.3057403
Deciduous Forest	12	-84.2944023	36.3060282
Deciduous Forest	13	-84.3018720	36.3096090
Deciduous Forest	14	-84.2895401	36.3045236
Deciduous Forest	15	-84.3011855	36.3074246

Table 3. Continued.

		GPS Coordinates	
Cover Type	Plot #	Longitude	Latitude
Deciduous Forest	16	-84.3005772	36.3105715
Deciduous Forest	17	-84.2922508	36.2874801
Deciduous Forest	18	-84.2858923	36.2974502
Deciduous Forest	19	-84.2899011	36.2845591
Deciduous Forest	20	-84.2880918	36.2979703
Deciduous Forest	21	-84.3065235	36.2947110
Deciduous Forest	22	-84.2903122	36.2932642
Deciduous Forest	23	-84.3030500	36.2969732
Deciduous Forest	24	-84.3043522	36.3104653
Deciduous Forest	25	-84.2929311	36.2994833
Deciduous Forest	26	-84.3042604	36.3118880
Deciduous Forest	27	-84.2968199	36.3050321
Deciduous Forest	28	-84.2855073	36.2886033
Deciduous Forest	29	-84.2944733	36.2992795
Deciduous Forest	30	-84.3034298	36.3057372
Deciduous Forest	31	-84.2957921	36.3014881
Deciduous Forest	32	-84.3042040	36.2997282
Deciduous Forest	33	-84.2938879	36.3067669
Deciduous Forest	34	-84.2926317	36.2868959

Table 3. Continued.

		GPS Coordinates	
Cover Type	Plot #	Longitude	Latitude
Deciduous Forest	35	-84.2977255	36.3107385
Deciduous Forest	36	-84.2887867	36.2921589
Deciduous Forest	37	-84.2881492	36.3039846
Deciduous Forest	38	-84.2887127	36.2926380
Deciduous Forest	39	-84.3093709	36.2975070
Deciduous Forest	40	-84.2809080	36.2970646
Deciduous Forest	41	-84.3040110	36.3076547
Deciduous Forest	42	-84.2985884	36.2908381
Deciduous Forest	43	-84.3051139	36.3123251
Deciduous Forest	44	-84.2918199	36.2960192
Deciduous Forest	45	-84.2972341	36.2904977
Deciduous Forest	46	-84.2915246	36.2821950
Deciduous Forest	47	-84.3014411	36.3048882
Deciduous Forest	48	-84.3034267	36.3050910
Deciduous Forest	49	-84.3042426	36.3045457
Deciduous Forest	50	-84.2861824	36.2885329
Deciduous Forest	51	-84.2947592	36.2876891
Deciduous Forest	52	-84.2876463	36.3022835
Deciduous Forest	53	-84.3053413	36.2931696

Table 3. Continued.

		GPS Coordinates	
Cover Type	Plot #	Longitude	Latitude
Deciduous Forest	54	-84.2992625	36.3123881
Deciduous Forest	55	-84.2966696	36.2919897
Deciduous Forest	56	-84.3027944	36.3092392
Deciduous Forest	57	-84.2958944	36.2971108
Deciduous Forest	58	-84.3083745	36.3058275
Deciduous Forest	59	-84.3075617	36.3106786
Deciduous Forest	60	-84.2931231	36.2906553
Deciduous Forest	61	-84.2927757	36.2978663
Deciduous Forest	62	-84.3064390	36.3030305
Deciduous Forest	63	-84.2915309	36.3053295
Deciduous Forest	64	-84.2888295	36.3046213
Deciduous Forest	65	-84.2935645	36.2886821
Deciduous Forest	66	-84.3093417	36.3066733
Deciduous Forest	67	-84.2972174	36.3121276
Deciduous Forest	68	-84.2975064	36.2909211
Deciduous Forest	69	-84.2953163	36.2951460
Deciduous Forest	70	-84.2910227	36.2891833
Deciduous Forest	71	-84.2859362	36.2888491
Deciduous Forest	72	-84.3031669	36.3102542

Table 3. Continued.

		GPS Coordinates	
Cover Type	Plot #	Longitude	Latitude
Deciduous Forest	73	-84.2968616	36.3127548
Deciduous Forest	74	-84.3011218	36.3145831
Deciduous Forest	75	-84.2999334	36.3000612
Deciduous Forest	76	-84.2982107	36.2873067
Deciduous Forest	77	-84.2937366	36.3090101
Deciduous Forest	78	-84.3088430	36.3088536
Deciduous Forest	79	-84.2903404	36.2944914
Deciduous Forest	80	-84.3046224	36.2912889
Deciduous Forest	81	-84.3008912	36.2922366
Deciduous Forest	82	-84.3013034	36.3026397
Deciduous Forest	83	-84.2999845	36.2964268
Deciduous Forest	84	-84.2854885	36.2969364
Deciduous Forest	85	-84.2932734	36.2953478
Deciduous Forest	86	-84.3067364	36.3017518
Deciduous Forest	87	-84.2971454	36.3046854
Deciduous Forest	88	-84.2941561	36.3067028
Deciduous Forest	89	-84.2922498	36.3010563
Deciduous Forest	90	-84.3027120	36.2899114
Deciduous Forest	91	-84.3056084	36.2924352

Table 3. Continued.

		GPS Coordinates	
Cover Type	Plot #	Longitude	Latitude
Deciduous Forest	92	-84.2976170	36.2996031
Deciduous Forest	93	-84.2992875	36.3026208
Deciduous Forest	94	-84.3029853	36.3037713
Deciduous Forest	95	-84.3042541	36.3099211
Deciduous Forest	96	-84.2858245	36.2927431
Deciduous Forest	97	-84.2830605	36.2992827
Deciduous Forest	98	-84.2993699	36.3092581
Deciduous Forest	99	-84.2943449	36.2895048
Deciduous Forest	100	-84.2966842	36.3061953
Deciduous Forest	101	-84.2966279	36.2854375
Deciduous Forest	102	-84.3048415	36.2990673
Deciduous Forest	103	-84.2979332	36.2983696
Deciduous Forest	104	-84.2966279	36.2896613
Deciduous Forest	105	-84.3037345	36.3126970
Deciduous Forest	106	-84.2893846	36.3047695
Deciduous Forest	107	-84.2964025	36.2990578
Deciduous Forest	108	-84.3019753	36.3123902
Deciduous Forest	109	-84.2958652	36.3102342
Deciduous Forest	110	-84.3018752	36.3115717

Table 3. Continued.

		GPS Coordinates	
Cover Type	Plot #	Longitude	Latitude
Deciduous Forest	111	-84.2882974	36.2879277
Deciduous Forest	112	-84.2951588	36.2962881
Deciduous Forest	113	-84.2886761	36.2866773
Deciduous Forest	114	-84.3060978	36.3017896
Deciduous Forest	115	-84.2873959	36.3012149
Deciduous Forest	116	-84.3004300	36.3080855
Deciduous Forest	117	-84.3044284	36.3036494
Deciduous Forest	118	-84.2821757	36.3000886
Deciduous Forest	119	-84.2889798	36.2964111
Deciduous Forest	120	-84.3027454	36.3075013
Deciduous Forest	121	-84.2880574	36.3028624
Deciduous Forest	122	-84.2982420	36.2913614
Deciduous Forest	123	-84.2947925	36.2985135
Grassland	124	-84.2966157	36.2887361
Grassland	125	-84.2898690	36.2894170
Grassland	126	-84.2952019	36.2916160
Grassland	127	-84.3041091	36.2920646
Grassland	128	-84.2964269	36.2929855
Grassland	129	-84.3019840	36.2981694

Table 3. Continued.

		GPS Coordinates	
Cover Type	Plot #	Longitude	Latitude
Grassland	130	-84.3006078	36.2871326
Grassland	131	-84.3052341	36.2881628
Grassland	132	-84.3001933	36.2853358
Grassland	133	-84.3029201	36.2890209
Grassland	134	-84.3107876	36.3025432
Grassland	135	-84.3095141	36.3022945
Grassland	136	-84.3107490	36.3019369
Grassland	137	-84.3092554	36.3033107
Edge	138	-84.2927668	36.2861110
Edge	139	-84.2859564	36.2908464
Edge	140	-84.3051327	36.3115795
Edge	141	-84.2980267	36.2882562
Edge	142	-84.2904068	36.2898409
Edge	143	-84.2947135	36.2911327
Edge	144	-84.2937375	36.2814900
Edge	145	-84.3048236	36.2924695
Edge	146	-84.3080111	36.2940270
Edge	147	-84.2977471	36.2955075
Edge	148	-84.3080523	36.2975328

Table 3. Continued.

		GPS Coordinates	
Cover Type	Plot #	X	Y
Edge	149	-84.3024496	36.2973446
Edge	150	-84.3086362	36.2983528

Table 4. Mean percent cover (10-m^2 square plots) from random samples for trees <10 cm diameter and shrubs 1-2 m tall in 789-ha core area (50% kernel home range) for reintroduced elk, November 2003 to October 2004, Royal Blue Wildlife Management Area, Tennessee, USA.

Species	% Cover Forest (n=123)	Edge (n=14)
American Basswood *(Tilia americana)*	0.02	0.00
American Beech *(Fagus grandifolia)*	0.56	0.00
Apple (*Malus* spp.)	0.04	0.38
Autumn Olive (*Elaeagnus* spp.)	0.00	1.15
Bitternut Hickory (*Carya cordiformis*)	0.06	0.00
Black Cherry *(Prunus serotina)*	0.16	0.00
Black Locust *(Robinia pseudoacacia)*	3.38	1.54
Blackgum *(Nyssa sylvatica)*	0.13	0.00
Black Willow (*Salix nigra*)	0.00	0.38
Blue Ash (*Fraxinus quadrangulata*)	0.01	0.00
Blueberry (*Vaccinium* spp.)	0.23	0.00
Carolina Silverbell (*Halesia tetraptera*)	0.01	0.00
Chestnut Oak (*Quercus montana*)	0.23	0.00
Cucumber Tree (*Magnolia acuminata*)	0.09	0.00
Eastern Hemlock *(Tsuga canadensis)*	0.76	0.00
Elm spp. *(Ulmus* spp.)	0.02	0.00

Table 4. Continued.

Species	% Cover Forest (n=123)	Edge (n=14)
Flame Azalea (*Rhododendron calendulaceum*)	0.02	0.00
Flowering Dogwood (*Cornus florida*)	0.01	0.00
Green Ash (*Fraxinus pennslyvanica*)	0.02	0.00
Hawthorn (*Crataegus* spp.)	0.02	0.00
Hickory spp. (*Carya* spp.)	0.17	0.00
Honey Locust (*Gleditsia triacanthos)*	0.04	0.00
Hophornbeam (*Ostrya virginiana*)	0.02	0.00
Iron Wood (*Carpinus caroliniana*)	0.02	0.00
Maple Leaf Viburnum (*Virburnum acerifolium*)	0.10	0.00
Mockernut Hickory (*Carya tomentosa*)	0.05	3.08
Mountain Laurel (*Kalmia latifolia*)	1.06	0.00
Northern Red Oak (*Quercus rubra*)	1.15	0.31
Persimmon (*Diospyros virginiana*)	0.00	0.08
Pignut Hickory (*Carya glabra*)	0.02	0.00
Princess Tree (*Paulownia tomentosa*)	0.07	0.00
Red Maple (*Acer rubrum)*	6.83	4.00
Red Mulberry (*Morus rubra*)	0.08	0.00
Sassafras (*Sassafras albidum)*	2.03	0.00
Shagbark Hickory (*Carya ovata*)	0.05	0.31

Table 4. Continued.

Species	% Cover Forest (n=123)	% Cover Edge (n=14)
Silver Maple (*Acer saccharinum*)	0.02	0.00
Sourwood *(Oxydendrum arboreum)*	0.31	0.00
Spicebush (*Lindera benzoin*)	0.06	0.00
Striped Maple (*Acer pensylvanicum*)	0.07	0.38
Sugar Maple *(Acer saccharum)*	0.89	0.00
Sumac (*Rhus* spp.)	0.10	0.15
Sweet Birch (*Betula lenta*)	0.01	0.00
Sweetleaf (*Symplocos tinctoria*)	0.21	0.08
Tulip Poplar *(Liriodendron tulipifera)*	1.37	1.85
Umbrella Magnolia (*Magnolia tripetala*)	0.04	0.00
White Ash *(Fraxinus americana)*	0.51	0.23
White Oak (*Quercus alba*)	0.05	0.00
Wild Hydrangea (*Hydrangea arborescens*)	1.12	0.00
Witch Hazel (*Hamamelis virginiana*)	0.10	0.00
Total	*22.31*	*13.92*

Table 5. Mean percent cover for plants measured in random plots (n=150; 4 square 1-m^2 samples per plot) throughout 789-ha core area (50% kernel home range) for reintroduced elk, November 2003 to October 2004, Royal Blue Wildlife Management Area, Tennessee, USA.

	Winter			Spring			Summer			Fall		
Species	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Alumroot (*Heuchera* spp.)	0.1	0.0	0.4	0.1	0.0	0.3	0.1	0.0	0.5	0.3	0.0	0.8
American Basswood *(Tilia americana)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
American Beech *(Fagus grandifolia)*	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
American Ginseng (*Panax quinquefolius*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anemone (*Anemone quinquefolia*)	0.0	0.0	0.1	0.0	0.0	0.2	0.6	0.0	0.2	0.0	0.0	0.2
Asters (*Aster* spp.)	0.0	0.0	0.0	0.4	0.1	0.2	2.8	0.0	1.1	2.4	1.9	1.2
Autumn Olive (*Elaeagnus* spp.)	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.1	0.0	0.1	0.2	0.0
Barnyard Grass (*Echinochloa crusgalli*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bedstraw (*Galium* spp.)	0.0	0.0	0.1	2.2	0.6	0.5	0.3	0.0	0.3	0.1	0.0	0.1

Table 5. Continued.

Species	Winter			Spring			Summer			Fall		
	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Bee Balm (*Monarda* spp.)	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1
Bellflower (*Campanula* spp.)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0	0.0	0.0
Bellwort (*Uvularia* spp.)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Big Bluestem (*Andropogon gerardii*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bitter Cress (*Cardamine* spp.)	0.5	0.8	0.0	0.0	0.4	0.2	0.0	0.0	0.1	0.0	0.0	0.0
Black Cherry *(Prunus serotina)*	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2
Black Cohosh (*Cimicifuga racemosa*)	0.0	0.0	0.0	1.3	0.1	1.2	1.4	0.0	1.6	0.0	0.0	0.2
Black Locust *(Robinia pseudoacacia)*	0.0	0.0	0.1	0.0	0.0	0.5	0.3	0.0	1.1	0.0	0.0	0.4
Black Snakeroot (*Sanicula* spp.)	0.0	0.0	0.0	0.3	0.0	0.2	0.1	0.0	0.1	0.0	0.0	0.0
Blackgum *(Nyssa sylvatica)*	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1
Bloodroot (*Sanguinaria canadensis*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1

Table 5. Continued.

Species	Winter			Spring			Summer			Fall		
	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Blue Ash (*Fraxinus quadrangulata*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue Cohosh (*Caulophyllum thalictroides*)	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.8	0.0	0.0	0.0
Blueberry (*Vaccinium* spp.)	0.0	0.0	0.3	0.0	0.0	0.5	0.0	0.0	0.4	0.0	0.0	0.4
Bluets (*Houstonia* spp.)	0.0	0.0	0.0	0.2	0.3	0.9	0.1	0.0	0.5	0.0	0.0	0.1
Bowman's Root (*Porteranthus trifoliatus*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Box Elder (*Acer negundo*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Briar (*Rubus* spp.)	10.3	0.1	3.0	8.2	1.6	4.4	1.1	0.8	5.4	2.5	0.7	3.6
Broomesedge (*Andropogon virginicus*)	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.1
Buttercup (*Ranunculus* spp.)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Butterfly Pea (*Centrosema virginianum*)	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.3	0.0	0.0	0.0
Canadian Wood Nettle (*Laportea canadensis*)	0.0	0.0	0.0	0.8	0.0	1.6	0.7	0.0	5.3	0.0	0.0	0.8

Table 5. Continued.

	Winter			Spring			Summer			Fall		
Species	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Carolina Horse Nettle (*Solanum carolinense*)	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carolina Silverbell (*Halesia tetraptera*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Catnip (*Nepeta cataria*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chestnut Oak (*Quercus montana*)	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.5	0.0	0.0	0.3
Chicory (*Cichorium intybus*)	0.0	0.0	0.0	0.2	0.0	0.0	0.5	0.1	0.0	0.3	0.1	0.0
Christmas Fern (*Polystichum acrostichoides*)	2.0	0.0	3.6	1.8	0.0	2.2	1.0	0.0	2.3	1.9	0.0	2.7
Cinnamon Fern (*Osmunda cinnamomea*)	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.5	0.1	0.0	0.0
Cinquefoil (*Potentilla* spp.)	0.5	0.0	0.2	0.2	0.0	0.4	0.6	0.0	0.5	0.8	0.0	0.3
Common Selfheal (*Prunella vulgaris*)	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.0	0.3	0.4	0.0
Coneflower (*Rudbeckia* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cross Vine (*Bignonia capreolata*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5. Continued.

	Winter			Spring			Summer			Fall		
Species	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Cucumber Tree (*Magnolia acuminata*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dandelion (*Taraxacum officinale*)	0.1	0.1	0.0	0.1	0.9	0.0	0.0	0.1	0.0	0.0	0.2	0.0
Deptford Pink (*Dianthus armeria*)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Dog Fennel (*Eupatorium capillfolium*)	0.0	0.0	0.0	0.2	1.6	0.0	0.0	0.9	0.0	0.0	0.1	0.0
Downy Lobelia (*Lobelia puberula*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Downy Rattlesnake Plantain (*Goodyera pubescens*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dwarf Crested Iris (*Iris cristata*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0
Eastern Hemlock (*Tsuga canadensis)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elderberry (*Sambucus canadensis*)	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.1
Elm spp. *(Ulmus* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
False Nettle (*Boehmeria cylindrica*)	0.0	0.0	0.0	4.2	0.0	1.2	0.0	0.0	1.3	0.0	0.0	0.1

Table 5. Continued.

Species	Winter			Spring			Summer			Fall		
	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
False Solomon's Seal (*Smilacina racemosa*)	0.0	0.0	0.0	0.0	0.0	0.6	0.2	0.0	0.5	0.2	0.0	0.0
Flame Azalea (*Rhododendron calendulaceum*)	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.2
Fleabane (*Erigeron* spp.)	0.0	0.0	0.0	0.0	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.0
Flowering Dogwood (*Cornus florida*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Foxglove (*Aureolaria* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Foxtail (*Setaria* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Goat's Beard (*Aruncus dioicus*)	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.0	0.3	0.0	0.0	0.0
Goldenrod (*Solidago* spp.)	0.2	0.0	0.0	1.8	4.4	0.1	8.0	4.8	0.8	2.9	4.6	0.7
Grape (*Vitis* spp.)	0.3	0.0	0.1	0.1	0.0	0.3	0.1	0.0	0.7	0.0	0.0	0.1
Green Ash (*Fraxinus pennslyvanica*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Greenbriar (*Smilax* spp.)	0.3	0.0	1.2	0.2	0.0	1.1	0.5	0.0	1.1	0.6	0.0	1.1

Table 5. Continued.

Species	Winter			Spring			Summer			Fall		
	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Hayscented Fern (*Dennstaedtia punctilobula*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hepatica (*Hepatica* spp.)	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.0
Hickory spp. (*Carya* spp.)	0.0	0.0	0.8	0.2	0.1	0.2	0.0	0.1	0.3	0.0	0.0	0.5
Honey Locust (*Gleditsia triacanthos)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hophornbeam (*Ostrya virginiana*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Horse Balm (*Collinsonia canadensis*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2
Indian Cucumber (*Medeola virginiana*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Indian Pinkroot (*Spigelia marilandica*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0
Iron Wood (*Carpinus caroliniana*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Jack In The Pulpit (*Arisaema triphyllum*)	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.4	0.0	0.0	0.0
Japan Grass (*Microstegium vimineum*)	0.0	0.0	0.0	3.2	5.5	1.0	4.3	9.5	1.9	0.5	0.0	1.1

Table 5. Continued.

Species	Winter			Spring			Summer			Fall		
	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Jewelweed (*Impatiens* spp.)	0.0	0.0	0.0	1.8	0.1	1.1	1.0	0.0	2.4	0.1	0.0	0.4
Lady Fern (*Athyrium filix-femina*)	0.2	0.0	0.0	0.0	0.0	1.1	0.0	0.0	1.1	0.0	0.0	0.6
Lambs Quarters (*Chenopodium album*)	0.0	0.0	0.0	0.2	0.2	0.0	0.2	0.3	0.0	0.0	0.0	0.0
Leafcup (*Polymnia* spp.)	0.0	0.0	0.0	0.3	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1
Lespedeza (*Lespedeza* spp.)	0.0	0.0	0.0	2.2	5.2	0.6	7.7	14.5	1.0	6.0	9.5	0.8
Little Bluestem (*Schizachyrium scoparium*)	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Little Brown Jug (*Hexastylis arifolia*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.2
Lyreleaf Sage (*Salvia lyrata*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maidenhair Fern (*Adiantum pedatum*)	0.5	0.4	0.0	0.1	0.2	0.1	0.1	0.0	0.1	0.2	0.0	0.0
Mandarin (*Disporum* spp.)	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.6	0.0	0.0	0.0
Maple Leaf Viburnum (*Viburnum acerifolium*)	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.0	0.7	0.0	0.0	0.0

Table 5. Continued.

	Winter			Spring			Summer			Fall		
Species	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
May Apple (*Podophyllum peltatum*)	0.0	0.0	0.0	0.7	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Milkweed (*Asclepias* spp.)	0.0	0.0	0.0	0.9	0.3	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Morning Glory (*Ipomoea* spp.)	0.0	0.0	0.0	0.4	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.0
Mountain Laurel (*Kalmia latifolia*)	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.2
Mountain Mint (*Pycnanthemum* spp.)	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.8	0.1	0.0	0.0	0.1
Multiflora Rose (*Rosa multiflora*)	0.1	0.3	0.0	0.9	0.0	0.0	0.5	0.0	0.0	0.1	0.6	0.0
New Jersey Tea (*Ceanothus americanus*)	0.0	0.0	0.0	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Northern Red Oak (*Quercus rubra*)	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.2	0.0	0.4
Oak (*Quercus* sp.)	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Obedient Plant (*Physostegia virginiana*)	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Orchard Grass (*Dactylis glomerata*)	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0

Table 5. Continued.

	Winter			Spring			Summer			Fall		
Species	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Panic Grass (*Panicum* spp.)	0.9	0.1	0.3	0.1	0.0	0.8	1.2	0.1	1.4	0.1	0.1	1.2
Parsnip (*Thaspium* spp.)	0.0	0.0	0.0	2.1	0.0	0.3	0.2	0.0	0.5	0.0	0.0	0.1
Partridge Berry (*Mitchella repens*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Persimmon (*Diospyros virginiana*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phlox (*Phlox* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Pigweed (*Amaranthus* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Pines (Pinus spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pipevine (*Aristolochia macrophylla*)	0.2	0.0	0.0	0.1	0.0	0.2	1.2	0.0	0.2	0.2	0.0	0.1
Plantain (*Plantago* spp.)	0.0	0.0	0.0	0.2	0.2	0.0	0.3	0.3	0.0	0.2	1.6	0.1
Poison Ivy (*Toxicodendron radicans*)	0.0	0.0	0.3	0.0	0.4	0.8	0.0	0.2	1.6	0.1	0.2	0.4
Pokeweed (*Phytolacca americana*)	0.0	0.0	0.0	0.9	0.0	0.3	0.7	0.0	0.5	0.0	0.0	0.1

Table 5. Continued.

	Winter			Spring			Summer			Fall		
Species	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Princess Tree (*Paulownia tomentosa*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pussytoes (*Antennaria* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Queen Anne's Lace (*Daucus carota*)	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.4	0.0	0.5	0.2	0.0
Ragweed (*Ambrosia* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	4.6	1.6	0.1	0.3	0.1	0.0
Rattlesnake Fern (*Botrychium virginianum*)	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Red Clover (*Trifolium pratense*)	0.0	4.6	0.0	0.1	5.4	0.0	0.6	1.6	0.0	0.2	2.8	0.0
Red Maple (*Acer rubrum)*	0.0	0.0	0.6	0.8	0.1	1.8	1.4	0.0	3.0	1.1	0.0	1.8
Red Mulberry (*Morus rubra*)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0
Redbud (*Cercis canadensis*)	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.1
Rue (*Thalictrum* spp.)	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.7	0.0	0.0	0.1
Rushes (*Juncus* spp.)/Sedges (*Carex* spp.)	1.8	1.0	1.1	2.3	1.6	1.3	1.1	3.8	0.0	0.9	1.2	0.8

Table 5. Continued.

Species	Winter			Spring			Summer			Fall		
	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Sassafras *(Sassafras albidum)*	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.8	0.0	0.0	0.2
Silver maple (*Acer saccharinum*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Skullcap (*Scutellaria* spp.)	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.0	0.0	0.0	0.0
Smartweed (*Polygonum* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	1.0	1.2	0.2
Solomon's Seal (*Polygonatum biflorum*)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.0	0.0	0.0
Sourwood *(Oxydendrum arboreum)*	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.6	0.0	0.0	0.1
Spicebush (*Lindera benzoin*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiderwort (*Tradescantia subaspera*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.0
Spotted Wintergreen (*Chimaphila maculata*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Spurge (*Euphorbia* spp.)	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Squawroot (*Conopholis americana*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5. Continued.

	Winter			Spring			Summer			Fall		
Species	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Star Chickweed (*Stellaria pubera*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stonecrop (*Sedum* spp.)	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.1
Strawberry Bush (*Euonymus americanus*)	0.0	0.0	0.2	0.2	0.0	0.2	0.1	0.0	0.3	0.1	0.0	0.2
Striped Maple (*Acer pensylvanicum*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sugar Maple *(Acer saccharum)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Sumac (*Rhus* spp.)	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1
Sunflower (*Helianthus* spp.)	0.0	0.0	0.0	2.3	0.5	1.2	1.4	0.5	2.2	0.0	0.3	0.5
Sweet Birch (*Betula lenta*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweet Clover (*Melilotus* spp.)	0.0	0.0	0.0	0.2	2.4	0.0	0.6	4.4	0.1	0.7	0.9	0.0
Sweetleaf (*Symplocos tinctoria*)	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.4	0.0	0.0	0.1
Tall Fescue (*Festuca arundinacea*)	2.8	40.0	0.2	5.4	34.0	0.1	12.7	27.2	0.3	19.2	42.1	0.1

Table 5. Continued.

	Winter			Spring			Summer			Fall		
Species	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Thistle (*Cirsium* spp.)	0.0	0.0	0.0	0.0	0.3	0.0	0.7	0.5	0.0	0.0	0.4	0.0
Thoroughwort (*Eupatorium* spp.)	0.0	0.0	0.0	0.1	0.0	0.0	3.4	0.2	0.6	0.9	0.7	0.3
Tickseed (*Coreopsis* spp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.1
Timothy (*Phleum pratense*)	0.0	0.5	0.0	0.0	2.5	0.0	0.0	6.3	0.0	0.0	0.6	0.0
Toothwort (*Dentaria* spp.)	0.0	0.0	0.2	0.0	0.1	0.4	0.0	0.0	0.1	0.1	0.0	0.7
Trefoil (*Desmodium* spp.)	0.0	0.0	0.0	0.0	0.3	0.1	0.2	0.5	1.4	0.2	0.0	0.8
Trillium (*Trillium* spp.)	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.0	0.1	0.0	0.0	0.1
Tulip Poplar *(Liriodendron tulipifera)*	0.0	0.0	0.1	0.1	0.0	0.6	0.5	0.0	1.1	0.0	0.0	0.7
Twinleaf (*Jeffersonia diphylla*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Twoflower Dwarf Dandelion (*Krigia biflora*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Umbrella Magnolia (*Magnolia tripetala*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1

Table 5. Continued.

Species	Winter			Spring			Summer			Fall		
	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Vasevine (*Clematis* spp.)	0.0	0.0	0.0	2.1	1.1	0.3	1.5	0.6	0.3	0.9	0.5	0.1
Vetch (*Vicia* spp.)	0.1	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.2	0.0	1.5
Violet (*Viola* spp.)	0.2	0.2	0.8	1.0	0.3	3.6	1.1	0.2	2.8	0.5	0.0	1.4
Virginia Creeper (*Parthenocissus quinquefolia*)	0.0	0.0	0.0	1.8	0.4	0.7	1.0	0.0	1.0	0.0	0.0	0.3
Wheat (*Triticum* spp.)	0.0	0.9	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0	0.8	0.0
White Ash (*Fraxinus americana)*	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0
White Clintonia (*Clintonia umbellulata*)	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
White Clover (*Trifolium* spp.)	0.1	3.0	0.0	0.1	3.7	0.0	0.3	11.0	0.0	2.8	7.3	0.0
White Oak (*Quercus alba*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White Snakeroot (*Ageratina altissima*)	0.0	0.0	0.0	2.1	0.4	3.0	3.3	0.3	3.1	0.8	0.0	1.3
Wild Garlic (*Allium* spp.)	0.2	0.0	0.0	0.3	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.0

Table 5. Continued.

Species	Winter			Spring			Summer			Fall		
	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest	Edge	Field	Forest
Wild Geranium (*Geranium maculatum*)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.0	0.0	0.0
Wild Ginger (*Asarum canadense*)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.8	0.0	0.0	0.5
Wild Hydrangea (*Hydrangea arborescens*)	0.2	0.0	0.3	1.3	0.0	1.6	0.8	0.0	1.5	0.0	0.0	0.8
Wild Yam (*Dioscorea villosa*)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.5	0.0	0.0	0.2
Witch Hazel (*Hamamelis virginiana*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Wood Betony (*Pedicularis canadensis*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wood Sorrel (*Oxalis* spp.)	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.0	0.1	0.0	0.0	0.1
Yellow Loosestrife (*Lysimachia* spp.)	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.4	0.1	0.0	0.4
Yellow Trout Lily (*Erythronium americanum*)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Yellowroot (*Xanthorhiza simplicissima*)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	21.9	52.3	15.3	58.2	82.6	48.2	74.9	92.8	67.5	51.4	80.0	34.5

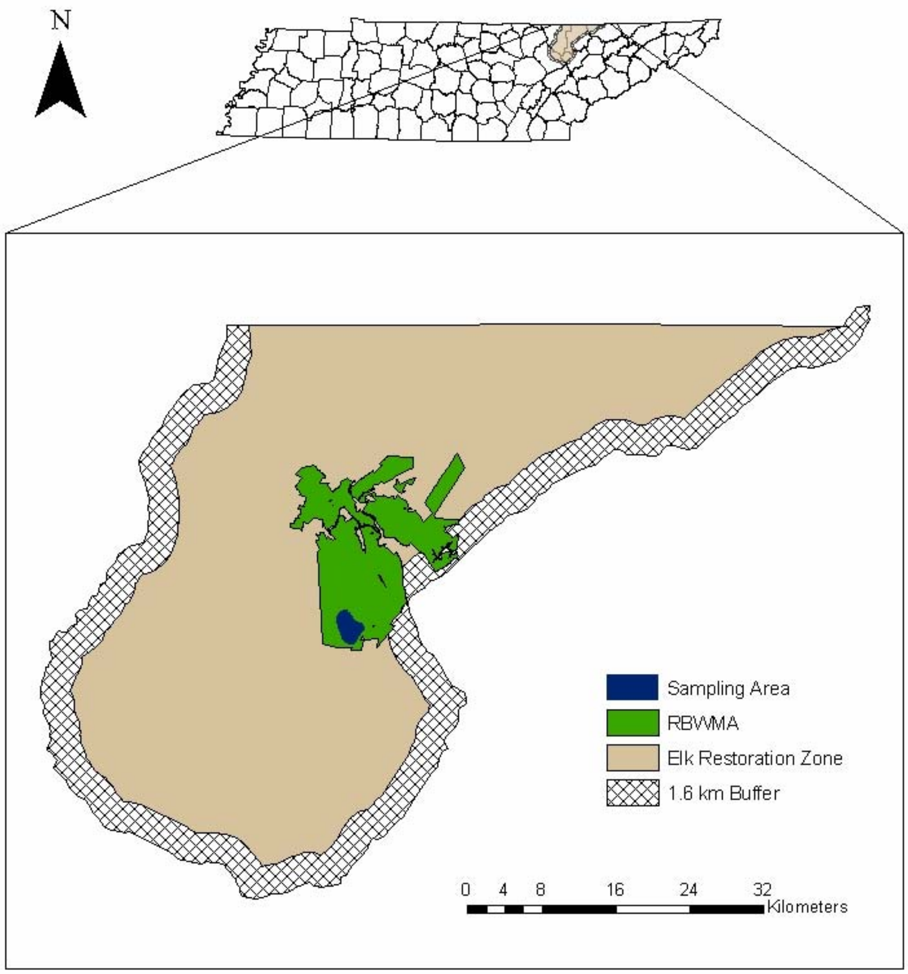

Figure 1. The 789-ha sampling area (50% kernel home range) for reintroduced elk in the 271,145-ha elk restoration zone, November 2003 to October 2004, Royal Blue Wildlife Management Area (RBWMA), Tennessee, USA.

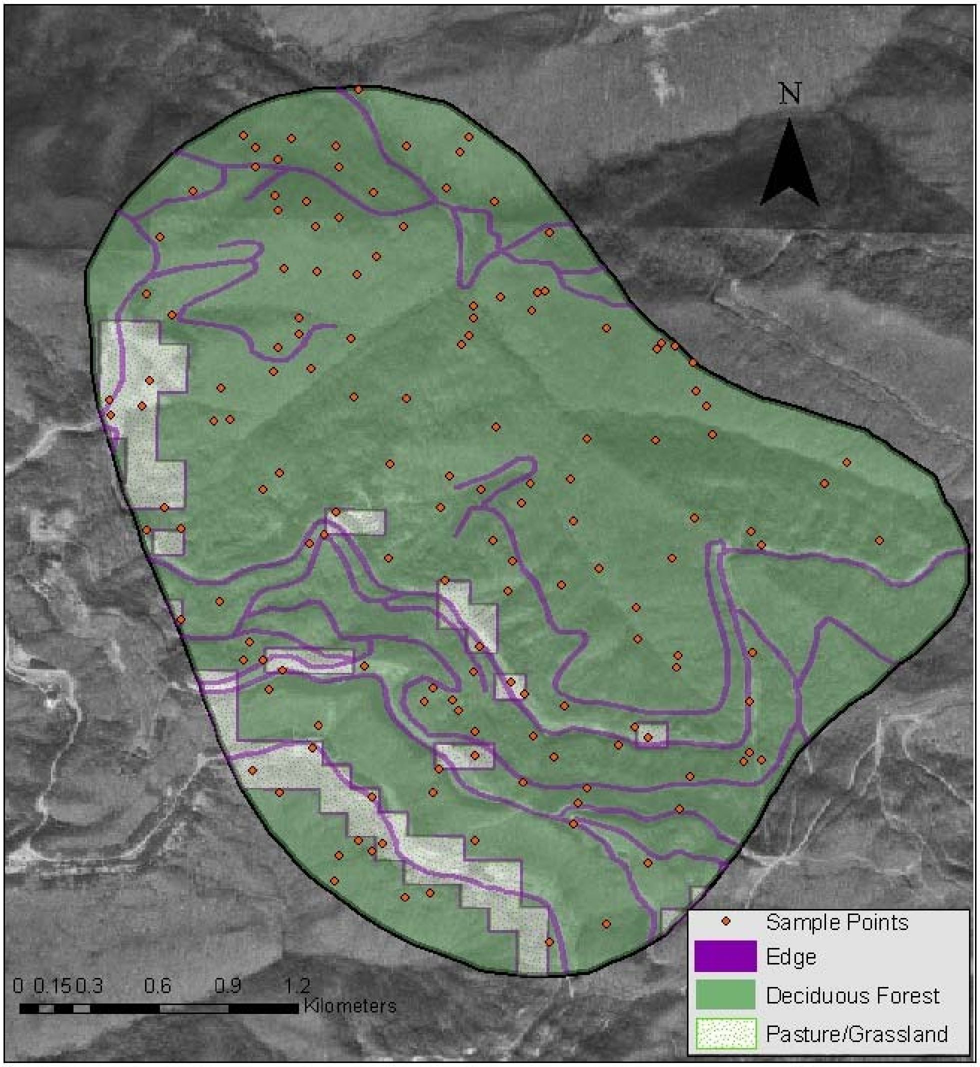

Figure 2. The distribution of 150 sampling points throughout the 3 major cover types within the 789-ha core elk area (50% kernel home range), November 2003 to October 2004, Royal Blue Wildlife Management Area, Tennessee, USA. Sample points were developed in Random Point Generator Extension (Jenness Enterprises, Flagstaff, Arizona, USA) for Arc View 3.2®.

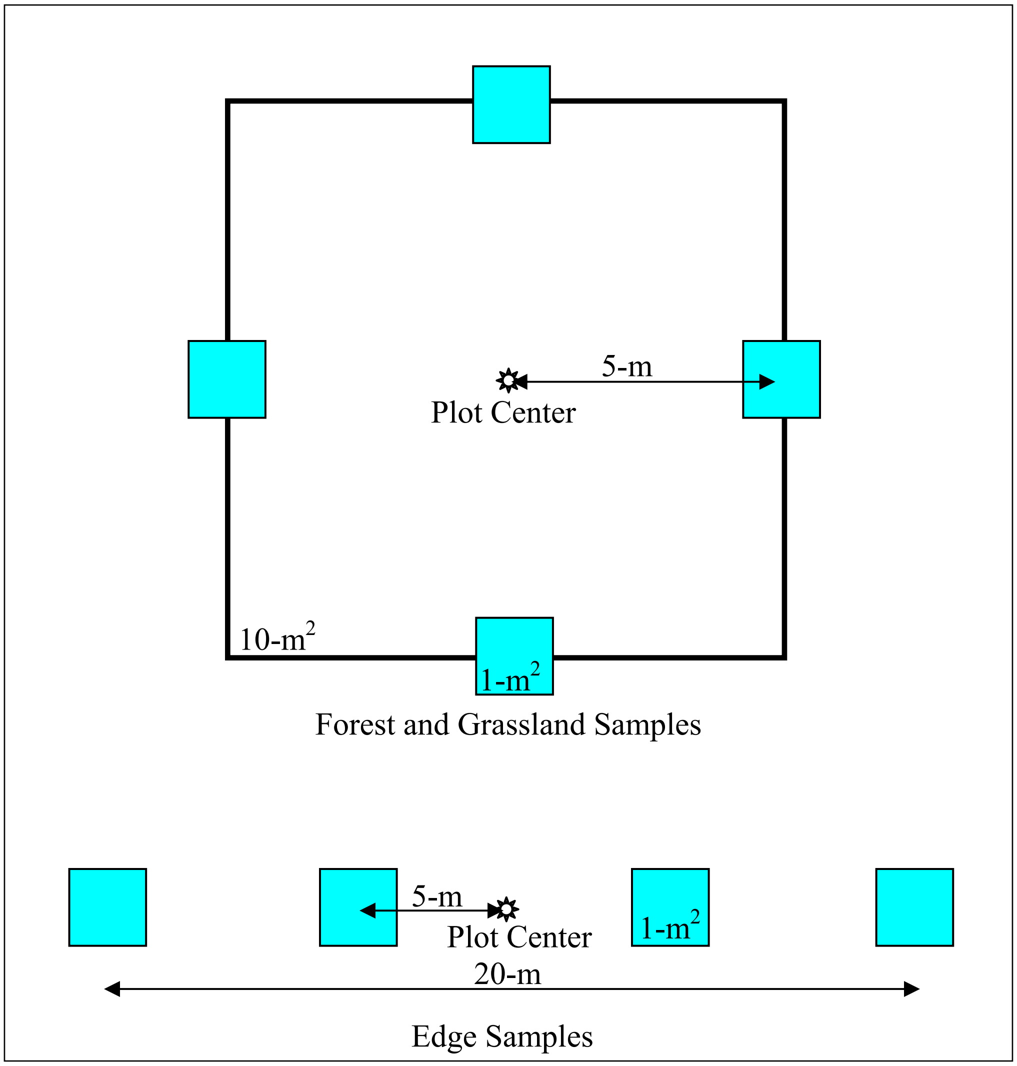

Figure 3. Illustration of forest, grassland, and edge samples where vegetation measurements were conducted at each plot within 789-ha core elk area (50% kernel home range), November 2003 to October 2004, Royal Blue Wildlife Management Area, Tennessee, USA.

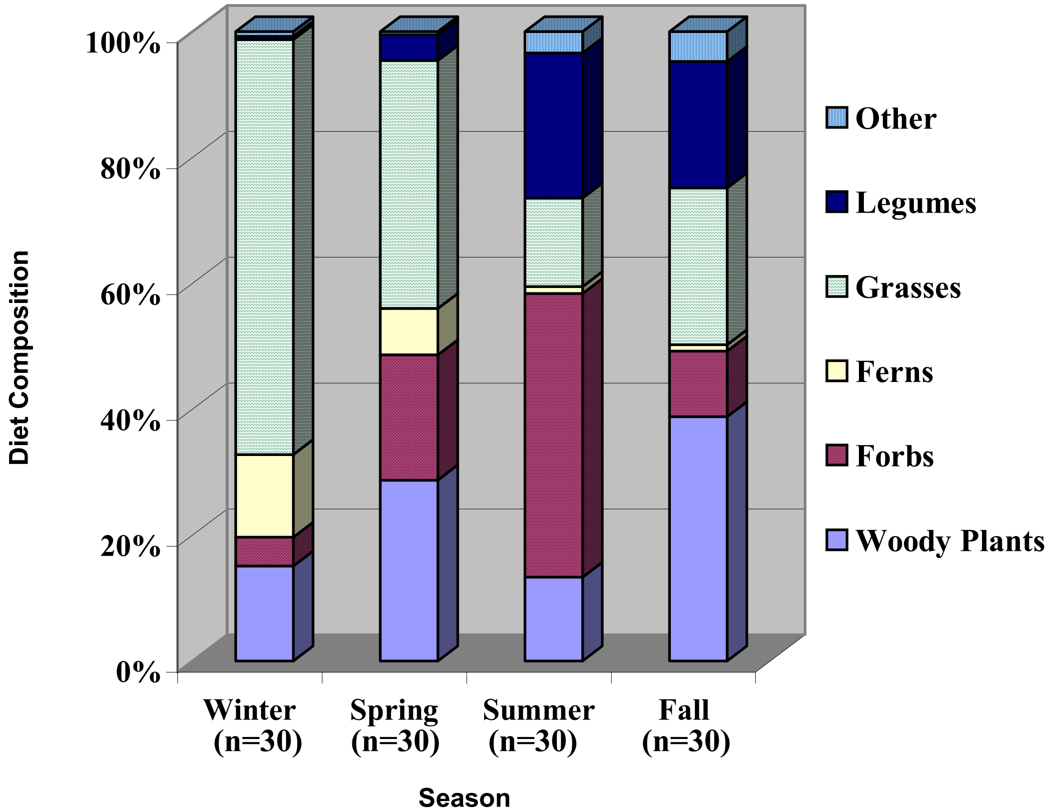

Figure 4. Major forage classes for the seasonal elk diet composition determined from microhistological analysis of plant material in feces within 789-ha core area (50% kernel home range), November 2003 to October 2004, Royal Blue Wildlife Management Area, Tennessee, USA.

VITA

Jason Lupardus was born in Florence, Alabama in August 1975 as Jason French. He grew up in the rural town of Frog Pond, Alabama. He went to grade and high school at Brooks. He attended the University of North Alabama on scholarships in chemical engineering for three years before he found his niche in life. His passion for conservation led him to the University of Tennessee, Knoxville where he received a B.S. in wildlife & fisheries science with a minor in forestry in 2003 and a M.S. in wildlife science in 2005.