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Response of Small Mammal Populations to Fescue Hayfield Conversion to Native Warm Season Grasses in Bath County, Virginia

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ABSTRACT

I investigated the effect on small mammal populations of converting an existing fescue (*Festuca arundinacea*) hayfield to switchgrass (*Panicium virgatum*) on the George Washington National Forest at Hidden Valley in Bath County, Virginia. Native warm season grasses are thought to provide better habitat than fescue pastures for Northern Bobwhite (*Colinus virginianus*) and several species of grassland birds as well as herbivorous small mammals. I established one live-trapping grid and conducted trapping (pre-treatment) in both the switchgrass (treatment) and the fescue (control) field in March and May 1997. The treatment field was sprayed with glyphosate herbicide (Roundup®) in June 1997, burned and seeded to switchgrass. Live trapping was conducted at approximately 60-day intervals during the growing season from March 1997 until October 1999. I caught significantly more individuals in the treatment field (n=349 individuals of 5 species) than in the control field (n=59 individuals of 4 species; X^2 = 196.7, d.f. = 1, P< 0.05). The overall capture index was 14.492 and 2.273 animals per 100 trap nights in the treatment and control fields, respectively. The treatment field had a significantly higher mean plant biomass weight ($\bar{x}$=58.24 g/m^2) than the control field ($\bar{x}$=38.41 g/m^2; t=4.323; P<0.00008, D.F. = 44).

INTRODUCTION

Over the past fifty years, land use practices related to farming have changed dramatically in Virginia and most of the Southeastern United States. These changes include: use of monocultures, large fields, loss of fence rows, mechanization and conversion of native forages to non-native, cool-season forage grasses for hay and pasture, decline in the use of prescribed fire as a management tool, dense pine plantations, and increased use of pesticides. For example, Kentucky once had 3 million acres of native grasslands that have now been largely converted to fescue (Kentucky DNR, 2004). In Texas, it is estimated that only 54% of the original native grassland remains and this has been detrimental to native species of wildlife (Hays et al., 2004). In Ohio, only 1% of native prairie remains (Anonymous, 2004).

While farm productivity has seen dramatic increases, unforeseen consequences resulting from this rush to "improve" farming include loss of Northern bobwhite (quail) (*Colinus virginianus*) habitat and changes in population structure of both small, herbivorous mammals and grassland birds (Askins, 1993). Early successional grassland birds have exhibited the greatest overall population decline in the U.S. (Sauer et

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al., 1995). This trend is attributed to loss of early successional habitat used as breeding grounds due to more intensive agricultural practices (Cederbaum, 2002). In addition to loss of breeding grounds for migratory songbirds, these changes in farming have contributed to a 62% decline in quail populations across the Southeast in the last 30 years (Capel et al., 1996).

Quail populations have undergone a steady decline in Virginia and other states in the bird's range over the past 50 years and this trend continues today (Capel et al., 1996). The conversion of native grasslands to fields dominated by cool season grasses such as tall fescue (*Festuca arundinacea*) is the number one problem facing quail managers in Virginia (Capel et al., 1996). Cool season grasses are relatively unproductive in both forage biomass and seed production during hot summer months typical of Virginia (Moser and Vogel, 1995). Efforts are currently underway in much of Virginia to establish native warm season grasses in an effort to both demonstrate their usefulness for forage and pasture and to halt and reverse the decline in quail (Capel et al., 1996).

Warm season grasses are so named because they tolerate and grow best in the warmer summer months of June-August. Various species of native grass fall under the heading of warm season grass. The most commonly planted species include switchgrass (*Panicum virgatum*), indiangrass, (*Sorghastrum nutans*) and big bluestem (*Andropogon gerardii*). Warm season grasses, which flower and produce seed from mid-summer to fall, are important food resources for numerous wildlife species.

Switchgrass is drought-tolerant and can grow well on poor soils though its best growth is on silt loam soil conditions. Switchgrass can produce up to 3 times more forage per inch (2.54 cm) of soil water than fescue (Wolf, no date). Switchgrass grows to 2.0 m tall and can have roots up to 3 m deep. It is considered a bunchgrass in that it grows in clumps with bare soil between bunches. It is this bare soil that forms the microhabitat mosaic that benefits quail chicks and small mammals. Switchgrass can produce 80,000 seeds per kilogram (Moser and Vogel, 1995).

Concomitant with the decline in quail and grassland bird populations are declines of unknown magnitude in populations of small, herbivorous mammals. Little work has been done to examine the effects of warm season grass restoration on small mammals. Rucker (1998) studied fescue pastures in Kansas restored to native prairie grasses by introducing fire and removing cattle and nitrogen fertilization. Rucker concluded that conversion of fescue pastures is effective in creating habitat suitable for several species of small mammals. Some work has been done on restoring strip mine lands but effects of such activity on small mammal populations is lacking. Other projects (Capel et al., 1996) have addressed the decline in quail populations in Virginia.

My project explored the differences between small mammal populations in hayfields of fescue and switchgrass. Many small mammals are grazers and seedeaters and it was hypothesized that they would benefit from the seed production attributable to warm season grasses especially as this relates to increased winter food supply. Therefore, my objective was to assess the impacts of hayfield conversion on populations of small, herbivorous mammals.

STUDY AREA

I conducted this study in the Hidden Valley Recreation Area on the Warm Springs Ranger District of the Jefferson/George Washington National Forest in Bath County, Virginia. The Jackson River bisects the valley flowing generally north to south and forms the western boundary of the treatment field. The control field was south of the treatment field. A wetland strip with a continuously flowing shallow stream separates the fields. The strip was approximately 15 m wide and the 2 trapping grids were a minimum of 120 m apart. The edge of the treatment grid was a minimum of 45 m from the Jackson River and the field has been mowed to within 3 meters of the river in the past. In 1996, the USDA Forest Service delineated a 45-m buffer strip and deleted that acreage from the mowing contract in the hope that native streamside woody vegetation would become established. In 1998, riparian vegetation (trees) was planted along this border. Recreationists heavily use the area for cycling, hiking, camping, hunting and fishing access. Horseback riding is allowed along a dirt road within 5 m of the Jackson River.

MATERIALS AND METHODS

The treatment field was sprayed with the herbicide Roundup® in late June 1997, burned on 3 July 1997, and seeded with switchgrass on 7 July 1997. No further hay cutting was conducted on the treatment field. The control field was cut and bailed for hay on 1 July 1997. Treatments were carried out by the USDA Forest Service – Warm Springs Ranger District or their contractors. Hay was cut twice per growing season in the control field only and transported off the study area. No cattle were grazed in either study field.

I established a single live trapping grid in each field. Each grid covered 1.2 ha. On each grid, I placed transects at 15 m intervals and stations were located at 10 m intervals along each line. In the treatment field, the grid was rectangular in shape with 5 lines and 20 trap stations per line for a total of 100 trap stations. In the control field, the grid had 7 lines and 12-14 stations per line for a total of 96 stations. When trapping, only 60-75 grid points in each field were randomly selected due to limitations of number of traps and time. A single Sherman live trap was placed at each trap station and marked with a plastic flag. Trap stations were randomly selected at the start of each trapping session. Traps were baited with sunflower seed and opened for 2-4 consecutive nights in each field simultaneously. Live trapping continued at approximately 60-day intervals during the growing season from March 1997 until October 1999. I identified captured animals to species, toe clipped, weighed and gender and age were determined. I released captured animals immediately at the capture site.

I assessed total aboveground forage biomass once in early April 1998 by randomly selecting 30 rectangular plots in each treatment (1/2 m by 2 m) and harvesting all living plant material. This material was bagged by plot and treatment and dried to constant moisture content before weighing to the nearest 0.1 g. I used a Student's t-test to compare mean biomass between fields. I compared small mammal captures using a Chi-square statistic and catch per effort measures (number of animals caught per 100 trap nights) and corrected for sprung traps using the method in Nelson and Clark (1973). Statistical significance was set at alpha = 0.05.

RESULTS

Herbicide spraying and burning successfully killed and removed nearly all of the existing vegetation on the treatment field (S. Tanquay, USDA Forest Service, pers. comm.). However, the entire process of spraying, burning and seeding occurred about

4 weeks later than the time frame recommended for establishment of warm season grasses in Virginia (Capel, 1996). The area experienced a mild drought during late summer 1997 and the winter of 1997-1998 was warmer than normal and there was less than normal snowfall that year. From January through April 1998, the 8-county area to the east and southeast of Bath County, including Bath County, received 35.5 cm above the normal rainfall amount. Rainfall patterns were near normal in 1999.

Trapping occurred 13 times over the study period. Although all live animals were toe-clipped, I was unable to compute population estimates because of low recapture rates (less than 30 total recaptures) and high trap mortality in some trap sessions. Instead, I computed captures per 10 trap nights (TN) as an index to abundance. The results indicate a low small mammal population in the control field. Nearly 6 times as many small mammals were collected in the treatment field as in the control field. In the treatment field, 349 individuals of five species were collected in 2,717 trap nights. The meadow vole (*Microtus pennsylvanicus*) (87% of total captures) was the most abundant species followed by meadow jumping mouse (*Zapus hudsonius*) (6.9%), northern short-tailed shrew (*Blarina brevicauda*) (4.3%), deer mouse (*Peromyscus maniculatus*) (2%), and one short-tailed weasel (*Mustela frenata*) (0.3%). A total of 59 individuals of four species were caught in the control field in 2,657 trap nights. Meadow voles made up 86% of the catch followed by meadow jumping mice (8.5%), northern short-tailed shrew (3.4%) and deer mice (1.7%). In the treatment field, captures ranged from 0-142 individuals per session with no captures in three trapping sessions. In the control field, captures ranged from 0-32 individuals per session with no captures in six trap sessions. Capture indices (per 100 trap nights) in each trap session are summarized in Table 1.

Overall capture index was 6.3 times higher in the treatment field (14.43 captures/100 TN) than the control field (2.27 captures/100 TN). Capture index was higher in the treatment field for all trap sessions during which small mammals were captured (Figure 1). Yearly capture index in the treatment field was 1.72, 10.61, and 42.06 compared to 0.41, 1.66, and 6.13 captures/100 TN on the control field for 1997, 1998, and 1999, respectively. Overall captures were not equally distributed between fields. The number of small mammals caught on the treatment field was significantly greater than the number captured on the control field (X^2 = 196.7, d.f. = 1, P< 0.01). Four species of small mammals were caught on the control field but only meadow voles were caught in more than one trap session (Table 1). Five species were collected on the treatment field, however the long-tailed weasel was represented by a single individual. Of the remaining four species, northern short-tailed shrews were caught in four of the last 5 trap sessions, meadow voles were caught throughout the 3-year study, and 86% of deer mice were caught in the first year (Table 1).

The treatment field had more aboveground biomass ($\bar{x}$ = 57.24 g/m^2, SE = 3.84 g/m^2) than the control field (biomass $\bar{x}$ = 38.41 g/m^2, SE = 2.04 g/m^2). The difference was statistically significant (t = 4.323, P< 0.00008, DF = 39).

DISCUSSION

Several factors contributed to the differences in small mammal populations between the two fields in my study. Although not measured, my observations over the length of the study indicated that the vegetation in the treatment field was more clumped with more areas of bare ground than in the control field. The higher biomass for

TABLE 1. Distribution of small mammals captured (% of species* total) during each trapping session on a fescue (control) and warm season grass field (treatment) in Bath County, Virginia.

Date	Field	BLBR	MIPE	PEMA	ZAHU	MUFR
Mar - 97	Control					
	Treatment					
May - 97	Control		1.9			
	Treatment		2.4	14.3		
Jul - 97	Control					
	Treatment					
Sep - 97	Control					
	Treatment		1.0			
Nov - 97	Control	100	1.9			
	Treatment		0.3	71.4		
Mar - 98	Control					
	Treatment					
May - 98	Control		3.7			
	Treatment		1.2			
Jun - 98	Control		16.7		100	
	Treatment		5.5	14.3	12	
Sep - 98	Control					
	Treatment	60	13.3		76	100
Apr - 99	Control		3.7			
	Treatment		9.4			
Jun - 99	Control		57.4	100		
	Treatment	7	37.9		8	
Aug – 99	Control		14.8			
	Treatment	13	12.7		4	
Oct –99	Control					
	Treatment	20	17.6			
Total Captures	Control	2	54	1	5	
	Treatment	15	330	7	25	1

* BLBR = *Blarina Brevicauda*; MIPE = *Microtus pennsylvanicus*; PEMA = *Peromyscus maniculatus*; ZAHU = *Zapus hudsonius*; MUFR = *Mustela frenata*

switchgrass is consistent with Virginia Tech Cooperative Extension Service literature. Wolf (no date) reported that switchgrass had a yield of 4.2 tons per acre while fescue produces only 2.0 tons per acre in a West Virginia study. Additionally, the treatment field contained a variety of plant species while the control field was estimated to contain over 95% fescue with only 2-3 sparsely scattered plant species. Observations in the control field indicated very uniform ground coverage by fescue with little or no bare ground except near occasional woodchuck (*Marmota monax*) burrows. There appeared to be twice as many woodchuck burrows in the treatment field as in the control field and more white-tailed deer (*Odocoileus virginianus*) fecal pellet groups were observed in the treatment field than in the control field. During the May 1999 trapping

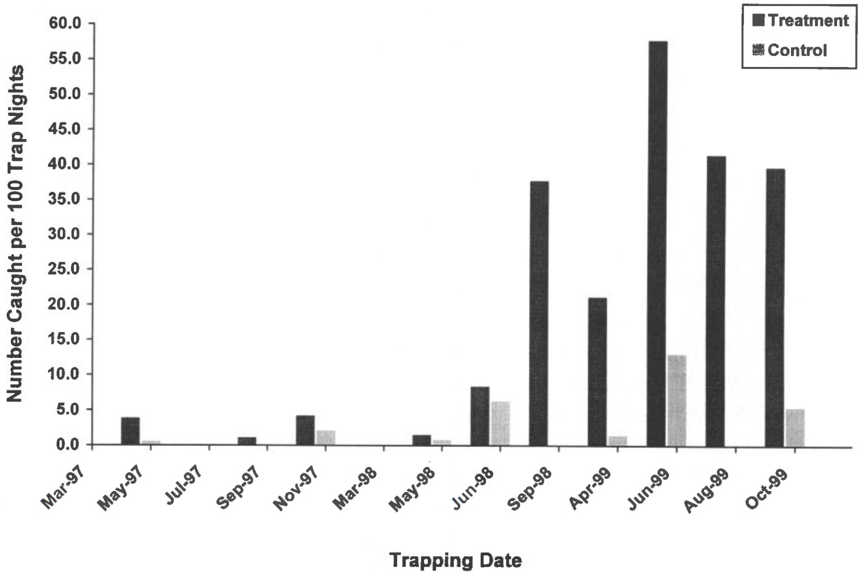

FIGURE 1. Small mammal index of abundance (captures per 100 trap nights) on a warm season grass (treatment) field and a fescue hayfield (control) during 1997-1999 in Bath County, Virginia.

period, I estimated that the vegetation in the control field was 30-35 cm high whereas vegetation in the treatment was nearly 1 m tall. While checking traps, both white-tailed deer fawns and cottontail rabbits (*Sylviligus floridanus*) were observed in the treatment field but neither was observed in the control field. I recorded no observations of songbird nests in either field.

In this study, I found an increasing trend in small mammal capture index with time since disturbance that is consistent with other studies of early successional plant communities (Atkeson and Johnson, 1978; Felix et al., 1983; Golley et al., 1965; Kirkland, 1977; Mengak et al., 1989). Michael (1995) working in ten undisturbed high elevation habitats in West Virginia found meadow voles to be the dominant species in habitat dominated by alder 2-4 m tall with various species of forbs, grasses and sedges in the understory. Michael (1995) found deer mice to be least abundant in hayfields. Deer mice preferred mature hardwoods or grassland ecotones. Meadow voles and short-tailed shrews were moderately abundant in hayfields.

Michael (1995) and others have noted oscillations in small mammal abundance or capture success. Peaks and valleys in abundance occur at approximately 5-6 year intervals. Numerous studies (Atkeson and Johnson 1979; Felix et al. 1983; Kirkland 1977; Mengak et al. 1989) have observed that small mammal populations require 1-3 years post-disturbance to reach high levels of abundance. Small mammal populations in this study appear to follow that trend. It is likely that the warm season grass field is functioning like other early successional old field habitats and mammal populations can be expected to oscillate in response to variables such as food resources, weather, competition, and plant species composition. Hay cutting operations will continue to suppress small mammal populations in the control field due to the impact on vegetation.

Rucker (1998) found that removing the disturbance factors of mowing and grazing allowed the plant community to undergo succession and provide suitable habitat for small mammal populations. Additional studies are necessary to determine whether plant species composition or structure of the vegetation has the greater impact on small mammals. I suggest that both plant species composition (monoculture fescue versus multi-species) and structure (i.e., dense mat of fescue versus bunchgrass with bare ground) are important to small mammals. Similar studies note that increasing plant species diversity is the first step to improving wildlife habitat and recommend planting native warm season grasses (McPeake et al. 2003).

Trapping results from my study indicate a large difference between the two fields. Nearly six times as many mice were collected in the treatment field. Numerous mice and other mammals were observed running through the treatment field as I walked from trap to trap. No similar activity was observed in the control field. Although switchgrass dominated the treatment field other plants were scattered throughout the field. Casual observation revealed thistle (*Carduus* spp.), nightshade (*Solanum* spp.), goldenrod (*Solidago* spp.), and needle grass (*Juncus* spp.) among the other prevalent plants. The increased plant diversity had a positive impact on the small mammal abundance. Numerous studies have noted the increase in small mammal species richness and abundance in early successional habitats such as pine plantations (Mengak and Guynn, 2003; Mengak et al., 1989; Atkeson and Johnson, 1979). On the contrary, the control field was almost exclusively a fescue community with a thick sod and little bare ground. Likewise, there were few if any signs of mammal tunnels in the thick vegetative mat.

While my study lacked replication, it seems evident that both the lack of disturbance and plant community structure in the treatment field contributed to the observed differences in small mammal capture index. Future studies should be conducted to more clearly separate the individual effects of plant community composition and structure on the small mammal community.

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LITERATURE CITED

Anonymous. 2004. Pasture/Hayland management for wildlife and livestock. Ohio Division of Wildlife Publication 388.

Askins, R. A. 1993. Population trends in grassland, shrubland, and forest birds in eastern North America. Pages 1-34 *in* D. M. Power, editor. Current Ornithology. Plenum Press, New York.

Atkeson, T. D. and A. S. Johnson. 1979. Succession of small mammals on pine plantations in Georgia Piedmont. American Midland Naturalist 101:385-392.

Capel, S. 1996. Warm season grasses for Virginia and North Carolina: Benefits for livestock and Wildlife. Virginia Department of Game and Inland Fisheries, Richmond, VA. 10 pp.

Capel, S. W., M. L. Fies, I. L. Kenyon, P. D. Keyser, and P. K. Moore. 1996. Virginia bobwhite quail management plan. Wildlife Information Publication No. 96-1. Virginia Department of Game and Inland Fisheries, Richmond, VA. 21 pp.

Cederbaum, S. B. 2002. The effects of alternative and conventional management systems in cotton agriculture on avian and arthropod populations in the upper coastal plain of Georgia. M. S. Thesis, University of Georgia, Athens, GA. 91 pp.

Felix, A. C. III, T. L. Sharik, B. S. McGinnes, and W. C. Johnson. 1983. Succession in loblolly pine plantations converted from second-growth forest in the central Piedmont of Virginia. American Midland Naturalist 110:365-379.

Golley, F. B., J. B. Gentry, L. D. Caldwell, and L. B. Davenport, Jr. 1965. Number and variety of small mammals on the AEC Savannah River Plant. Journal of Mammalogy 46: 1-18.

Hays, K. B., M. Wagner, F. Smeins, and R. N. Wilkins. 2004. Restoring native grasslands. Texas Cooperative Extension Service, Texas A and M University, Extension Publication L-5456.

Kentucky Department of Fish and Wildlife. 2004. Native warm season grasses. KY Department of Fish and Wildlife website http://fw.ky.gov/native.asp accessed on 5 October 2004.

Kirkland, G. L. 1977. Responses of small mammals to the clearcutting of northern Appalachian forest. Journal of Mammalogy 58:600-609.

McPeake, R., J. Jennings, F. Ward, and D. Long. 2003. Managing pastures and haylands for wildlife. University of Arkansas, Cooperative Extension Service Publication FSA-9083-6-00N.

Mengak, M. T. and D. C. Guynn, Jr. 2003. Small mammal microhabitat use on young loblolly pine regeneration areas. Forest Ecology and Management 173:309-317.

Mengak, M. T., D. C. Guynn, Jr., and D. H. Van Lear. 1989. Ecological implications of loblolly pine regeneration for small mammal communities. Forest Science 35:503-514.

Michael, E. D. 1995. Habitat diversity and small mammal populations in Canaan Valley, West Virginia. Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies 49:314-322.

Moser, L. E., and K. P. Vogel. 1995. Switchgrass, Big Bluestem, and Indiangrass. Pages 409-420 in D. A. Barnes, et al. (eds.) Forages: An Introduction to Grassland Agriculture. Vol. 1. 5th Ed. Iowa State University Press, Ames, IA. 515 pp.

Nelson, L. Jr. and F. W. Clark. 1973. Correction for sprung traps in catch/effort calculations of trapping results. Journal of Mammalogy 54:295-298.

Rucker, A. D. 1998. Conversion of tall fescue pastures to tallgrass prairie in southeastern Kansas: Small mammal responses. M.S. Thesis, Kansas State University, Manhattan, KS. 68 pp.

Sauer, J. R., B. G. Peterjohn, S. Schwartz, and J. E. Hines. 1995. The grassland bird home page. Version 95.0. Patuxent Wildlife Research Center, Laurel, MD.

Wolf, D. (No date). Switchgrass Literature. Virginia Tech Agriculture Extension Service, Blacksburg, VA. Mimeo. 13 pp.