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Distributions and Abundances of *Microstegium vimineum* along Forest Roadsides at the Grassy Hill Natural Area, Franklin County, Virginia

Gregory D. Turner [1], Department of Biology, West Chester University of Pennsylvania, West Chester, PA 19383

ABSTRACT

In summer 2005, plots were surveyed along roads passing through forest habitats at the Grassy Hill Natural Area Preserve in Franklin County, Virginia to assess the distributions and abundances of *Microstegium vimineum* in transects located at increasing distances away from roadsides into forest interiors. Across plots, *Microstegium* was encountered almost exclusively in roadside transects, where abundances were relatively high. While forest composition and topographic features were similar across plots, percent canopy cover and leaf litter depth were greater in interior compared to roadside transects due to undisturbed tree canopies and ground cover located in interior plot areas. Results imply that *Microstegium* was restricted to forest roadsides at Grassy Hill at the time of the study, likely due to factors that differ between forest edges and interiors.

Key words: canopy cover, edge, Grassy Hill Natural Area, leaf litter, *Microstegium vimineum*

INTRODUCTION

Microstegium vimineum (Trin.) A. Camus (i.e. Japanese stiltgrass) is an Asian endemic widespread in the eastern United States, including Virginia (Gibson et al. 2002, VDCR 2009), where it is invasive (VDCR 2009, Miller and Matlack 2010) and among the most targeted of exotics for management (Heffernan et al. 2001). It occurs in mountain habitats in the state (Heffernan et al. 2001), including those at Grassy Hill where it grows along roads and in limited areas of undisturbed forest (Turner and Demkó 2007). This is not surprising given that it thrives in both open forests and disturbed sites such as roadside habitats (Redman 1995), as well as in less disturbed forest interiors (Oswalt et al. 2007, Warren et al. 2011) where its presence is alarming since it can spread and outcompete native species (Barden 1987, Adams et al. 2009).

Microstegium's success in invading forests results from a high invasive potential related to a large seed set (Gibson et al. 2002, Bauer and Flory 2010), multiple seed dispersal modes (Christen and Matlack 2009), and dense growth (DeMeester and Richter 2010), which give it competitive advantages over other plants, reducing their growth and survival (Bauer and Flory 2010). However, *Microstegium* is not always invasive. While shade tolerant, it is inhibited by dense shade (Miller and Matlack 2010) and grows optimally under moderately high light conditions (Cole and Weltzin 2004, Glasgow and Matlack 2007). It also germinates and grows best on bare mesic soil

[1]610-436-3009 gturner@wcupa.edu

compared to soil covered by plants and/or leaf litter (Barden 1987, Oswalt and Oswalt 2007). Together, these and other factors can inhibit *Microstegium* recruitment, which benefits management efforts at natural areas like Grassy Hill.

The main purpose of this study was to quantify *Microstegium* distributions and abundances along forest roads at Grassy Hill to determine if the species is found in both roadside and adjacent forest interiors, and if so, at what frequencies. Because *Microstegium* was previously observed almost exclusively along roadsides (Greg Turner, personal observations), it was predicted that it would decline in abundance with road distance. The study also assessed canopy and leaf litter cover to determine if these factors differ with road distance, given that they can inhibit *Microstegium* recruitment.

METHODS

I conducted this study at the Grassy Hill Natural Area, a 524 ha state preserve located northwest of Rocky Mount (36°59 60″N, 79°53 23″W). The preserve lies in the Piedmont physiographic province (Roberts & Bailey 2000) and contains magnesium-rich bedrock overlain with mafic soils (VDCR 2003). It is mountainous, with northwest-oriented slopes reaching 535 m ASL (USGS and VDMR 1985), and is dominated by hickory (*Carya*), oak (*Quercus*), and pine (*Pinus*) species. A few roads and other corridors cross the preserve, but at the time of the study there were no records of fire, logging, or other major disturbances since the mid-twentieth century (John Ebbert, VA Department of Forestry, personal communication).

In summer 2005, I placed nine 50 x 50 m plots along three roads (i.e. three per road) passing through relatively even-aged forest: a paved two-lane road, a gravel access road, and a dirt access road. Plot locations were determined using a random numbers table and a preserve map to choose start points for each plot, none of which was located within 500 m of another. Roads were chosen because they were contiguous and, thus, not independent from one another, and because they are conduits for exotic plant recruitment. Within each plot, five 4 x 50 m belt transects were established using the methods of Brothers and Spingarn (1992) to form a road proximity gradient in which transects were arrayed parallel to roadsides. Transects ran (-2)-2, 2-6, 10-14, 20-24 and 45-49 meters away from roadsides into interiors and were labeled T(-2), T(2), T(10), T(20), and T(45), respectively. T(-2) transects included road shoulder areas located 2 meters outside of canopy edges (i.e. -2 m from edges). *Microstegium* was sampled in June and July by noting its presence and by counting culms in those transects where it was found to determine its general distributions across plot transects, total abundances per transect in each plot, and mean abundances per transect across roads. Percent canopy cover and leaf litter depth were measured on three consecutive days in July, at 10 equidistant points (i.e. every 2.5 m) within each transect, to yield mean values per transect across roads for each measure. Canopy cover was measured with a handheld spherical densiometer (Forest Densiometers, Bartlesville, OK) and leaf litter depth with a meter stick as the distance between the bottom duff and top leaf layers. Because *Microstegium* was found almost exclusively in T(-2) transects, statistical tests for road distance effects on *Microstegium* abundance, and for associations between abundance and canopy cover or leaf litter depth, could not be conducted since the assumptions of regression and correlation tests could not be met. Thus, only analyses of observational results were attempted.

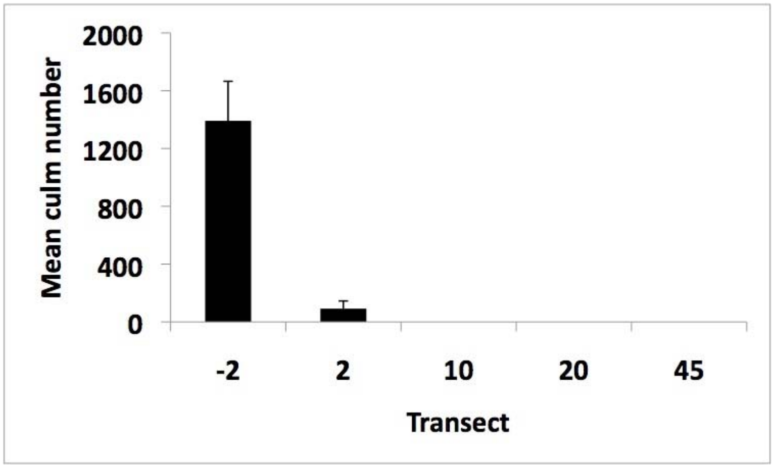

FIGURE 1. *Microstegium vimineum* abundance, measured as the mean number of culms per transect across road plots (error bars = + 1 standard error).

RESULTS

Microstegium vimineum was encountered in every T(-2) transect of each road plot, and in one T(2) transect. Abundance was relatively similar across plots, with relatively high frequencies recorded in T(-2) transects, low numbers in T2 transects, and none beyond any T2 transect (Figure 1). These findings imply that there was virtually no *Microstegium* recruitment into forest interiors away from roadsides at the time of the study. Measures of percent canopy cover showed a pattern of increasing percent cover with distance away from roadsides across plots, with mean percent canopy cover increasing from 82% in T(-2) transects, to 91% in T2 transects, to 98% and higher in T20 and T45 transects across plots (Table 1). Similarly, leaf litter depth generally increased with distance away from roadsides, as mean depth increased from a low of 2.3 cm in T(-2) transects, to 9.9 cm in T2 transects, and to 21.6 cm in T45 transects across plots (Table 1).

DISCUSSION

Microstegium vimineum was found in every study plot, suggesting that it was widespread at Grassy Hill at the time of the study. This is not surprising given that forest structure and topography, and human activities that facilitate *Microstegium* recruitment, did not differ greatly between plots before or during this study (Greg Turner, personal observations). Though widely distributed, *Microstegium* was largely restricted to T(-2) transects, which is important from a management perspective at this preserve, since other regional studies report its presence in less disturbed forest interior habitats. These studies report that *Microstegium* prefers to grow along roadsides and

TABLE 1: Mean canopy cover (%) and leaf litter depth (cm) measured across road transects. The numbers -2, 2, 10, 20, and 45 represent transect distances (m) from forest edges.

Variable \ Transect	-2	2	10	20	45
Mean canopy cover (%)	82.2	91.0	94.6	98.0	98.4
Mean leaf litter depth (cm)	2.3	9.9	9.1	10.4	21.6

in semi-open habitats, but does grow in closed-canopy interiors (Redman 1995, Huebner 2003, Cole and Weltzin 2004), likely due to shade tolerance (Leicht et al. 2005, DeMeester and Richter 2010). Which leads to the question of why *Microstegium* was absent from plot interiors in my study.

While *Microstegium* grows under high shade (Miller and Matlack 2010), it is light sensitive (Glasgow and Matlack 2007), so much so that germination and seedling growth by the species are negatively correlated with shade (Schramm and Ehrenfeld 2010). Thus, relegation of *Microstegium* to T(-2) transects, where canopy cover was lowest, was not surprising. However, I did expect to find *Microstegium* in some interior transects, given its shade tolerance and past accounts of it growing in interior habitats at Grassy Hill (Greg Turner, personal observations), but I did not. Thus, the high canopy cover conditions that I measured in interior transects may have had some influence on the *Microstegium* distributions I found. Likewise, leaf litter may have been influential, as it has been reported to inhibit *Microstegium* seedling growth, survival, and recruitment in other regional forests (Oswalt and Oswalt 2007, Miller and Matlack 2010). Since litter depth generally increased away from roadsides, due to uniform canopy cover and lack of ground disturbances from humans, large animals, or wind, it is reasonable to infer that it too may have had some influence on the *Microstegium* distributions I found.

Distributions may also have been affected by seed dispersal, which is facilitated by animal and human activities, and by water (Barden 1987, Oswalt and Oswalt 2007). Given the abrupt falloff of *Microstegium* beyond roadsides, seed dispersal may have been lower in forest interiors than along roadsides. Lack of animal dispersal is unlikely, given that granivores common at Grassy Hill (e.g. birds and mice) move in both edge and interior habitats. Similarly, human activities, such as vehicles carrying seed on tires or roadwork that disturbs soil and ground cover (Schmidt 1989, Tyser and Worley 1992), were relegated to roadsides before and during study time. A more likely influential dispersal mode was water, given that no streams or erosion scours were found in any interior transect in any plot, while scours were seen in most T(-2) transects. Thus, *Microstegium* absence from interior transects may reflect a lack of water borne seed dispersion in them. At this point, it is important to note that any assertions made about any factor that may have influenced *Microstegium* distributions and abundances were only speculative, given that the absence of *Microstegium* beyond most all T(2) transects negated statistical testing. Further, it is also likely that unknown factors, or interactions among factors, influenced *Microstegium* distributions and abundances.

In conclusion, *Microstegium* was restricted to roadsides at Grassy Hill at the time of the study. Given its high invasive potential, its absence from interiors was welcome news. However, periodic new surveys of *Microstegium* along preserve roads are suggested, as well as are studies examining potentially causative factors for *Microstegium* distributions and abundance. Meanwhile, efforts to maintain intact canopies and minimize leaf litter disruption in forest habitats fragmented by roads might be considered as a potentially pragmatic way to restrict *Microstegium* from forest interiors at the preserve.

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