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Alternative Mowing Regimes' Influence on Native Plants and Deer.

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Alternative Mowing Regimes' Influence on Native Plants and Deer

SS228 Final Project Report

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16. Abstract
This study evaluated mowing regimes, changes in native and non-native plant communities, deer presence in the research plots, and public perception of various management practices on ROWs. No significant difference was found in the height of vegetation 3 weeks after each mowing between research plots mowed 4 times per year and plots mowed only once per year in uplands or lowlands. Native plants increased in plots mowed once per year and deer preferred the frequently mowed plots where clovers and vetches had been seeded. Increasing the carrying capacity of the lowlands with more extensive plantings of clover and vetch may attract deer, thus encouraging them to browse and use the underpasses beneath bridges and making the ROWs safer. The public survey found strong support for wildflowers on ROWs and a distaste for litter. Further, respondents would tolerate a less manicured ROW if it saved money, made the roads safer, and hid litter. The study suggests that ROWs

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Executive Summary (SS228)

Because highway, bridge, and right-of-way construction and maintenance costs continue to escalate and traditional highway management practices fragment natural ecosystems, facilitate highways' function as corridors for the spread of invasive non-native species, and inadvertently attract white-tailed deer, a new paradigm is needed. Reduced mowing may encourage the return of a natural ecosystem replete with native plants including grasses and wildflowers and possibly discourage white-tailed deer while saving taxpayers' money or enabling the diversion of funds to other highway projects. However, public complaints of weedier roadsides is a significant factor in the frequency of mowing, so a survey was undertaken to gain a better understanding of their willingness to accept a weedier right of way (ROW) if it saved funds, resulted in wildflowers making the highways more attractive, hid litter, and made the roadsides safer by reducing deer presence.

Numerous studies have suggested management practices could be modified to restore and enhance a more naturalized ROW. Native seed banks on ROWs and adjacent properties have been found useful in restoring natural ROWs. Mississippi's natural history includes native grasses and wildflowers that are not palatable to white-tailed deer. If allowed to propagate and grow on ROWs, these plants could become a point of pride for the Mississippi Department of Transportation (MDOT) and make the roadways safer.

This study was designed to evaluate the effect, if any, of two reduced mowing regimes on changes in plant communities, including variations in native and non-native species richness and percent coverage, with research plots in both uplands and lowlands. Native vegetation was provided the opportunity to set seed in late fall in one set of these plots and supplemental wildflower and native grass seeding was included in the second, thus increasing their abundance on the ROW. That the supplemental seeded plots were not successful during the short duration of the study was likely due to sowing without land preparation (the least costly approach). A second component evaluated deer presence in the various treatments, the concern being that with only one mowing per year the higher grasses may provide cover for deer too close to the highway. The third component was a public perception survey aimed at determining if the public would tolerate a less manicured ROW until its attractiveness and increased safety could garner favor.

The study area, Highway 25 in northeast Mississippi, represented a typical highway that was recently converted from two lanes to four lanes using standard construction practices. Roadside ROWs are typically mowed 4 or more times per year and agronomic grasses are used for soil stabilization. Highway 25 passes through typical environments including agricultural fields, pastures, fallow fields, mixed forests, pine plantations, and a national wildlife refuge. Several bridges over streams, in the lowland research plots, have the potential to serve as corridors under the highway for the safe passage of wildlife, including white-tailed deer.

A research plot, divided into 3 treatment subplots, was established at each of 10 locations. The treatments were as follows: 1) the control group, mowed ≤4 times per year (mowed); 2) one mowing during fall months (reduced mowed); and 3) one mowing during fall months with supplemental wildflower seeding (reduced mowed–seeded). The 30 subplots were monitored to estimate plant community metrics that included percent coverage, percent coverage of plants in different height categories, species richness, stem density of woody plants, and deer presence.

No significant difference was found in the height of vegetation 3 weeks after each mowing between control plots that were mowed 4 times per year and plots mowed only once in respective uplands or lowlands near bridges. Native plants increased in plots mowed only once per year. Deer preferred the frequently mowed plots where clovers and vetches had been seeded, a standard practice by MDOT. The greatest numbers of deer were observed in the lowland plots along streams. Increasing the carrying capacity of the lowlands with more extensive plantings of clover and vetch may attract deer away from the uplands and encourage them to browse in the lowlands and use the area beneath bridges to cross the highways, thus making the ROWs safer.

The public perception survey found strong support for wildflowers on ROWs and a distaste for litter. Further, respondents indicated they would tolerate a less manicured ROW if it saved money, made the roads safer, and/or hid litter. However, from the survey it also appeared that a public education program would be critical to bolster the public's understanding of the management strategies being implemented.

Overall the study suggested that ROWs would be less costly to maintain, safer, and more attractive to motorists if mowing were reduced to once per year in late fall after seed set. However, the concurrent implementation of a comprehensive education program would be essential.

The cost savings from a reduced mowing regimen could be substantial. Mississippi mows approximately 139,253 acres of roadsides four times per year at a cost per acre of greater than $250, or a total annual cost of around $35 million. Reducing mowing of ROWs to once per year is unrealistic for numerous reasons including visibility and the safety of motorists who have flat tires, vehicle fires, or other problems. However, the reduction of an equivalent mowing of once per year could save approximately $8.7 million; eliminating two mowings could save over $17 million.

Reduced mowing is a first logical step to decreasing the fragmentation of Mississippi's ecosystem and restoring the ROW to an ecologically sound, sustainable, and attractive landscape. A phased implementation involving the reduction of mowing areas distant from the ROW in wetlands adjacent to creeks and streams, and small plots along the highways would be a gradual and prudent way to implement the program. Regrowth of woody vegetation would serve as an appropriate metric to gauge when mowing is necessary. Of critical importance is keeping the public informed with a comprehensive education program and making sure wildflowers and native grasses in the small plots adjacent to the ROW thrive.

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Introduction and Literature Review

Roadside right-of-ways (ROWs) are areas adjacent to roadways. Many states, such as Texas and North Carolina, have well-established wildflower programs along their highways and other roads. These beautiful vistas actually tend to increase tourism and visitor satisfaction in these states. Guyton and Jones (2009) proposed that native wildflowers would colonize naturally along Mississippi's roadsides if the frequency of mowing and herbicide applications were modified. Encouragement of native wildflowers and grasses along roadways could also benefit pollinators including butterflies, other insects, birds, and small mammals while proving unpalatable to white-tailed deer. The resulting reduction in deer numbers along roadsides has great potential to make them safer.

Plant communities of ROWs can be very diverse depending on the type of road, the width and slope, and adjacent land uses (Li et al. 2008). Both native and introduced (non-native) plant species typically occur in ROWs, and these plant communities can enhance beauty and vegetation communities for pollinating insects, small mammals, selected reptiles and amphibians, and grassland birds if roadsides are managed to encourage native wildflowers and grasses (Telfair 1999; U.S. Department of Transportation–Federal Highway Administration 2004). Historically, ROWs have been managed to reduce the height of vegetation and to increase drivers' visibility. However, ROWs managed intensively to reduce competing vegetation through frequent mowing, herbicide application, and soil disturbance often create negative environmental impacts and require increasing operations and maintenance budgets (Hunter 1990; Hunter and Schmiegelow 2010).

By the 1950s, state highway agencies no longer had adequate budgets for maintenance of manicured ROWs, so better and more cost-effective ecological approaches to maintenance of ROW vegetation were needed. The 1965 Highway Beautification Act, catalyzed by the activities of Lady Bird Johnson, expanded perceptions that roadsides could provide for pleasing visual and aesthetic quality (U.S. Department of Transportation–Federal Highway Administration 2011).

In the 1970s, increases in the cost of fuels caused highway administrators to again seek alternatives that could potentially reduce costs of roadside maintenance. By the early 1990s, the Federal Highway Administration (FHWA) had recognized a nationwide trend toward an ecological approach in roadside maintenance. The FHWA also worked with other organizations to incorporate the use of native plants along roadsides. By 1994, the FHWA had produced an executive memorandum on landscaping signed by President William J. Clinton that recommended the use of native plants along roadsides (Harper-Lore 1996).

In recent decades, highway roadside beautification and wildflower management programs in the southeastern United States have become common due to many reported benefits (U.S. Department of Transportation–Federal Highway Administration 2011). One recognized benefit of native plant enhancement along ROWs has been slowing the spread of invasive non-native plants. In 1999, Executive Order 13112 defined and reported negative impacts of non-native invasive plant species. Documentation associated with this order reported that >42% of native species were threatened and endangered by exacerbated spread of invasive species along roads and associated ROWs (Center for Environmental Excellence

2008). Roadside maintenance often contributes to the spread of non-native species, and establishment of non-native plants results in costs to private landowners and public agencies (Forman and Alexander 1998; Forman et al. 2003; Huijser and Clevenger 2006; Simberloff et al. 2012). In studies conducted in the U.S., researchers have reported that well-established native plant communities exhibited a resistance to non-native plant colonization and reduced expenditures for invasive species control (Daar 1994; Bugg et al. 1997; Green and Welker 2003; Young and Claassen 2007; CalTrans 2013).

Other benefits of native plants on ROWs may include reduction in erosion, protection of water quality, and the enhancement of roadside aesthetics, wildlife, and plant communities. Roadside plantings of native wildflowers, grasses, and shrubs help control erosion and promote cost-effective vegetation maintenance (Transportation Research Board 2005). For example, drought-tolerant native plants provide erosion control through deep root systems that develop in the absence of soil amendment and irrigation (CalTrans 2013). Diverse native plant communities that include wildflowers and native prairie grasses can have positive impacts due to beautification of ROWs. Enhancement of aesthetic quality and beauty along ROWs has been reported to reduce stress levels in motorists (Forman and Alexander 1998; Cackowski and Nasar 2003). Proactive management that features roadside beautification through establishment of native plant communities can provide motorists with safe travel experiences, increase in life quality, and enhancement of public perception of the environment and management agencies (Arner and Jones 2009).

In many states, the presence of native plant communities on ROWs has been recognized to improve certain wildlife species habitat value. The Louisiana Department of Transportation and Development (2000) recognized the presence of native vegetation along highway ROWs as a positive value for wildlife. Trees, shrubs, and herbaceous plants in ROWs often mitigated some negative impacts of highway systems through increasing soil stabilization, providing wildlife habitat for certain species, creating noise and visibility buffers, and moderating temperature and air quality extremes (CalTrans 2013). Furthermore, preservation of existing vegetation under bridges can be very beneficial for many wildlife species, plant communities, and people (Gonser and Horn 2007). Presence of high quality vegetation cover in riparian areas of ROWs often promotes safe passage of animals under bridges associated with streams and deters their use of roadways (McKee and Cochran 2012). This approach can be especially important in deer-vehicle collisions (Gonser and Horn 2007).

Because large mammals such as white-tailed deer (*Odocoileus virginianus*) are often involved in wildlife-vehicle collisions, managers must prioritize safety and maintenance of visibility on ROWs (McKee and Cochran 2012). In Mississippi, wildlife-vehicle collisions have continued to be a safety concern. In 2008, Mississippi's transportation officials reported over 3,000 vehicle-deer collisions (Mississippi Department of Wildlife, Fisheries, and Parks Deer Committee 2010). Similar trends have been reported for the U.S. with deer-vehicle collisions being estimated at 720,000 to 1.5 million incidents annually (Conover et al. 1995). Factors that have been cited for increases in deer-vehicle collisions in the southeastern United States include locating roadways in habitats with dense deer populations; increases in the number of roadways; increased traffic intensity; and ROW management that promotes the growth of highly palatable forage plants, such as seeding of annual plants, frequent mowing, and fertilization (Harper-Lore and Wilson 2000; Arner and Jones 2009). Because large herbivores such as white-tailed deer pose threats to vehicles, ROW management should entail establishment of plants that do not attract deer (Michael and Kosten 1981). Many native grasses and forbs are not highly palatable deer food plants, especially compared to frequently eaten non-native legumes such as clovers (*Trifolium* spp.), lespedezas (*Lespedeza* spp.), and vetches (*Vicia* and *Securigera* spp.; Arner and Jones 2009). Native wildflowers of low palatability to deer that may occur or be established along highways include species in the genera of black-eyed Susans (*Rudbeckia*), sunflowers (*Helianthus*), rosinweeds (*Silphium*), blazing stars (*Liatris*), and milkweeds (*Asclepias*; Miller and Miller 1999).

Although concern exists over attraction of large mammals to ROWs, native plant coverage can create vegetation communities for many other wildlife species including small mammals, birds, reptiles, amphibians, and insects (Forman and Alexander 1998; Huijser and Clevenger 2006). Rare forbs, legumes, native prairie grasses, pollinating insects, and grassland birds are among the species that can benefit in early successional plant communities of ROWs (Arner and Jones 2009). With proper management, roadside vegetation can provide a diversity of plant foods and nesting cover for many native birds and small mammals (Louisiana Department of Transportation and Development 2000). Ecotones at ROW-woodland interfaces are preferred by many wildlife species, and these areas of ROWs can serve as linear reservations for native fauna and flora and dispersal corridors for many species of wildlife (Forman and Alexander 1998; Forman et al. 2003).

Many grassland birds and insects that utilize native plants are typically aesthetically pleasing and pose limited threats to motorists during vehicle collisions (Michael and Kosten 1981). In general, seed, pollen, nectar, and forage production by wildflowers and native grasses provides important foods for native birds and small mammals (Anderson 1996). Pollen and nectar production of wildflowers attracts a diversity of insects that serve as high protein foods for eastern wild turkeys (*Meleagris gallopavo*), northern bobwhite quails (*Colinus virginianus*), and nongame birds such as indigo buntings (*Passerina cyanea*) and eastern meadowlarks (*Sturnella magna*; Hurst 1972; Anderson 1996; Yarrow and Yarrow 1999. Most native wildflowers and native grasses are also preferred food and larval host plants of many butterflies and moths (Dole et al. 2004). Wildlife food plants that can be expected to grow naturally in ROWs may include sunflowers (*Helianthus*), daisies (*Erigeron*), asters (Asteraceae), partridge peas (*Chamaecrista*), lespedezas (*Lespedeza*), coreopsis (*Coreopsis*), blazing stars (*Liatris*), mints (Lamiaceae), milkweeds (*Asclepias*), and many native grasses (Poaceae) and sedges (Cyperaceae; Miller and Miller 1999; Dickson and Wigley 2001).

Although roadsides can attract wildlife and support diverse native flora and fauna, roads and ROWs are often associated with plant community fragmentation, barriers to movement and dispersal, and increased wildlife mortality. However, reduced wildlife mortality has been achieved by allowing woody plants to develop in areas that are not important for visibility and safety along ROWs. Numerous studies have reported that shrub and tree plantings along ROWs may support greater wildlife diversity and result in a 35% reduction of wildlife mortality (Machan 1981; Zimmerman 1981). Traffic-related mortality in animals may be related to traffic intensity and impacted by vegetation communities' proximity to roadways (Jacobson 2005; Arner and Jones 2009). Jacobson (2005) reported that barn owls (*Tyto alba*), great horned owls (*Bubo virginianus*), and short-eared owls (*Asio flammeus*) often forage near roads and are common victims of vehicle collisions.

Vegetation along roadsides can have both positive and negative effects depending on localized conditions, traffic density, and management agency requirements. Vegetation on roadside ROWs is an important aspect of limiting the negative impacts of road construction and maintenance by absorbing sound and reducing visual impacts to adjacent lands (Forman and Alexander 1998; Forman et al. 2003; Huijser and Clevenger 2006). Visibility along roadways, public perception of ROWs, and loss of native plant coverage are concerns reported by Louisiana Department of Transportation and Development (2000). Young and Claassen (2007) stated that the dense non-native plant coverage on ROWs generates several undesirable characteristics, including fire hazard, mowing and herbicide requirements, and exclusion of native plants. Although benefits have been reported for native plant enhancement along roadways, the conversion to native plant species can be challenging due to the high cost of seeding and competition from established non-native invasive plant communities (Bugg et al. 1997). Because of the numerous benefits, many road management agencies seek to establish and manage for native plant cover along ROWs through planting of native wildflowers and grasses. Primary management components needed for successful planting of native plants along roadsides include site preparation, plant selection, and control of vegetative competition. Initial costs of establishment can exceed $250 per acre, but lower maintenance and replanting costs can result in long-term savings (Young and Claassen 2007). Therefore, long-term economic benefits of native plant communities can produce savings in terms of erosion control and vegetation maintenance costs.

One consideration prior to planting native plants on ROWs is implementation of management strategies that allow for enhancement of these communities. Alternative management strategies that allow existing native plants to colonize and become established on ROWs can be more cost effective than plantings. In Mississippi, many native legumes, grasses, and wildflowers will colonize naturally if mowing and herbicide practices are modified along ROWs. If native plants exist along the ROWs, then purchase and establishment is not generally necessary due to existing sources of seed and propagules in the soil seed bank. Seeds of many native wildflowers and grasses in adjacent vegetation communities are transported by wind or animals, and may colonize ROWs over time. If herbicide application and mowing are modified or curtailed on ROWs, wildflowers may become established within one to two growing seasons through propagules dispersed by wind, water, and wildlife (Arner and Jones 2009).

To sustain native wildflowers and native grasses on ROWs, mowing and herbicide application frequencies are often reduced (Telfair 1999; U.S. Department of Transportation–Federal Highway Administration 2004; Arner and Jones 2009). Modifications in vegetation management that include less intensive management can often result in budgetary savings due to reduced mowing and invasive plant control (Young and Claassen 2007). In Mississippi, roadway managers are responsible for maintenance of approximately 14,617 miles of highways and mowing of over 139,253 acres annually. From 2009 to 2013, MDOT's annual cost for mowing ROWs averaged more than $250 per acre (D. Thompson, Mississippi Department of Transportation, personal communication). As the cost of mowing ROWs has increased, many states have implemented native plant enhancement on ROWs (Louisiana Department of Transportation and Development 2000). Texas Department of Transportation (2013) estimated an annual mowing cost savings of $20 million–$30 million as the result of wildflower program establishment. As mowing was reduced in Texas, the following impacts were reported: native flora and fauna communities thrived, biodiversity increased, erosion was reduced, aesthetics were enhanced and tourism increased, partnerships with natural resource agencies and volunteer groups were strengthened, noxious non-native weeds were suppressed, and the commitment by managers and the public to preserve and perpetuate native flora was strengthened (Markwardt 2005).

Rotational mowing can be used to maintain communities in various stages of growth and vegetation diversity, whereas annual mowing once in late fall may be beneficial to promote maturation and germination of seeds and attract pollinating insects along ROWs (USDA and NRCS Wildlife Habitat Management Institute 1999). With reduced mowing, woody plant colonization may occur on ROWs, and these plants can be controlled through selective herbicide application (Arner and Jones 2009).

Over 10 million acres of land are maintained in ROWs in the United States. This degree of roadway development and increased urbanization has resulted in degradation and loss of plant communities for native flora and fauna. Due to budgetary, aesthetic, environmental quality, and wildlife conservation issues, modifications in ROW management that reduce negative impacts of roads and associated ROWs are needed (Harper-Lore and Wilson 2000; Ament et al. 2008). In addition, in many southern states ROWs can contain remnants of rare ecosystems such as native prairies, sand hill communities, wetlands, and pitcher plant savannas. Therefore, roadsides may provide areas for populations of rare flora and fauna.

Modifications in ROW management, including mowing and herbicide applications, could reduce maintenance cost, improve safety for motorists, reduce the spread of invasive plants, and beautify the ROWs. This two-year study was conducted to gain a better understanding of plant community response to different mowing treatments, deer presence along roadsides, and public perception of a more natural roadside. The study was conducted along Highway 25 in Oktibbeha and Winston counties, Mississippi, from 2010 to 2012. Objectives of this research were to: 1) compare differences in percent coverage and species richness of native and non-native plants in areas that received two different mowing treatments and one reduced mowed–seeded treatment in upland and lowland elevations within the ROW; 2) estimate and compare differences in percent coverage of vegetation in three height categories and woody plant stem densities in two mowing treatments and one reduced mowed–seeded treatment in upland and lowland elevations within the ROW; 3) estimate white-tailed deer use of ROWs using spotlight counts along ROWs; and 4) report results of a public perception survey concerning vegetation management, appearance, and wildlife occurrence on ROWs.

Anticipated Benefits of the Study

This research provided an improved understanding of plant community changes resulting from different mowing regimes. We anticipate the findings of this research could lead to 1) the beautification of Mississippi's ROWs by encouraging native wildflowers and grasses, 2) a reduction in litter, and 3) a significant reduction in mowing costs.

The study suggested a ROW with concentrations of native plants could discourage the spread of invasive plants and reduce the fragmentation of natural ecosystems. Spotlight counts confirmed the locations and seasonal peaks of deer on the ROW. Vegetation surveys determined deer were making use of known deer foods that included planted clover and vetches. The greatest concentrations of deer were observed in the lowlands, suggesting deer could be further encouraged to use bridges as underpasses. Additional plantings to increase the lowlands' carrying capacity for deer may improve the safety of highways by reduced vehicle-deer collisions.

The public use survey suggested a well-informed populace would support a reduced mowing regime and taller vegetation if it saved money, looked attractive, hid litter, and/or made the roadways safer.

Study Area, Field Methods, and Statistical Analyses

Study Area

This study was designed to evaluate vegetation community responses to alternative ROW management practices from the intersection of highways 12 and 25 in Oktibbeha County south into Winston County in northeast Mississippi (Figure 1). Research plots were located within the Interior Flatwoods (33°12’N, 88°54’W; Township 15-18N, Range 13-14E). Mississippi Highway 25 is a four-lane state highway that transects diverse land including agricultural fields, pastures, fallow fields, mixed forests, and pine plantations. The ROW was crossed by third- to fourth-order streams that characterized lowland elevations. Upland areas of the ROW exhibited well-drained soils.

The study area is categorized as a humid subtropical climatic region of North America. Winter temperatures typically range from 32–59° F and summer temperatures range from 70–100° F, with annual temperatures averaging about 62° F (Posner 2012). Precipitation rates range from 50–65 in. per year (Mississippi State University Department of Geosciences 2010).

Roadside ROW management consisted of multiple mowings per growing season (≤4 times per year) and herbicide use including Imazapyr (non-selective herbicide), Tryclopyr (foliar herbicide), and Roundup (broad-spectrum herbicide) for control of invasive non-native plant species, including Johnsongrass (*Sorghum halepense*), kudzu (*Pueraria montana* var. *lobata*), cogongrass (*Imperata cylindrica*), and encroaching woody vegetation (D. Thompson, personal communication). Primary vegetation cover on the ROW was comprised of non-native grasses including Bermudagrass (*Cynodon dactylon*), tall fescue (*Schedonorus phoenix*), and Vasey’s grass (*Paspalum urvillei*).

Field Methods

Study Design and Plot Establishment

In April 2010, five upland and five lowland plots were established through stratified random selection based on lowland and upland topography along the highway. The plots, approximately 100 ft. x 100 ft., were divided into three equal subplots (Figure 2). Exact sizes of plots and subplots varied depending on landscape and roadway characteristics. Distance between each of the 10 plots along the Highway 25 corridor ranged from 0.5 mi to 2 mi (Figure 1).

We used a randomized complete block design (Li et al. 2008) by dividing each plot into three equal subplots and assigned one of three treatments randomly to each subplot: 1) annual mowing during November, 2) annual mowing during November and seeding with wildflower seeds, and 3) the control, mowing ≤4 times annually in May, July, September, and November. In seeded subplots, one mowing was conducted during late November to reduce vegetation height prior to planting. Seeds of wildflowers were sown by hand or hand-operated seeder over existing mowed vegetation during March 2011. Native seed mixtures purchased for the seeded subplots were applied at the following rates: black-eyed Susan (*Rudbeckia hirta*) at 1.5 lb. per acre, dense blazing star (*Liatris spicata*) at 8.5 lb. per acre, and lanceleaf tickseed

(*Coreopsis lanceolata*) at 8.5 lb. per acre. Seeds were obtained commercially from Native American Seed Company and the rates used were recommended by this company. Additional seeds of dense blazing star were collected during March 2011 in Oktibbeha and Winston counties and planted in the seeded subplots.

Transect Establishment

Line intercept transects measuring100 ft. in length were established in each subplot for estimation of plant community characteristics: percent coverage of woody and herbaceous plants, species richness, percent coverage in height categories of woody and herbaceous plants, and stem densities (stems/acre) of woody plants. Transect lines were established in the middle of each of the 30 subplots to avoid edge effects (Table 1, Figure 2). Line transect beginning and ending points were located at least three feet from the subplot edge to avoid potential edge effects on plant community interactions. One belt transect measuring 1.5 ft. x 100 ft. was established adjacent to each line transect to estimate stem densities of woody plants (stems per acre; Hays et al. 1981; Buckland et al. 2007). Initiation and end points of each line transect were recorded using a Garmin E-Trex HCx Vista GPS unit and overlaid into ArcMap.

Vegetation Surveys

Vegetation surveys were conducted during summer and fall months (July–September) and spring months (April–early June) from 2010 to 2012. Transects within each subplot were surveyed to estimate plant species richness, percent coverage of vegetation in three height categories, percent coverage of woody and herbaceous plants, and woody stem densities. One transect line per subplot was sampled during each season, which yielded 30 subplot transects per survey period. Along line transects, species richness of native and non-native plants and percent coverage of plants occurring in three height categories (<18 in., 18–36 in., and >36 in.) were recorded (Hays et al. 1981; Buckland et al. 2007). Plants were identified to species and percent coverage of native and non-native plants was recorded for forbs, grasses, legumes, sedges, rushes, and woody plants (i.e., trees, shrubs, and vines; Hays et al. 1981; Buckland et al. 2007).

Plant species were identified using over 20 taxonomic references including Radford et al. (1968), Hitchcock and Chase (1971), Godfrey and Wooten (1979, 1981), Miller and Miller (1999), Miller (2003), Timme (2007), and USDA and NRCS (2013). Difficult identifications were verified by Dr. Victor Maddox, plant taxonomist at Mississippi State University.

Spotlight Surveys for Wildlife

Wildlife spotlight surveys were conducted from January 2011 to January 2012 for white-tailed deer. Observations of other wildlife species were noted and recorded as incidental sightings. Spotlight surveys were conducted from dusk until approximately 3 hours after dark, 1–3 times per month (>10 times per season) along the 30-mile Highway 25 ROW. Permits to conduct spotlight counts were obtained by Dr. John Guyton from Chad M. Dacus, Deer Program Coordinator for Mississippi Department of Wildlife, Fisheries, and Parks.

Statistical Analyses

Null hypotheses were tested at $\alpha \leq 0.05$ using multiple approaches as follows.

H_1: *There will be no significant differences in total species richness, native species richness, and non-native species richness among treatments.*

Response variables for H_1 were species richness of native and non-native plants. The independent variables were the control (mowed ≤4 times per year), treatment 1 (reduced-mowed: mowed once in November), treatment 2 (reduced mowed–seeded: mowed once in November with supplemental native wildflower seeding), season (spring vs. fall), elevation (upland vs. lowland), and year.

Statistical analyses included mixed models, univariate repeated measures analysis of variance (PROC MIXED) in SAS. Multiple measurements of plant metrics over time was incorporated by surveying the same plots each season. Interactions of treatment, elevation, and year (fixed effects) and random effects of elevation with year as the repeated measure were investigated. Akaike's Information Criterion corrected to compare auto-regressive, compound symmetry, and unstructured covariance structures for each response variable under the restricted maximum likelihood for comparisons of species richness was used for model selection. The best top model structures according to the lowest ΔAIC*c* values were selected. After the AIC*c* tests, pairwise comparisons of Fisher's Least Significant Difference (LSD) were used to compare significant effects of each variable.

H_2: *There will be no significant differences in percent coverage vegetation categorized according to growth form and native/non-native status among treatments.*

Response variables for H_2 were percent coverage of native and non-native plants according to growth form. The independent variables were the control (mowed ≤4 times per year), treatment 1 (reduced-mowed: mowed once in November), treatment 2 (reduced mowed–seeded: mowed once in November with supplemental native wildflower seeding), season (spring vs. fall), elevation (upland vs. lowland), and year.

Statistical analyses utilized analysis of variance with distance matrices (ADONIS) in Program R's vegan package. Analysis of variance included distance matrices by partitions and distance matrices among sources of variation while fitting linear models to distance matrices using permutation test with pseudo-F ratios. The permutation test analyzed the randomized data to get replicates. Biplot Sord, Scree Plots (Broken-stick), Eigenvectors and Eigenvalues loadings and Princomp Correlation Matrix within Principle Component Analysis were used to investigate interactions of treatment, elevation, and year (fixed effects) and random effects by elevation. When a significant interaction was detected, Wilcoxon Signed-Rank Test for pairwise comparisons with elevation as a blocking variable was used to determine which growth forms differed. The Wilcoxon Signed-Rank Test was used for comparison of more than 2 groups because of the lack of treatment effects.

H_3: *There will be no significant differences in percent coverage of vertical height at <18 inches, 18 inches to 36 inches, and >36 inches of herbaceous and woody vegetation among treatments.*

Response variables for H_3 were percent coverage of various heights of herbaceous and woody vegetation. Over the 2010–2012 study period, independent variables were the control (mowed ≤4 times per year), treatment 1 (reduced-mowed: mowed once in November), treatment 2 (reduced mowed–seeded: mowed once in November with supplemental native wildflower seeding), season (spring vs. fall), and elevation (upland vs. lowland).

Statistical analyses used included mixed models, univariate repeated measures analysis of variance (PROC MIXED) in SAS. Multiple measurements of plant metrics over time was incorporated by surveying the same plots each season. The interactions of treatment, elevation, and year (fixed effects) and the random effects of elevation with year as the repeated measure were investigated. Model selection Akaike's Information Criterion corrected was used to compare auto-regressive, compound symmetry, and unstructured covariance structures for each response variable under the restricted maximum likelihood for comparisons of percent coverage of height variables. The best top model structures were selected according to the lowest ΔAIC*c* values. After the AIC*c* tests, pairwise comparisons of Fisher's Least Significant Difference (LSD) were used to compare significant means for each variable.

H_4: *There will be no significant differences in stem densities of woody plants within vine, shrub, and tree growth forms among treatments.*

Response variables for H_4 were woody plant (vine, shrub, and tree) stem densities (stems/acre) of native vs. non-native species. Over the 2010–2012 study period, independent variables were the control (mowed ≤4 times per year), treatment 1 (reduced-mowed: mowed once in November), treatment 2 (reduced mowed–seeded: mowed once in November with supplemental native wildflower seeding), season (spring vs. fall), and elevation (upland vs. lowland).

Statistical analyses used included mixed models, univariate repeated measures analysis of variance (PROC MIXED) in SAS. Multiple measurements of plant metrics over time was incorporated by surveying the same plot each season. Interactions of treatment, elevation, and year (fixed effects) and the random effects of elevation with year as the repeated measure were investigated. Akaike's Information Criterion corrected to compare auto-regressive, compound symmetry, and unstructured covariance structures was used for each response variable comparison of woody stem densities for model selection. The best top model structures according to the lowest ΔAIC*c* values were selected. After the AIC*c* tests, pairwise comparisons of Fisher's Least Significant Difference were used to compare the significant means for each variable.

Normality and homogeneous variance assumptions for woody stem densities were tested using IBM SPSS Statistics v.20 software. Kolmogorov-Smirnov Z-test and Lilliefors Significance Correction were used to test the upper and lower bounds. Shapiro-Wilk goodness-of-fit test and kurtosis and skewedness were also used to test for normality (Royston 1992). After square root and $\log_{10}$ transformations of percent coverage within growth forms, species richness, percent coverage of three different height categories, and woody stem density, it was discovered that not all the data would transform into normally distributed data. Then, all data was treated as non-normal distributions and nonparametric analysis methods were used rather than the normal parametric analyses. The analyzed data were grouped by season (fall vs. spring) in the expectation of a difference due to growing seasons and ecological differences among vegetation, species richness, and species occurrences during certain seasons. Differences between comparisons of data were considered significant at $P \leq 0.05$.

Vegetation Studies of Roadside Right-of-Ways

Introduction and Objectives

The central focus of this study was to evaluate plant community response to three different mowing regimes over a two-year period on the Highway 25 ROW. Plant community response was evaluated within three treatments: 1) ≤4 mowings per year, 2) one mowing during fall, and 3) one mowing during fall with supplemental seeding of wildflowers. Specific objectives were to survey and compare:

1) plant species richness between treatments, elevations, seasons, and years;
2) ground cover characteristics between treatments, elevations, seasons, and years;
3) percent coverage of vegetation in three height categories in treatments, elevations, seasons, and years;
4) stem densities of woody plants in treatments, elevations, seasons, and years.

Results

Species Richness

During the study, 277 plant species were identified. Of the total plant species detected, 76% (211 species) were native, 21% (57 species) were non-native, and 3% (9 plants) were identified to genus only, so their native v. non-native status was undetermined. In lowlands, approximately two-thirds (64%) of the observed plant species were native, whereas less than half (44%) of the species in uplands were native. The native plants included 111 forbs, 21 grasses, 4 legumes, 8 rushes, 15 sedges, 7 shrubs, 24 trees, and 21 vines. Non-native plants included 23 forbs, 18 grasses, 12 legumes, 1 sedge, and 3 vines (Table 2).

During fall survey periods, 10 native species and 20 non-native species in uplands, and 92 native species and 45 non-native species in lowlands were detected during the two-year study. During spring survey periods, 30 native species and 45 non-native species in uplands, and 106 native species and 68 non-native species in lowlands were counted (Table 3).

Within lowland plots of the three different treatments, total plant species richness during fall seasons ranged from 33 to 88 species in mowed treatments, 34 to 84 species in reduced mowed treatments, and 34 to 92 species in reduced mowed–seeded treatments (Table 3). In lowland plots during spring periods, species richness counts ranged from 48 to 106 species in mowed treatments, 52 to 90 species in reduced mowed treatments, and 54 to 102 species in reduced mowed–seeded treatments. In upland plots during fall surveys, 18 to 43 species in mowed treatments, 10 to 37 species in reduced mowed treatments, and 22 to 36 species in reduced mowed–seeded treatments were recorded. In upland plots during spring surveys, total species richness ranged from 34 to 52 species in mowed treatments, 41 to 53 species in reduced mowed treatments, and 30 to 56 species in reduced mowed–seeded treatments (Table 3).

In lowland subplots, the mean plant species richness was calculated at 22.13 ± 1.13 species during fall sampling seasons and 29.67 ± 1.11 species during spring sampling seasons.

Of the plant species detected in lowlands, 64% were native species and 36% were non-native species. In upland subplots an average of 10.87 ± 1.13 plant species during fall and 17.50 ± 1.11 during spring were detected (Table 4). Upland plant communities were comprised of 44% native and 56% non-native species.

Greatest plant species richness was recorded in lowland plots with over 106 species and an average of 82.33 ± 4.96 species being recorded over all lowland plots during the study period. For spring and fall survey periods, mean species richness of native plants in lowland plots was about three times that of upland plots. Mean species richness of non-native plants averaged 5.97 ± 0.40 species in upland plots and 7.57 ± 0.40 species in lowland plots (Table 4). Total species richness, native species richness, and non-native species richness means were significantly greater ($P < 0.01$) in the lowlands during fall and spring seasons.

Differences were detected in species richness among years, seasons, and elevations during fall. Total and native species richness of plants differed between year ($F_{1, 96} > 13.43$, $P \leq 0.001$) and elevation ($F_{1, 96} > 59.31$, $P \leq 0.001$) during fall seasons of the study. Non-native species richness differed among years ($F_{1, 96} = 25.84$, $P \leq 0.001$) and elevations ($F_{1, 96} = 10.31$, $P \leq 0.01$), respectively. Total species richness of native and non-native plants was similar among years and elevations; however, species richness did not differ between treatments during the fall seasons over the two-year study (Table 5).

Significant differences were detected in spring species richness in upland versus lowland elevations. Total, native, and non-native species richness differed between elevations ($F_{1, 96} > 5.64$, $P \leq 0.02$). In addition, non-native species richness differed among years ($F_{1, 96} = 10.04$, $P \leq 0.01$). However, species richness of total, native, and non-native plants did not differ between treatments and years during spring seasons. Species richness of total, native, and non-native plants differed between upland and lowland elevations, seasons, and years over the two-year study period (Table 5).

In terms of numbers of species, native forbs and native grasses were the most dominant native plants detected, with species occurring on >95% of the transects during the study. Genera in the family Asteraceae, the most common along transects (>90%), included goldenrod (*Solidago* spp.), sunflowers (*Helianthus* spp.), bonesets (*Eupatorium* spp.), and fleabanes (*Erigeron* spp.). Native legumes were detected on >50% of the line transects, with partridge pea (*Chamaecrista fasciculata*) and beggarticks (*Desmodium* spp.) being the most numerous native legumes. Native grasses, sedges (*Carex* and *Cyperus* spp.), and rushes (*Eleocharis* and *Juncus* spp.) were detected on >65% of transects. The most common native grasses were panicgrasses (*Dichanthelium* and *Panicum* spp.), paspalums (*Paspalum* spp.), and bluestem grasses (*Andropogon* spp.). The most dominant non-native grasses, with coverages of >60% in most study plots, included Bermudagrass (*Cynodon dactylon*), tall fescue (*Schedonorus phoenix*), Bahiagrass (*Paspalum notatum*), Johnsongrass (*Sorghum halepense*), and Vasey's grass (*Paspalum urvillei*). Woody plants, including shrubs, trees, and vines, were detected on 60% of the line transects. The most common woody plants were woody vines, especially blackberry and dewberry (*Rubus* spp.). The most common genera of non-native legumes and forbs were clovers (*Trifolium* spp.), vetches (*Vicia* spp.), sericea lespedeza (*Lespedeza cuneata*), and vervains (*Verbena* spp.).

Vegetation Percent Coverage

Non-native agronomic grasses comprised <5% of the total species detected (Table 2), however they represented the dominant coverage in all treatments. Mean percent coverage of non-native grasses in different treatments was as follows: mowed (57.71% ± 3.14%), reduced mowed (60.88% ± 2.87%), and reduced mowed–seeded (58.33% ± 2.84%; Figure 3). *No treatment effects for percentage vegetation coverage for any response variables in fall or spring were observed.* On all subplots over the study period, percent coverage of non-native grasses averaged 88.63% ± 3.03% and non-native legumes averaged 31.86% ± 3.49%. Native grasses, legumes, and forbs comprised approximately 22% collectively of ground coverage on all transects. Woody plants comprised <8% coverage over the study period (Table 6).

In the reduced mowed–seeded subplots, mean percent coverage of native forbs increased from 1.5% to 4.2% during the study, and there was a slight change in ground coverage of non-native forbs from 1.8% to 2.2%. However, in reduced mowed–seeded subplots, mean percent coverage of non-native grasses exhibited a decrease from 39.5% to 25.2%, whereas native grass coverage increased from 1.1% to 5.3% during the study (Figures 3 and 4).

During fall survey periods, percent coverage of vegetation within upland study plots was dominated by non-native grasses that exhibited an average coverage of 134.51% ± 8.77% over all study plots. Percent coverage >100% is due to species overlap along each line transect. Non-native legumes averaged 6.79% ± 2.87% while native and non-native forbs comprised approximately 10% coverage within study plots. Native grasses, legumes, and rushes, and non-native sedges averaged <2% coverage during fall. Of woody species measured, native and non-native woody vines were dominant. Greatest coverage of native woody vines was detected in upland elevations during fall seasons, with an average percent coverage of 12.02% ± 4.09%, whereas the least percent coverage of woody vines was recorded for non-native vines during the fall season with an average coverage of 2.10% ± 1.03% (Table 7).

Percent coverage of most plant growth forms was greater in lowlands than in uplands during fall sampling seasons; however, non-native grasses comprised the majority (>100%) of ground coverage in lowlands. Coverage of native forbs, primarily in the Asteraceae family, was greater in lowlands than in uplands, averaging approximately 50% coverage in lowlands. All other plants, including native grasses, legumes, rushes, sedges, shrubs, trees, vines, and non-native forbs, sedges, and vines, exhibited percent coverage of ≤10% (Table 7). Dominant non-native species that comprised most of fall seasons' ground coverage included agronomic grasses such as field brome (*Bromus arvensis*), soft brome (*Bromus hordeaceus*), Bermudagrass (*Cynodon dactylon*), Dallisgrass (*Paspalum dilatatum*), Vasey's grass (*Paspalum urvillei*), bahiagrass (*Paspalum notatum*), yellow foxtail (*Setaria pumila*), green foxtail (*Setaria viridis*), tall fescue (*Schedonorus phoenix*), Johnsongrass (*Sorghum halepense*), and non-native legumes such as Japanese clover (*Kummerowia striata*), sericea lespedeza (*Lespedeza cuneata*), field clover (*Trifolium campestre*), crimson clover (*Trifolium incarnatum*), white clover (*Trifolium repens*), bird vetch (*Vicia cracca*), and garden vetch (*Vicia sativa*; Table 2).

During spring on uplands, non-native grasses and legumes comprised the greatest percent coverage of the roadside ROW vegetation with an average of 159.13% ± 9.81% and

84.02% ± 7.43%, respectively (Table 7). Most dominant non-native grasses and legumes during spring included Bermudagrass (*Cynodon dactylon*), bahiagrass (*Paspalum notatum*), Vasey's grass (*Paspalum urvillei*), tall fescue (*Schedonorus phoenix*), yellow foxtail (*Setaria pumila*), and Johnsongrass (*Sorghum halepense*). Percent coverage of native and non-native forbs averaged 20.10% ± 2.72% and 3.83% ± 0.96%, respectively, during the spring seasons of the study period (Table 7). The primary native forb species that occurred on ROW plots during spring were hairy white old-field aster (*Symphyotrichum pilosum*), Carolina geranium (*Geranium carolinianum*), goldenrods (*Solidago* spp.), goldentops (*Euthamia* spp.), roundleaf thoroughwort (*Eupatorium rotundifolium*), Canadian horseweed (*Conyza canadensis*), and annual ragweed (*Ambrosia artemisiifolia*). Native grasses, legumes, and other herbaceous plant cover types, including species of the genera bluestems (*Andropogon*), partridge peas (*Chamaecrista*), bundleflowers (*Desmanthus*), rosette grass (*Dichanthelium*), crabgrass (*Digitaria*), barleys (*Hordeum*), panicgrasses (*Panicum*), little bluestems (*Schizachyrium*), foxtails (*Setaria*), and tridens, averaged <3% coverage. Native trees and shrubs, including red maple (*Acer rubrum*), eastern baccharis (*Baccharis halimifolia*), common persimmon (*Diospyros virginiana*), green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), loblolly pine (*Pinus taeda*), oaks (*Quercus* spp.), black willow (*Salix nigra*), and winged elm (*Ulmus alata*), comprised <2% coverage. Native and non-native woody vines, including sawtooth blackberry (*Rubus argutus*), southern dewberry (*Rubus trivialis*), Japanese honeysuckle (*Lonicera japonica*), purple passionflower vine (*Passiflora incarnata*), greenbriers (*Smilax* spp.), trumpet creeper (*Campsis radicans*), eastern poison ivy (*Toxicodendron radicans*), summer grapevine (*Vitis aestivalis*), and muscadine grapevine (*Vitis rotundifolia*), averaged <10% coverage of on all plots (Tables 2 and 7).

In lowlands during spring, non-native grasses were the dominant cover type averaging 127.51% ± 7.42%. Other dominant cover included native forbs and non-native legumes with an average percent coverage of 47.45% ± 7.21% and 42.31% ± 5.25%, respectively. Other herbaceous plants, including non-native forbs, native grasses, legumes, sedges, and rushes, exhibited an average percent coverage of <11%. Woody plants, including vines, trees, and shrubs, exhibited an average coverage of <12% in lowlands during spring seasons (Table 7).

Percent coverage of native forbs ($z = 4.81$, $P \leq 0.001$), grasses ($z = 3.51$, $P \leq 0.001$), legumes ($z = 3.37$, $P \leq 0.001$), and rushes ($z = 4.54$, $P \leq 0.001$) was greatest in lowlands during fall (Table 7). The *z*-statistic values were used to test the normal distribution from the mean and standard deviation. Spring percent vegetation coverage by species also differed between uplands and lowlands ($F_{1, 59} = 24.12$, $P \leq 0.001$), with coverage of native forbs ($z = 3.03$, $P \leq 0.01$), legumes ($z = 2.62$, $P \leq 0.01$), rushes ($z = 5.00$, $P \leq 0.001$), sedges ($z = 4.15$, $P \leq 0.001$), and non-native legumes ($z = 3.82$, $P \leq 0.001$), was greatest in lowlands (Table 7). Total percent coverage of native and non-native plants by growth forms did not differ significantly among treatments ($F_{2, 96} = 0.85$, $P = 0.48$), but differed between uplands and lowlands ($F_{1, 96} = 18.22$, $P \leq 0.001$), between study years ($F_{1, 96} = 14.54$, $P \leq 0.001$), and between fall and spring seasons ($F_{1, 96} = 16.25$, $P \leq 0.001$; Table 7). In addition, interactions between years and seasons ($F_{1, 96} = 24.08$, $P \leq 0.001$) and seasons and elevations were detected ($F_{1, 96} = 5.00$, $P \leq 0.001$; Table 7).

Debris and Bare Ground Percent Coverage

During the two-year study, percent coverage of bare ground in all plots exhibited a mean coverage ranging from 0 to 19.11%. Over 50% of the subplots within the study exhibited <5% coverage of bare ground during the two-year study. Bare ground on most plots was due to soil disturbance from installation of water pipelines, contour grading, and erosion, some of which was caused by the tractors that mowed the ROWs. Debris included dead grass clippings and other vegetation matter, whereas fine woody debris was classified as sticks, twigs, and branches. Percent coverage of debris ranged from an average of 6.79% ± 2.72% in reduced mowed–seeded subplots during fall 2011 to an average of 42.48% ± 5.46% in reduced mowed–seeded subplots during spring 2012. The control plots exhibited a minimum average of 1.75% ± 1.09% coverage of bare ground in upland plots during fall 2011 to a maximum average of 13.34% ± 9.22% in lowland plots during fall 2010. Reduced mowed subplots exhibited average bare ground coverage of <12.20% over the two-year study period. Reduced mowed–seeded subplots exhibited an average of <19.11% bare ground with no change from 2010 to 2012.

During fall sampling seasons in 2010 and 2011, percent coverage of bare ground ranged from 12.20% ± 12.20% in reduced mowed subplots to 13.34% ± 9.22% in mowed subplots and 19.11% ± 18.97% in reduced mowed–seeded subplots. Percent coverage of debris on plots during fall sampling seasons ranged from a mean of 17.83% ± 6.82% in mowed subplots to a mean of 19.46% ± 6.42% in reduced mowed–seeded subplots and a mean of 23.87% ± 6.09 in reduced mowed subplots.

During spring sampling seasons in 2011 and 2012, percent coverage of bare ground ranged from 8.97% ± 4.59% in mowed subplots to 7.50% ± 6.89% in reduced mowed subplots and 5.70% ± 5.10% in reduced mowed–seeded subplots. Percent coverage of debris on plots during fall sampling seasons ranged from a mean of 34.34% ± 6.11% in mowed subplots to a mean of 35.59% ± 4.22% in reduced mowed subplots and a mean of 42.48% ± 5.46% in reduced mowed–seeded subplots.

Plant Height Characteristics

The specific objectives for evaluating plant height characteristics involved measuring and comparing differences in percent coverage of vegetation in three height categories in three different treatments within upland and lowland plots.

Percent coverage of plants in the ≤18-in. height category exceeded 110% in upland and lowland plots during study years due to overlap of individual species. However, percent coverage of plants occurring in the 18–36 in. height category exhibited mean coverages ranging from 49.15% ± 4.69% to 69.20% ± 4.42% in upland and lowland plots over two study years, 2010–2012. Plants ≤ 36 inches in height exhibited mean coverage of <30% during spring and fall over the two-year study period. Percent coverage of vegetation in different height categories differed between upland and lowland elevations ($F_{1,\,96} > 4.65$, $P \leq 0.03$) and between study years ($F_{1,\,96} > 4.91$, $P < 0.03$). However, coverage of vegetation did not differ in different height categories among treatments ($F_{2,\,96} < 1.34$, $P > 0.27$; Table 8, Figures 5 and 6).

During fall seasons, percent coverage of plants in the three height categories did not differ among treatments ($F_{2,\,96} < 0.47$, $P > 0.62$). However, coverage in all height categories differed between study years ($F_{1, 96} > 8.39$, $P < 0.01$. Percent coverage of vegetation in all height categories did not differ between lowland and upland elevations ($F_{1, 96} < 3.41$, $P > 0.07$) during fall seasons (Table 8; Figure 7). No significant differences were detected in the interactions between year and elevation in the 18–36 in. height category ($F_{1, 96} = 3.71$, $P = 0.06$) during fall seasons. [These values were not statistically significant at the stated 0.05 level for rejection. However, for practical purposes it should be noted that a level of significance of $P = 0.06$ is very close.]

During spring seasons, percent coverage of plants in the three height categories did not differ among treatments ($F_{2, 96} < 1.34$, $P > 0.27$). However, percent coverage of plants in the 18–36 in. ($F_{1, 96} = 18.03$, $P < 0.001$) and >36 inch ($F_{1, 96} = 4.91$, $P = 0.032$) height categories differed among years, but there was no significant difference in percent coverage of vegetation in the <18 in. height category among study years ($F_{1, 96} = 0.48$, $P = 0.492$). No significant differences were detected in percent coverage of plants in all three height categories ($F_{1, 96} > 3.60$, $P \leq 0.06$) among upland and lowland elevations during spring seasons (Table 9). Significant interactions between year and elevation were detected for percent coverage of vegetation in the 18–36 in. height category during spring seasons ($F_{1, 96} = 19.17$, $P \leq 0.001$; Table 9). Differences in percent coverage of vegetation occurring among the three height categories was greatest during spring, with lowland elevations exhibiting the greatest coverage of vegetation within the ≤18 in. height category (Table 8; Figures 6 and 7).

Woody Plant Stem Density

Woody plant stems per acre were compared in the three treatments. Stem densities of native and non-native woody plants ranged from a mean of 3,146.6 (± 802.4) stems per acre during year 1 of the study to 4,058.8 (± 822.3) stems per acre in year 2 in all study plots. Woody vines comprised the majority (>68%) of stem densities, whereas 24% were trees and <8% were shrubs. Of the woody plants detected in the study, 91% were native species and 9% were non-native species during the two-year study period. See Figure 8 for the mean stem density of the most common woody plant species during the study.

Mean stem density of all woody plants was greater in upland elevations during fall seasons, ranging from 516.5 (± 138) stems per acre to 4,133.2 (± 799.6) stems per acre. In spring seasons, greatest stem densities of woody plants were recorded in lowland elevations, with a range of 698.8 (± 209.3) stems per acre to 4,404.9 (± 804.9) stems per acre (Table 10). Woody stem density did not differ between upland and lowland elevations ($F_{1, 96} < 3.34$, $P >$ 0.07), years ($F_{1, 96} < 3.21$, P > 0.08), or treatments ($F_{2, 96} < 1.19$, $P > 0.31$; Table 10, Figure 9).

During fall seasons, stem densities of native plus non-native, non-native only, and native only woody plants did not differ among years ($F_{1, 96} < 2.17$, $P > 0.14$), treatments ($F_{2, 96} < 1.19$, P > 0.31), or elevations ($F_{1, 96} < 3.34$, $P > 0.07$). There were no significant interactions among years, treatments, or elevations during fall. During spring, stem densities of native plus non-native, native only, and non-native only woody plants did not differ among years ($F_{1, 96} < 3.21$, P > 0.08), treatments ($F_{2, 96} < 0.66$, $P > 0.52$), or elevations ($F_{1, 96} < 2.32$, $P > 0.13$). Woody plant stem density did not differ among years, treatments, or elevations when data were combined over fall and spring seasons ($F_{1, 96} < 3.34$, $P > 0.07$). There were no significant interactions among years, treatments, or elevations during spring. Overall, woody stem densities did not differ between study years, treatments, or elevations (Figure 8). Stem densities of trees and shrubs did not exhibit increases from year 1 to year 2; however, stem densities of woody vines increased greater than twofold from year 1 to year 2.

Summary and Trends

Of the 277 plant species identified, 76% (211 species) were native and 21% (57 species) were non-native. In lowlands, approximately two-thirds (64%) of the plant species were native, whereas less than half (44%) of the species in uplands were native plants (Table 2). Native plants included 111 forbs, 21 grasses, 4 legumes, 8 rushes, 15 sedges, 7 shrubs, 24 trees, and 21 vines, and non-native plants included 23 forbs, 18 grasses, 12 legumes, 1 sedge, and 3 vines. Nine additional plants remained unidentified, thus their native vs. non-native species status could not be verified.

Differences in native and non-native species richness and the percent coverage of growth forms throughout the two-year study revealed significant interactions between seasons, elevations, and years. The greatest plant species richness was in lowland plots.

Native species richness was greater within the reduced mowed and reduced mowed–seeded subplots. Percent coverage of native forbs tripled from 1.5% to 4.2% while coverage of non-native forbs remained relatively stable (1.8% to 2.2%).

Although agronomic grasses and other non-native plant species comprised <25% of the total species in this study, non-native species typically dominated vegetation coverage (>90%) in all subplots, with mean percent coverage ranging from 74.64% ± 18.27% in reduced mowed and reduced mowed–seeded treatments to 117.63% ±17.93 in mowed treatments.

Native grasses increased fivefold (from 1.1% to 5.3%) from fall 2010 to spring 2012. Of the non-native species, agronomic grasses remained the most dominant in lowlands with >60% coverage in the fall, whereas uplands had >75% coverage over the two-year study period.

Vegetation coverage did not differ in different height categories among treatments and vegetation height in uplands in fall and spring seasons were similar. However, percent coverage within the specific height categories differed among fall and spring seasons. The greatest percent coverage of vegetation in the fall was 18–36 inches and in the spring >36 inch in lowlands, whereas coverage in <18 inches and 18–36 inches heights were greatest in uplands during spring. The mowed and reduced mowed treatments did not exhibit differences among percent coverage in different height categories during the two-year study period. Upland or lowland elevations and season exhibited the greatest influences over vegetation height in the study.

Woody vines comprised the majority (>68%) of woody stems. Trees and shrubs comprised 24% and <8% of stem density, respectively. Of the woody plants detected, 91% were native species and 9% were non-native species.

Overall, woody stem densities did not differ between treatments and elevations, possibly due to drought during 2010 and 2011. Woody vines increased more than twofold from year 1 to year 2 and shrub and tree densities remained constant in the reduced mowed and reduced mowed–seeded plots during the study. Soil moisture in lowlands during drought conditions may have been associated with greater stem densities of woody plants and greater coverage within <18 inches and 18–36 inches in the lowland areas.

Surveys were conducted at least 2 to 3 weeks after mowing, therefore measurements indicated that vegetation structure did not change significantly in terms of height development over the course of the growing season.

White-Tailed Deer Observation Counts

Introduction and Study Areas

Accidents involving vehicles and white-tailed deer (*Odocoileus virginianus*) are a major concern in wildlife and highway management nationwide (Dixon et al. 1984). The number of vehicle collisions with deer may range from 720,000 to >1.5 million annually in the United States (Conover et al. 1995). In Mississippi, wildlife-vehicle collisions have continued to be a safety and financial concern to vehicle owners and insurance companies. Increases in deer population levels and numbers of roadways statewide have resulted in more deer-vehicle collisions during the past 3 decades (Mississippi Department of Wildlife, Fisheries, and Parks Deer Committee 2012).

Establishment and management of vegetation may actually attract deer to ROWs due to enhanced availability of food plants. Types of vegetation management on ROWs that typically enhance the quantity of food plants include soil amendments, mowing, and plantings for erosion control. Desirable deer food plants that are often seeded for erosion control include cool-season, annual legumes such as clovers (*Trifolium* spp.) and vetches (*Vicia* spp.). Establishment of these legumes can often result in concentrations of foraging deer, especially during late fall, winter, and early spring months. In contrast to cool-season legumes, most grasses and many native forbs are not highly palatable deer food plants. Plant species such as native bluestems (*Andropogon* spp., *Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), black-eyed-Susans (*Rudbeckia hirta*), sunflowers (*Helianthus* spp.), laserworts (*Silphium* spp.), blazing stars (*Liatris* spp.), and milkweeds (*Asclepias* spp.) often occur on ROWs and are not strong attractants for foraging deer. Although native grasses and forbs may colonize ROWs naturally, coverage of these plants may be reduced by repeated mowing and herbicide applications. With modifications in management practices, ROW managers may be successful in the establishment and maintenance of plants that enhance roadside beauty and control erosion while conserving the diversity of native plants, insects, and grassland birds without creating attractive food sources for deer (Michael and Kosten 1981; Jacobson 2005; Miller and Miller 1999; Dickson and Wigley 2001; Arner and Jones 2009). Although availability and composition of food plants on ROWs may influence utilization by deer, adjacent land use and vegetation communities also influence deer utilization of early successional areas on ROWs (Blair and Enghardt 1976; Conroy et al. 1982; Thill et al. 1990; Ford et al. 1997; Strickland and Demarais 2008). When roadways transect areas that are dominated by closed canopy tree plantations and older forests, deer are often attracted to ROWs due to availability of forage and browse plants because of food scarcity in adjacent plant communities. Managers may be confronted with finding new ways of limiting deer food plants adjacent to roadways. Several modifications in choice of seed mixtures and vegetation management can be employed. These include planting reclamation seed mixtures that include native wildflowers that are unpalatable to deer and reductions in fertilization and mowing (Jacobson 2005; Arner and Jones 2009).

After consultation with MDOT personnel we added this component to the study to gain a better understanding of deer presence and interaction with available forage plants along the Highway 25 ROW. We anticipated this research could assist highway managers in selecting vegetation to discourage deer on right of ways. We monitored deer using spotlight counts and forage plants used by deer on ROWs seasonally. Surveys were conducted 2 to 3 times monthly from January 2011 through January 2012.

Results

A total of 723 white-tailed deer were observed during 29 survey nights with an average of 24.93 (±2.65) deer per survey night. Deer numbers averaged 0.86 deer per mile over the study period (Figures 10 and 11). Approximately 95% of the deer recorded were observed within 800 ft. of the highway's edge. Most (85%) of the observed deer occurred in groups of 4 or less. Of the total deer observed, 237 deer (33%) were recorded in uplands and 486 deer (67%) were recorded in lowlands. Throughout the study, lowlands exhibited approximately twice the number of deer sightings as did uplands (Figure 10). Lowlands were associated with streams and exhibited shrub–herbaceous plant communities. Areas adjacent to lowland ROWs were typically bottomland hardwood forests or regeneration areas (<10 years of age). In all lowlands, highway bridges spanned streams and floodplains.

Numbers of deer observations varied among seasons on the ROW. The greatest numbers of deer (n = 267; 37%) were observed from January to March. From October through December, 204 deer (28%) were observed. From April through June, 156 deer (22%) were observed. During July through September, 96 deer (13%) were recorded (Figures 10 and 11). The GPS points were used to overlay a map in ArcMap GAP (Global Information System) program to show wildlife observations in different physiographic regions along the ROW (Figure 12).

Conclusions

Deer Numbers Observed

Deer numbers detected in our study were less than those reported by other studies, which reported ranges of 8 to 19 deer per mile along highway ROWs nationwide. Variations in survey methods, plant community types, deer population levels, disturbance from traffic and hunting, weather conditions, and observer experience may account for detected differences between our study and others (McCullough 1982; Fafarman and DeYoung 1986; Fuller 1989; Richardson 2002; Brunjes et al. 2009; Hoffman et al. 2011).

Seasonal Deer Observations

Greatest numbers of deer were detected during late fall through early spring, whereas lowest numbers were detected during the summer months (Table 10, Figure 14). Seasonal trends were potentially related to changes in vegetation communities on ROW and adjacent plant communities. During late fall through spring, vegetation surveys revealed a greater coverage and species richness of cool-season legumes, including yellow hop clover (*Trifolium campestre*), crimson clover (*Trifolium incarnatum*), white clover (*Trifolium repens*), and vetches (*Vicia* spp.). In our study, these cool-season plants exhibited >72% ground coverage during spring months in comparison to <30% coverage during summer and early fall months. Active growth of these plants begins in late fall and extends through spring. During this time palatable cool-season plants are more available for deer (Miller and Miller 1999; Dillard et al. 2005; Moreland 2005; Harper 2008). Our findings were similar to those of other researchers who reported that forage plants were a factor in seasonal use of plant communities by deer (Hanley et al. 2012; Vandeloecht et al. 2012).

Concentrations of deer along the ROW during winter and spring months may have been related to availability of forage plants. These food resources may have been especially attractive to deer in areas where the ROW transected dense pine plantations with closed canopies where food plants are limited (Strickland and Demarais 2008).

Based on results of deer counts and vegetation surveys, we recommend that modifications in seed mixtures near roadsides should be considered. Seeding of non-native clovers and vetches near roadways is not recommended due to the potential to attract foraging deer. When used in erosion control seed mixtures, cool-season legumes may be more effective at reducing deer on ROW when planted in lowlands or at greater distances from the highway. Use of these plants in lowlands could potentially attract deer to these areas, thus encouraging their use of bridge underpasses.

Deer Observations and Plant Community Types

Twice as many deer were observed in ROW lowlands as in uplands. Greater numbers of deer observations in lowlands may have been related to greater distances and isolation from roadway disturbances, better escape and loafing cover along streams, adjacent forest conditions, and a greater availability of food plants. In lowlands we detected a greater species richness of deer food plants during spring and summer months. Herbaceous food plants that were more abundant in lowlands included butterfly milkweed (*Asclepias tuberosa*), smallhead doll's daisy (*Boltonia diffusa*), partridge pea (*Chamaecrista fasciculata*), ticktrefoil (*Desmodium* spp.), velvet panicum (*Dichanthelium scoparium*), crabgrass (*Digitaria* spp.), Virginia buttonweed (*Diodia virginiana*), eastern daisy fleabane (*Erigeron annuus*), lateflowering thoroughwort (*Eupatorium serotinum*), Canada goldenrod (*Solidago canadensis*), meadow beauty (*Rhexia mariana*), and clovers (*Trifolium* spp.). Palatable browse plants along drainages and streams included greenbriars (*Smilax* spp.), blackberry and dewberry (*Rubus* spp.), Japanese honeysuckle (*Lonicera japonica*), green ash (*Fraxinus pennsylvanica*), blackgum (*Nyssa sylvatica*), and winged elm (*Ulmus alata*). These food resources in combination with on-site cover and adjacent riparian forests may have influenced deer utilization in lowlands of our study area. Our findings were similar to others who reported that white-tailed deer utilized lowland and riparian areas due to availability of food plants and cover (Knowlton 1964; Michael 1965; Cadenasso and Pickett 2000).

Implications

Modifications in vegetation management to enhance plant communities and carrying capacity for white-tailed deer in lowlands might result in greater deer numbers using these areas and the associated bridge underpasses. Utilization of underpasses has reduced vehicle-wildlife collisions in Florida. In many cases, bridges and underpasses have been used successfully to provide safe crossings for federally and state-protected wildlife, such as Florida panthers (*Felis concolor coryi*) and Florida black bears (*Ursus americanus floridanus*; Andrews 1990).

Public Perception Survey of Roadside Management and Vegetation

A public perception survey was prepared during the summer of 2012 to assess public opinions of vegetation management on highway right-of-ways in Mississippi. This survey was an integral component of this study. The objective of the survey was to determine if the public would tolerate a weedier roadside if the results of the study suggested a weedier ROW would provide benefits and reduce the cost of mowing. Other factors included the encouragement of native plants (wildflowers and grasses), hiding litter, and reducing deer on ROWs.

The survey contained 39 questions. Demographic information and participation in outdoor nature activities was collected (Appendix B). Most questions utilized a Likert-scale design. Four short answer questions completed the questionnaire. On August 2, 2012, the Mississippi State University (MSU) Institutional Review Board (IRB) reviewed the survey. Final approval by MSU-IRB was received (IRB # 12-242).

Questionnaire Administration and Data Collection

Surveys were administered at two locations during 2012 and 2013: Fred's Super Dollar Store on North Jackson Street in Starkville, MS, and Mississippi State University Crosby Arboretum in Picayune, MS. Using a standard script, Entsminger requested respondent participation, inviting each participant to complete the survey anonymously. Each respondent completed the survey individually. No verbal communication between the respondent and Entsminger occurred during the completion of the survey. No data on personal identifiable characteristics was collected.

Results

A total of 129 completed surveys were collected in the months of August 2012 and September 2013. Fifty-two surveys (40%) were collected from Fred's Super Dollar Store during August 2012, and 77 (60%) surveys were collected at Mississippi State University Crosby Arboretum during September 2013. Respondents were comprised of 58 males and 71 females. The majority of respondents were Caucasian. Ethnic minority respondents included black males (n = 11), black females (n = 18), and Hispanic and Indian males or females (n = 3). Ages of respondents were reported in the following age groups: 18–24, 25–34, 35–44, 45–54, 55–64, and >65 years of age. Caucasian males and females comprised most of the respondents in each age category. Most (>95%) of the survey respondents reported that they participated in outdoor activities such as hiking, fishing, nature walks, or gardening. The following responses indicated the frequency of participation in outdoor activities:

A few times a year – 44 respondents (34%)
A few times a month – 40 respondents (31%)
Every week – 38 respondents (30%)
Never – 7 respondents (5%)

Over 85% of respondents reported that they often drove on interstates and/or highways. Of 129 respondents, 123 individuals (95%) indicated strong support or support for seeing wildflowers along the roadside ROWs in Mississippi. Respondents' perceptions of unmowed grasses along ROWs were more evenly distributed, with 66 (51%) respondents supporting unmowed grasses, 49 (38%) respondents indicating not in favor of unmowed grasses, and 14 (11%) respondents neutral (Table 12). When queried about mowed ROWs, 13 (10%) respondents reported neutral attitudes, 76 (59%) respondents indicated support for mowed ROWs, and 40 (31.0%) reported they did not support mowed ROWs. However, >98% of respondents ranked seeing visible litter after mowing as extremely undesirable. Seventy-five (58%) respondents indicated that they supported taller, natural-looking grasses if trash and litter were concealed.

Visibility of invasive plant species, such as kudzu (*Pueraria lobata*), was ranked as undesirable by 100 (78%) respondents. However, cogongrass in bloom and seed was viewed as desirable by 45 (35%) respondents and undesirable by 33 respondents (26%). Sixty-five percent of respondents indicated support for reduced mowing if this approach would reduce spread of invasive plant species (Table 12). Over 90% of respondents expressed a desire for natural-looking roadsides with native grasses, wildflowers, and butterflies and indicated strong agreement with seeing more wildflowers along Mississippi roadsides (Table 12).

Questions that addressed perceptions concerning wildlife along roadsides focused on presence of deer and deer-vehicle accidents, and vegetation management strategies that might influence their presence on ROWs. Over 70% of respondents indicated concern about deer-vehicle accidents; however, 54% of respondents had never experienced such an accident (Table 12). Eighty-six respondents (67%) indicated a belief that deer would be attracted to roadsides by taller, unmowed vegetation. Most respondents (60%) indicated support for reduced mowing regimes if these management actions could potentially reduce vehicle-wildlife accidents.

Another section pertained to the public's perception of mowing and support for MDOT's mowing cycles/regimes. Of the 129 respondents, about two-thirds stated that they supported reduced mowing regimes, approximately 17% were neutral, and <17% were opposed to a reduced mowing regime. Most respondents supported taller vegetation if it discouraged deer presence on ROWs. Eighty-two respondents (64%) indicated support for strategies that saved money, whereas 23 (18%) respondents were neutral toward this approach (Table 12). Most respondents (75%) supported a reduced mowing regime if wildflowers on ROWs promoted tourism, and >80% of respondents indicated support for mowing once per year during fall months to allow native wildflower and grass seeds to propagate. Less than 70% of respondents thought that highway ROWs were mowed 3–8 times annually and <30% thought ROWs were mowed 25 to 200 times annually.

Respondents were asked to rank several highway management categories in terms of the best use of tax dollars. Most respondents (82%) supported road maintenance and repair as their top priority for expenditure of tax dollars. Construction and improvement for new roads were ranked second, with 72 (56%) responses. Removal of litter from roadsides as a priority was supported by 49 (38%), whereas mowing of ROWs was ranked a priority by only 21 (16%) respondents. Data analysis suggested that 109 of 129 (85%) respondents agreed that MDOT should maintain and repair roadways instead of mowing so often. Over 80% of respondents were in favor of a reduced mowing regime if it helped discourage deer from roadways, enhance native wildflowers, reduce invasive plant spread, and/or save taxpayers money.

Conclusions

People preferred wildflowers on the ROW and disliked litter. A similar number favored a mowed ROW and attractive high grasses, suggesting that mowing on locations with grasses could be reduced immediately. With 71% supporting tall vegetation if it reduces deer on the ROW, 64% supporting tall grass if it saves taxpayer money, and >75% in favor of reduced mowing if it encourages wildflowers and tourism, a series of public service announcements may be highly successful in gaining support.

With only 65% of respondents interested in reduced mowing to control the spread of invasive plants and just 35% finding cogongrass undesirable, a motorists' education program seems to be warranted. The recognition of kudzu as undesirable by 78% of respondents is a good sign that it may be useful in advertising efforts to alert motorists to the problems associated with invasive non-native species.

Study Conclusions and Implications

Conclusions

Plant Community Composition

A total of 277 plant species including native and non-native grasses, forbs, legumes, rushes, sedges, trees, shrubs, and woody vines were documented in the study plots. Of the total plant species identified, 79% (211 species) were native and 21% (57 species) were non-native. Nine additional plants were not identified to species and thus their native status was unknown. In the lowlands, approximately two-thirds (64%) of the observed plant species were native, whereas less than half (44%) of the species in uplands were native. The native plants included 111 forbs, 21 grasses, 4 legumes, 8 rushes, 15 sedges, 7 shrubs, 24 trees, and 21 vines. Non-native plants included 23 forbs, 18 grasses, 12 legumes, 1 sedge, and 3 vines. The prevalence of numerous native species indicates a resilient native seed bank on the ROWs.

Non-native grasses, including Bermudagrass (*Cynodon dactylon*), tall fescue (*Schedonorus phoenix*), Bahiagrass (*Paspalum notatum*), Johnsongrass (*Sorghum halepense*), field brome (*Bromus arvensis*), yellow foxtail (*Setaria pumila*), and Vasey's grass (*Paspalum urvillei*), comprised the greatest coverage (>88%) of all growth forms on all research plots. Non-native legumes including clovers (*Trifolium* spp.), vetches (*Vicia* spp. and *Securigera* spp.), sericea lespedeza (*Lespedeza cuneata*), and vervains (*Verbena* spp.) covered an average of 32% of the research plots and were the second-most prevalent plant growth form.

Native forbs, the most numerous native plants recorded, were found on >85% of the line transects. All Asteraceae (asters, daisies, and sunflowers) were commonly found, included goldenrod (*Solidago* spp.), sunflowers (*Helianthus* spp.), bonesets (*Eupatorium* spp.), and fleabanes (*Erigeron* spp.). Native legumes were recorded on <10% of line transects, with partridge pea (*Chamaecrista fasciculata*) and beggarticks (*Desmodium* spp.) most common. Other native species found on around 11% of transects included sedges (*Carex*, *Rhynchospora*, and *Cyperus* spp.) and rushes (*Eleocharis* and *Juncus* spp.). Native grasses, including panicgrasses (*Dichanthelium* and *Panicum* spp.), paspalums (*Paspalum* spp.), and bluestem grasses (*Andropogon* spp.), were found on <11% of line transects.

Woody plant (shrubs, trees, and vines) densities did not differ within treatments. The most common vines were blackberry and dewberry (*Rubus* spp.). Other woody species in the study plots included pioneer species such as sumac (*Rhus* spp.), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), pines (*Pinus* spp.), and non-native species such as Japanese honeysuckle (*Lonicera japonica*) and wisteria (*Wisteria* spp.). Vines comprised >68% of the woody stems, trees 24%, and shrubs <8%. Overall, 91% of the woody plants were native, 9% were non-native species and woody plants comprised <11% of the species.

Trends in Plant Community Results

Native species richness was greater in the reduced mowed and reduced mowed–seeded subplots. In these subplots, the percent coverage of native forbs tripled (from 1.5% to 4.2%) during the study period and non-native forbs remained stable (1.8% to 2.2%). Native grasses increased fivefold (from 1.1% to 5.3%) from fall 2010 to spring 2012. Of the non-native species, agronomic grasses maintained the most dominant coverage in lowland elevations with >60% cover, whereas upland elevations had >75% cover over the two-year study period. The stem densities of woody plants did not differ between treatments or elevations during the study. Native species richness increased over time in the reduced mowed and reduced mowed–seeded plots.

The percent coverage of vegetation in three height categories differed between the upland and lowland sites and between study years. However, coverage of vegetation did not differ among height categories or treatments. Rainfall amounts varied between year 1 and year 2 of the study with year 1 exhibiting lower than average precipitation and year 2 exhibiting normal to above normal precipitation. Vegetation heights did not differ under varying precipitation within different mowing treatments.

During the study, >85 native woodland plants and approximately 15 prairie plants were documented within the reduced mowed and reduced mowed–seeded subplots. Their tenacity suggests they spread and prosper if management on ROWs allows for their maturation.

White-Tailed Deer Trends

Annual cool-season legumes, including clovers and vetches that are exceptional deer foods, are often included in seed mixtures used for erosion control. As preferred food plants for deer become scarce in the fall, these legumes are in season. Vegetation surveys revealed cool-season legumes, including yellow hop clover (*Trifolium campestre*), crimson clover (*Trifolium incarnatum*), white clover (*Trifolium repens*), and vetches (*Vicia* spp. and *Securigera* spp.), were plentiful from late fall through spring. Spotlight counts revealed the greatest numbers of deer were on the ROWs during late fall through early spring.

Twice as many deer were sighted in lowland plots than upland plots throughout the study. The greater plant diversity occurring in the lowlands in combination with cover and adjacent forests likely influenced deer concentrations within these areas.

Public Perception Survey

Public complaints of weedy roadsides are a significant factor in the number of times the ROWs are mowed, and frequent mowing is the most detrimental cause of the demise of native wildflowers and grasses on ROWs. However, complaints may not be the best gauge of public perceptions. The public perception survey found strong support for wildflowers on ROWs and a distaste for litter. Further, respondents indicated they would tolerate a less manicured ROW if it saved money, made the roads safer, and/or hid litter. However, from the survey it also appeared that a public education program would be critical to bolster the public's understanding and tolerance of the management strategies being implemented.

Implications

The research resulted in an improved understanding of Mississippi's ROW plant communities and changes that resulted from different mowing treatments. The duration of the study was not long enough to see huge changes, but native grasses and forbs responded as anticipated within the reduced mowed and reduced mowed–seeded subplot treatments.

A reduction of mowing to once per year after seed set could result in native wildflowers and grasses repopulating ROWs in Mississippi, as well as a corresponding decrease in mowing costs. A ROW covered by native plants would likely discourage the spread of invasive plants and reduce the fragmentation of adjacent natural ecosystems. Spotlight counts confirmed the locations and seasonal peaks of deer on the ROW and the plants that were possibly attracting them. The greatest concentrations, observed in the lowlands, suggested the possibility that more extensive use of the bridges and highway underpasses for deer crossings could be encouraged. The public perception survey suggested that a comprehensive advertising campaign explaining why ROWs were being allowed to naturalize would reduce complaints.

Roadside ROW safety could be improved by restricting seeding of annual cool-season legumes, including clovers (*Trifolium* spp.) and vetches, to lowlands. Mowing could be reduced to once per year for the 50 feet (or as national standards dictate) adjacent to highways, reducing the cost of ROW maintenance. The one mowing should be started in late fall (October or November) after seed set and run through the winter. This represents an important rescheduling of the periods when ROWs will be mowed to late fall and early winter, but it is necessary for the most cost-effective, although slow, method of utilizing the seed bank to naturalize the landscape. More extensive stretches of ROWs in rural areas could possibly be left unmowed without generating complaints. Our experience seeding wildflowers without ground preparation was not successful during the period of the study. This suggests that when funds are available for seeding native plants, other techniques such as hydroseeding may be more effective.

The public perception survey suggested many respondents would tolerate a weedier ROW if it saved money, made the roads safer, or concealed litter. It was also clear that many respondents were not familiar with non-native species and problems associated with them, and probably do not understand the concept of highways serving as corridors for their spread. Education programs would help strengthen and reinforce the public's knowledge of road maintenance, cost reduction, and the spread of non-native, invasive plants. A comprehensive public relations campaign could be developed to extol the virtues of a natural ROW. Partnering organizations such as the Garden Clubs of Mississippi, the Mississippi Native Plant Society, the Mississippi Environmental Education Alliance, and Keep Mississippi Beautiful could be engaged with this campaign. In addition, exhibits on the native plants of Mississippi ROWs could be developed for the state's welcome centers, accompanied by Mississippi wildflower pamphlets and/or seed packets. A series of native plant public service announcements could be produced for radio and television stations including Mississippi Public Radio, while a series of editorials could be written for the Clarion Ledger and local newspapers. A panel of the state highway map could describe MDOT's wildflower and native grasses program. The utilization of a diverse array of media outlets would probably give broad enough coverage to accomplish the needed education.

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Appendix A: Tables and Figures

Table 1. Overview of study methods used to assess vegetation characteristics

Type of survey	Methodology	Sampling design	Frequency
Genera and/or species composition and percent coverage of herbaceous and woody plants	Line intercept and transects	Treatment plots in uplands (N = 5) and lowlands (N = 5). Three treatment subplots in each plot	Early spring and late summer/fall (2 times/year)
Stem density of woody plants (shrubs, trees, and woody vines)/acre	Belt transects along line intercept	Line intercept and belt transects in each subplot	Early spring and late summer/fall (2 times/season)
Spotlight counts of white-tailed deer (*Odocoileus virginianus*)	Drive <20 mph Spotlight area adjacent to roadway within ROW. Deer recorded with GPS and rangefinder	Coordinates of all deer observed over the length of the ROW containing research plots	2–3 times/month 2011 and January 2012

Table 2. Plant species found along Highway 25 ROW in Oktibbeha and Winston counties, Mississippi, 2010–2012

Common name	Scientific name	Vegetation type	Status
Common Threeseed Mercury	*Acalypha rhomboidea* Raf.	Forb	Native
Boxelder Maple	*Acer negundo* L.	Tree	Native
Red Maple	*Acer rubrum* L.*	Tree	Native
Wild Meadow Garlic	*Allium canadense* L.	Forb	Native
Nodding Wild Onion	*Allium cernuum* Roth.	Forb	Native
Common Annual Ragweed	*Ambrosia artemisiifolia* L.*	Forb	Native
Peppervine	*Ampelopsis arborea* (L.) Koehne	Vine	Native
Broomsedge Bluestem	*Andropogon virginicus* L.	Grass	Native
Indianhemp/Dogbane	*Apocynum cannabinum* L.	Forb	Native
Giant Switchcane	*Arundinaria gigantea* (Walter) Muhl. ssp. *gigantea*	Grass	Native
Switchcane	*Arundinaria gigantea* (Walter) Muhl. ssp. *tecta* (Walter) McClure	Grass	Native
Butterfly Milkweed	*Asclepias tuberosa* L.	Forb	Native
Eastern Baccharis	*Baccharis halimifolia* L.*	Shrub	Native
Bearded Beggartick	*Bidens aristosa* (Michx.) Britton*	Forb	Native
Devil's Beggartick	*Bidens frondosa* L.*	Forb	Native
Beggartick	*Bidens* L. spp.*	Forb	Native
Crossvine	*Bignonia capreolata* L.	Vine	Native
False Nettle	*Boehmeria cylindrica* (L.) Sw.	Forb	Native
White Doll’s Daisy	*Boltonia asteroids* (L.) L'Hér.*	Forb	Native
Smallhead Doll’s Daisy	*Boltonia diffusa* Elliott*	Forb	Native
Silver Beardgrass	*Bothriochloa laguroides* (DC.) Herter	Grass	Native
Little Quaking Grass	*Briza minor* L.*	Grass	Non-Native
Field Brome	*Bromus arvensis* L.*	Grass	Non-Native
Soft Brome	*Bromus hordeaceus* L.*	Grass	Non-Native
Bald Brome	*Bromus racemosus* L.*	Grass	Non-Native
Redvine/American Buckwheat Vine	*Brunnichia ovata* (Walter) Shinners	Vine	Native
Trumpet Creeper	*Campsis radicans* (L.) Seem. ex Bureau	Vine	Native
Green White Sedge	*Carex albolutescens* Schwein.	Sedge	Native
Yellow-Fruited Fox Sedge	*Carex annectens* (E.P.Bicknell) E.P.Bicknell	Sedge	Native
Oval Leafed Sedge	*Carex cephalophora* Muhl. ex Willd.	Sedge	Native
Cherokee Sedge	*Carex cherokeensis* Schwein.*	Sedge	Native
Limestone Meadow Sedge	*Carex granularis* Muhl. ex Willd.*	Sedge	Native
False Hop Sedge	*Carex lupuliformis* Sartwell ex Dewey*	Sedge	Native
Sedge	*Carex* L. spp.*	Sedge	Native
Fox Sedge	*Carex vulpinoidea* Michx.*	Sedge	Native
Spurred Butterfly Pea	*Centrosema virginianum* (L.) Benth.	Legume	Native

Partridge Pea	*Chamaecrista fasciculata* (Michx.) Greene	Legume	Native
Prostrate Spurge/Spotted Sandmat	*Chamaesyce maculata* (L.) Small	Forb	Native
Indian Woodoats	*Chasmanthium latifolium* (Michx.) Yates	Grass	Native
Spotted Water Hemlock	*Cicuta maculata* L.	Forb	Native
Field Thistle	*Cirsium discolor* (Muhl. ex Willd.) Spreng.	Forb	Native
Yellow Thistle	*Cirsium horridulum* Michx.	Forb	Native
Carolina Coralbead	*Cocculus carolinus* (L.) DC.	Vine	Native
Asiatic Dayflower	*Commelina communis* L.	Forb	Non-Native
Virginia Dayflower	*Commelina virginica* L.	Forb	Native
Bluemist Flower	*Conoclinium coelestinum* (L.) DC.	Forb	Native
Canadian Horseweed	*Conyza canadensis* (L.) Cronquist*	Forb	Native
Lanceleaf Tickseed/Coreopsis	*Coreopsis lanceolata* L.	Forb	Native
Flowering Dogwood	*Cornus florida* L.	Tree	Native
Wooly Croton	*Croton capitatus* Michx.	Forb	Native
Bermudagrass	*Cynodon dactylon* (L.) Pers.*	Grass	Non-Native
Globe Flat Sedge	*Cyperus echinatus* (L.) Alph. Wood*	Sedge	Native
Yellow Nut Sedge	*Cyperus esculentus* L.	Sedge	Non-Native
Many Spike Flat Sedge	*Cyperus polystachyos* Rottb.*	Sedge	Native
Flat Sedge	*Cyperus* L. spp.*	Sedge	Native
Orchard Grass	*Dactylis glomerata* L.	Grass	Non-Native
Queen Anne's Lace	*Daucus carota* L.*	Forb	Non-Native
Illinois Bundleflower	*Desmanthus illinoensis* (Michx.) MacMill. ex B.L.Rob. and Fernald	Legume	Native
Hoary Ticktrefoil	*Desmodium canescens* (L.) DC.	Forb	Native
Prostrate Ticktrefoil	*Desmodium rotundifolium* DC.	Forb	Native
Pine Barren Ticktrefoil	*Desmodium strictum* (Pursh) DC.	Forb	Native
Needleleaf Rosette Grass	*Dichanthelium aciculare* (Desv. ex Poir.) Gould and C.A.Clark*	Grass	Native
Cypress Panicgrass	*Dichanthelium dichotomum* (L.) Gould*	Grass	Native
Velvet Panicum	*Dichanthelium scoparium* (Lam.) Gould*	Grass	Native
Roundseed Panicgrass	*Dichanthelium sphaerocarpon* (Elliott) Gould*	Grass	Native
Rosette Grass	*Dichanthelium* (Hitchc. and Chase) Gould spp.*	Grass	Native
Southern Crabgrass	*Digitaria ciliaris* (Retz.) Koeler*	Grass	Native
Smooth Crabgrass	*Digitaria ischaemum* (Schreb.) Schreb. ex Muhl.*	Grass	Non-Native
Boykin's Clusterpea	*Dioclea multiflora* (Torr. and A.Gray) C.Mohr	Legume	Native
Virginia Buttonweed	*Diodia virginiana* L.*	Forb	Native
Persimmon	*Diospyros virginiana* L.	Tree	Native
Clasping Coneflower	*Dracopis amplexicaulis* (Vahl) Cass.	Forb	Native
Barnyardgrass	*Echinochloa crus-galli* (L.) P. Beauv.	Grass	Non-Native
Needle Spike Rush	*Eleocharis acicularis* (L.) Roem. and Schult.	Sedge	Native
Blunt Spike Rush	*Eleocharis obtusa* (Willd.) Schult.*	Sedge	Native
Spike Rush	*Eleocharis* R.Br. spp.	Sedge	Native

Carolina Elephantsfoot	*Elephantopus carolinianus* Raeusch.	Forb	Native
Daisy Fleabane/Sweet Scabious	*Erigeron annuus* (L.) Pers.*	Forb	Native
Fleabane	*Erigeron* L. spp.*	Forb	Native
Prairie Fleabane	*Erigeron strigosus* Muhl. ex Willd.*	Forb	Native
Dogfennel	*Eupatorium capillifolium* (Lam.) Small*	Forb	Native
Common Boneset	*Eupatorium perfoliatum* L.*	Forb	Native
Roundleaf Thoroughwort	*Eupatorium rotundifolium* L.*	Forb	Native
Lateflowering Boneset	*Eupatorium serotinum* Michx.*	Forb	Native
Flowering Spurge	*Euphorbia corollata* L.	Forb	Native
Slender Goldenrod	*Euthamia caroliniana* (L.) Greene ex Porter and Britton	Forb	Native
Goldenrod	*Euthamia* Nutt. ex Cass. spp.*	Forb	Native
Hollow-Stemmed Joe Pye Weed	*Eutrochium fistulosum* (Barratt) E.E.Lamont	Forb	Native
White Ash	*Fraxinus americana* L.	Tree	Native
Green Ash	*Fraxinus pennsylvanica* Marshall*	Tree	Native
Downy Milkpea	*Galactia volubilis* (L.) Britton	Legume	Native
Slickwilly Bedstraw	*Galium aparine* L.	Forb	Native
Bluntleaf Bedstraw	*Galium obtusum* Bigelow	Forb	Native
Bedstraw	*Galium* L. spp.*	Forb	Native
Stiff Marsh Bedstraw	*Galium tinctorium* (L.) Scop.	Forb	Native
Spoonleafed Purple Everlasting Cudweed	*Gamochaeta purpurea* (L.) Cabrera	Forb	Native
Evening Trumpetflower	*Gelsemium sempervirens* (L.) W.T.Aiton	Vine	Native
Carolina Cranesbill Geranium	*Geranium carolinianum* L.*	Forb	Native
Cutleaf Geranium	*Geranium dissectum* L.*	Forb	Non-Native
Fine-leaved Bitter Sneezeweed	*Helenium amarum* (Raf.) H.Rock	Forb	Native
Common Sneezeweed	*Helenium autumnale* L.	Forb	Native
Swamp Sunflower	*Helianthus angustifolius* L.	Forb	Native
Indian Heliotrope	*Heliotropium indicum* L.	Forb	Non-Native
Swamp/Crimsoneyed Rosemallow	*Hibiscus moscheutos* L.	Shrub	Native
Queendevil Hawkweed	*Hieracium gronovii* L.	Forb	Native
Rattlesnake Hawkweed	*Hieracium venosum* L.	Forb	Native
Little Barley	*Hordeum pusillum* Nutt.	Grass	Native
Virginia/Eastern Waterleaf	*Hydrophyllum virginianum* L.	Forb	Native
St. Andrews Cross/St. Johnswort	*Hypericum hypericoides* (L.) Crantz	Shrub	Native
Dwarf St. Johnswort	*Hypericum mutilum* L.	Shrub	Native
Hairy Cat's Ear	*Hypochaeris radicata* L.	Forb	Non-Native
Cat’s Ear	*Hypochaeris* L. spp.	Forb	Non-Native
Jewelweed/Touch-Me-Nots	*Impatiens capensis* Meerb.	Forb	Native
Morning Glory	*Ipomoea* L. spp.*	Forb	Unknown
Sumpweed/Annual Marsh Elder	*Iva annua* L.	Forb	Native
Smallflowering Morning Glory	*Jacquemontia tamnifolia* (L.) Griseb.	Forb	Native
Flat Tipped Rush	*Juncus acuminatus* Michx.	Rush	Native

Leathery Rush	*Juncus coriaceus* Mack.	Rush	Native
Common Rush	*Juncus effuses* L.*	Rush	Native
Grassleaf Rush	*Juncus marginatus* Rostk.	Rush	Native
Manyheaded Rush	*Juncus polycephalus** Michx.	Rush	Native
Needle Pod Rush	*Juncus scirpoides** Lam.	Rush	Native
Rush	*Juncus* L. spp.*	Rush	Native
Path Rush/Poverty Rush	*Juncus tenuis* Willd.*	Rush	Native
Eastern Red Cedar	*Juniperus virginiana* L.*	Tree	Native
Weedy Dwarf Dandelion	*Krigia caespitosa* (Raf.) K.L.Chambers	Forb	Native
Japanese Clover	*Kummerowia striata* (Thunb.) Schindl.*	Legume	Non-Native
Wild Canada Lettuce	*Lactuca canadensis* L.*	Forb	Native
Woodland Lettuce	*Lactuca floridana* (L.) Gaertn.*	Forb	Native
Henbit Deadnettle	*Lamium amplexicaule* L.	Forb	Non-Native
Purple Deadnettle	*Lamium purpureum* L.	Forb	Non-Native
Caley Pea Vine (Perennial Pea)	*Lathyrus hirsutus* L.	Legume	Non-Native
Narrowleaf Pinweed	*Lechea tenuifolia* Michx.	Forb	Native
Rice Cutgrass	*Leersia oryzoides* (L.) Sw.	Grass	Native
Mucronate Sprangletop	*Leptochloa panicea* (Retz.) Ohwi	Grass	Native
Sericea Lespedeza/Chinese Bushclover	*Lespedeza cuneata* (Dum. Cours.) G.Don*	Legume	Non-Native
Ox-Eye Daisy	*Leucanthemum vulgare* Lam.	Forb	Non-Native
Tall Blazing Star	*Liatris aspera* Michx.	Forb	Native
Blazing Star Gayfeather	*Liatris mucronata* DC.	Forb	Native
Blazing Star	*Liatris* Gaertn. ex Schreb. spp.	Forb	Native
Sweetgum	*Liquidambar styraciflua* L.*	Tree	Native
Cardinal Flower	*Lobelia cardinalis* L.	Forb	Native
Italian Annual Rye Grass	*Lolium perenne* L. ssp. *multiflorum* (Lam.) Husnot*	Grass	Non-Native
Japanese Honeysuckle	*Lonicera japonica* Thunb.*	Vine	Non-Native
Wingleaf Primrose Willow	*Ludwigia decurrens* Walter	Forb	Native
Angled-Stem Primrose Willow	*Ludwigia leptocarpa* (Nutt.) H.Hara	Forb	Native
Marsh Seedbox	*Ludwigia palustris* (L.) Elliott	Forb	Native
Floating Primerose Willow	*Ludwigia peploides* (Kunth) P.H.Raven	Forb	Native
Creeping Primrose Willow	*Ludwigia repens* J.R.Forst.	Forb	Native
American Water Horehound Mint	*Lycopus americanus* Muhl. ex W.P.C.Barton	Forb	Native
Yellow Sweet Clover	*Melilotus officinalis* (L.) Lam.	Legume	Non-Native
Mint	*Mentha* L. spp.	Forb	Non-Native
Japanese Stilt Grass/Nepalese Browntop	*Microstegium vimineum* (Trin.) A.Camus	Grass	Non-Native
Black Gum	*Nyssa sylvatica* Marshall	Tree	Native
Pink Primrose	*Oenothera speciosa* Nutt.	Forb	Non-Native
Slender Yellow Woodsorrel	*Oxalis dillenii* Jacq.*	Forb	Native
Common Yellow Woodsorrel	*Oxalis stricta* L.*	Forb	Native
Sourwood	*Oxydendrum arboreum* (L.) DC.	Tree	Native

Small's Golden Ragwort	*Packera anonyma* (Alph. Wood) W.A.Weber and Á.Löve	Forb	Native
Butterweed Ragwort	*Packera glabella* (Poir.) C.Jeffrey	Forb	Native
Panic Grass	*Panicum* L. spp.*	Grass	Native
Switchgrass	*Panicum virgatum* L.	Grass	Native
Virginia Creeper	*Parthenocissus quinquefolia* (L.) Planch.	Vine	Native
Dallisgrass	*Paspalum dilatatum* Poir.	Grass	Non-Native
Field Paspalum	*Paspalum laeve* Michx.	Grass	Native
Bahiagrass	*Paspalum notatum* Flueggé*	Grass	Non-Native
Vasey's Grass	*Paspalum urvillei* Steud.*	Grass	Non-Native
Purple Passion Flower	*Passiflora incarnata* L.*	Vine	Native
Beefstake Plant	*Perilla frutescens* (L.) Britton	Forb	Non-Native
Shortleaf Pine	*Pinus echinata* Mill.	Tree	Native
Pine	*Pinus* L. spp.	Tree	Native
Loblolly Pine	*Pinus taeda* L.*	Tree	Native
Largebracted Plantain	*Plantago aristata* Michx.	Forb	Native
Narrowleaf English Plantain	*Plantago lanceolata* L.*	Forb	Non-Native
Common Plantain	*Plantago major* L.*	Forb	Non-Native
Virginia Plantain	*Plantago virginica* L.	Forb	Native
Camphor Pluchea	*Pluchea camphorata* (L.) DC.	Forb	Native
Stinkweed	*Pluchea odorata* (L.) Cass.	Forb	Native
Kentucky Bluegrass	*Poa pratensis* L.	Grass	Non-Native
Little Bluegrass	*Poa* L. spp.	Grass	Unknown
Oriental Lady's Thumb Smartweed	*Polygonum cespitosum* Blume, nom. inq.*	Forb	Non-Native
Dense Flowered Knotweed	*Polygonum glabrum* Willd.	Forb	Native
Swamp Smartweed	*Polygonum hydropiperoides* Michx.*	Forb	Native
Pennsylvania Smartweed	*Polygonum pensylvanicum* L.	Forb	Native
Spotted Lady's Thumb Smartweed	*Polygonum persicaria* L.	Forb	Non-Native
Dotted Smartweed	*Polygonum punctatum* Elliott	Forb	Native
Wild Black Cherry	*Prunus serotina* Ehrh.	Tree	Native
Rabbit Tobacco	*Pseudognaphalium obtusifolium* (L.) Hilliard and B.L.Burtt	Forb	Native
Mock Bishopweed/Herb William	*Ptilimnium capillaceum* (Michx.) Raf.	Forb	Native
Whiteleaf Mountainmint	*Pycnanthemum albescens* Torr. and A.Gray	Forb	Native
Hoary Mountainmint	*Pycnanthemum incanum* (L.) Michx.	Forb	Native
White Oak	*Quercus alba* L.	Tree	Native
Scarlet Oak	*Quercus coccinea* Münchh.	Tree	Native
Southern Red Oak	*Quercus falcata* Michx.	Tree	Native
Water Oak	*Quercus nigra* L.	Tree	Native
Pin Oak	*Quercus palustris* Münchh.	Tree	Native
Willow Oak	*Quercus phellos* L.	Tree	Native
Oak	*Quercus* L. spp.*	Tree	Native

Post Oak	*Quercus stellata* Wangenh.	Tree	Native
Littleleaf Buttercup	*Ranunculus abortivus* L.	Forb	Native
Early Buttercup	*Ranunculus fascicularis* Muhl. ex Bigelow	Forb	Native
Bristly Buttercup	*Ranunculus hispidus* Michx.	Forb	Native
Low Spearwort	*Ranunculus pusillus* Poir.*	Forb	Native
Blisterwort Buttercup	*Ranunculus recurvatus* Poir.	Forb	Native
Creeping Buttercup	*Ranunculus repens* L.*	Forb	Non-Native
Hairy Buttercup	*Ranunculus sardous* Crantz*	Forb	Non-Native
Buttercup	*Ranunculus* L. spp.*	Forb	Unknown
Maryland Meadow Beauty	*Rhexia mariana* L.	Forb	Native
Snoutbean	*Rhynchosia* Lour. spp.	Forb	Native
Twining Snoutbean	*Rhynchosia tomentosa* (L.) Hook. and Arn.	Forb	Native
Shortbristle Horned Beaksedge	*Rhynchospora corniculata* (Lam.) A.Gray	Sedge	Native
Black Locust	*Robinia pseudoacacia* L.	Tree	Native
Sawtooth Blackberry	*Rubus argutus* Link*	Vine	Native
Northern Dewberry	*Rubus flagellaris* Willd.	Vine	Native
Southern Dewberry	*Rubus trivialis* Michx.*	Vine	Native
Black-Eyed Susan	*Rudbeckia hirta* L.	Forb	Native
Curly Dock	*Rumex crispus* L.*	Forb	Non-Native
Common Broadleafed Arrowhead	*Sagittaria latifolia* Willd.	Forb	Native
Black Willow	*Salix nigra* Marshall*	Tree	Native
Lyre-Leaved Sage	*Salvia lyrata* L.*	Forb	Native
Black Elderberry	*Sambucus nigra* L.	Shrub	Native
Tall Fescue	*Schedonorus phoenix* (Schreb.) Dumort., nom. cons.*	Grass	Non-Native
Little Bluestem	*Schizachyrium scoparium* (Michx.) Nash	Grass	Native
Hairy Skullcap	*Scutellaria elliptica* Muhl. ex Spreng.	Forb	Native
Helmet Flower	*Scutellaria integrifolia* L.	Forb	Native
Crown Vetch	*Securigera varia* (L.) Lassen	Legume	Non-Native
Bigpod Coffeeweed	*Sesbania herbacea* (Mill.) McVaugh	Legume	Native
Marsh Bristlegrass	*Setaria parviflora* (Poir.) Kerguélen*	Grass	Native
Yellow Foxtail	*Setaria pumila* (Poir.) Roem. and Schult.*	Grass	Non-Native
Green Bristlegrass	*Setaria viridis* (L.) P. Beauv.*	Grass	Non-Native
Hedge Mustard	*Sisymbrium officinale* (L.) Scop.	Forb	Non-Native
Narrowleafed Blue-eyed Grass	*Sisyrinchium angustifolium* Mill.	Forb	Native
Annual Blue-eyed Grass	*Sisyrinchium rosulatum* E.P.Bicknell	Forb	Native
Saw Greenbrier	*Smilax bona-nox* L.	Vine	Native
Cat Greenbrier	*Smilax glauca* Walter	Vine	Native
Laurel Greenbrier	*Smilax laurifolia* L.	Vine	Native
Roundleaf Greenbrier	*Smilax rotundifolia* L.	Vine	Native
Lanceleaf Greenbrier	*Smilax smallii* Morong	Vine	Native
Greenbrier	*Smilax* L. spp.	Vine	Native

Carolina Horsenettle	*Solanum carolinense* L.	Forb	Native
Tall Canada Goldenrod	*Solidago altissima* L.*	Forb	Native
Canada Goldenrod	*Solidago canadensis* L.*	Forb	Native
Anisescented Goldenrod	*Solidago odora* Aiton*	Forb	Native
Goldenrod	*Solidago* L. spp.*	Forb	Native
Johnsongrass	*Sorghum halepense* (L.) Pers.*	Grass	Non-Native
Hairy White Oldfield Aster	*Symphyotrichum pilosum* (Willd.) G.L.Nesom*	Forb	Native
Aster	*Symphyotrichum* Nees spp.*	Forb	Native
Common Dandelion	*Taraxacum officinale* F.H.Wigg.	Forb	Non-Native
Eastern Poison Ivy	*Toxicodendron radicans* (L.) Kuntze	Vine	Native
White Nymph	*Trepocarpus aethusae* Nutt. ex DC.	Forb	Native
Purpletop Tridens	*Tridens flavus* (L.) Hitchc.	Grass	Native
Pink Rabbit-foot Clover	*Trifolium arvense* L.	Legume	Non-Native
Field Clover/Low Hop Clover	*Trifolium campestre* Schreb.*	Legume	Non-Native
Crimson Clover	*Trifolium incarnatum* L.*	Legume	Non-Native
Red Clover	*Trifolium pretense* L.*	Legume	Non-Native
White Clover	*Trifolium repens* L.	Legume	Non-Native
Clover	*Trifolium* L. spp.	Legume	Non-Native
Common Venus's Looking Glass	*Triodanis perfoliata* (L.) Nieuwl.*	Forb	Native
Winged Elm	*Ulmus alata* Michx.*	Tree	Native
Unknown – Forb	Unknown	Forb	Unknown
Unknown – Grass	Unknown	Grass	Unknown
Unknown – Shrub	Unknown	Shrub	Unknown
Unknown – Tree	Unknown	Tree	Unknown
Unknown – Vine	Unknown	Vine	Unknown
Broadleaf Signalgrass	*Urochloa platyphylla* (Munro ex C.Wright) R.D.Webster	Grass	Native
Stinging Nettle	*Urtica dioica* L.	Forb	Native
Brazilian Vervain	*Verbena brasiliensis* Vell.*	Forb	Non-Native
Tall Ironweed	*Vernonia gigantea* (Walter) Trel.	Forb	Native
Cow/Bird/Tufted Vetch	*Vicia cracca* L.*	Legume	Non-Native
Garden Vetch	*Vicia sativa* L.*	Legume	Non-Native
Violet	*Viola* L. spp.	Forb	Unknown
Prostrate Blue/Purple Violet	*Viola walteri* House	Forb	Native
Summer Grapevine	*Vitis aestivalis* Michx.	Vine	Native
Muscadine Grape Vine	*Vitis rotundifolia* Michx.	Vine	Native
Japanese Wisteria	*Wisteria floribunda* (Willd.) DC.*	Vine	Non-Native
Chinese Wisteria	*Wisteria sinensis* (Sims) DC.*	Vine	Non-Native
Rough Cocklebur	*Xanthium strumarium* L.	Forb	Native

(*) The most frequently seen (>65% of the line transects).

Table 3. Species richness (numbers of native and non-native plant species) recorded by season along line transects, 2010–2012

		Status							
		Native plants				Non-native plants			
Elevation	Treatment[a]	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2010	Spring 2011	Fall 2011	Spring 2012
Lowland[b]	Mowed	65	92	88	106	33	61	43	48
Lowland	Reduced mowed	51	74	84	90	33	56	39	52
Lowland	Reduced mowed–seeded	57	87	92	102	34	68	45	54
Upland[c]	Mowed	18	34	27	41	23	52	43	46
Upland	Reduced mowed	10	41	34	43	20	53	37	45
Upland	Reduced mowed–seeded	22	30	36	39	22	56	34	45

[a]Mowed = ≤ 4 mowings throughout the growing seasons; Reduced mowed = one mowing during late fall; Reduced mowed–seeded = one mowing during late fall with supplemental native wildflowers.
[b]Lowland N = 5, riparian areas.
[c]Upland N = 5, hills, slopes, and dry soils.

Table 4. Mean number of total, native, and non-native plant species recorded, 2010–2012

Fall Seasons 2010–2011			Spring Seasons 2011–2012		
Species Richness	Elevation	Mean (SEM)	Species Richness	Elevation	Mean (SEM)
Total	Lowland[a]	22.13 (1.13)	Total	Lowland	29.67 (1.11)
	Upland[b]	10.87 (1.13)		Upland	17.50 (1.11)
Native	Lowland	14.57 (0.91)	Native	Lowland	18.37 (1.05)
	Upland	4.90 (0.91)		Upland	7.60 (1.05)
Non-Native	Lowland	7.57 (0.40)	Non-Native	Lowland	11.30 (0.42)
	Upland	5.97 (0.40)		Upland	9.90 (0.42)

[a]Lowland N = 5, riparian.

[b]Upland N = 5, hills, slopes, dry soils.

Table 5. Statistics for comparison of total non-native and native species richness

Source	DF	Total Native/Non-Native Species Richness F Value	Pr > F		Non-Native Species Richness F Value	Pr > F		Native Species Richness F Value	Pr > F	
Fall Seasons 2010-2011 Species Richness										
YEAR[a]	1	24.61	0.001	*	25.84	0.001	*	13.43	0.001	*
TRT[b]	2	0.59	0.560		0.57	0.570		0.43	0.652	
ELEVATION[c]	1	61.40	0.001	*	10.31	0.002	*	59.31	0.001	*
YEAR*TRT	2	0.13	0.877		0.22	0.804		0.34	0.710	
YEAR*ELEVATION	1	0.26	0.612		2.17	0.148		1.37	0.248	
ELEVATION*TRT	2	0.06	0.942		0.58	0.565		0.20	0.816	
YEAR*ELEVATION*TRT	2	0.21	0.813		0.41	0.668		0.08	0.926	
Spring Seasons 2011-2012 Species Richness										
YEAR[a]	1	0.02	0.894		10.04	0.003	*	1.68	0.201	
TRT[b]	2	0.26	0.776		0.87	0.424		0.20	0.819	
ELEVATION[c]	1	48.41	0.001	*	5.64	0.022	*	44.17	0.001	*
YEAR*TRT	2	0.01	0.987		0.41	0.668		0.01	0.989	
YEAR*ELEVATION	1	0.16	0.691		0.12	0.736		0.31	0.581	
ELEVATION*TRT	2	0.83	0.441		0.36	0.703		0.73	0.486	
YEAR*ELEVATION*TRT	2	0.10	0.904		0.30	0.744		0.02	0.976	

(*) Denotes significant differences at alpha level = 0.05.
a) Over the two-year study period 2010-2012.
b) TRT = Treatments – mowed, reduced mowed, reduced mowed-seeded.
c) Upland vs. lowland elevations.

Table 6. Mean percent coverage of plants by growth form

Growth form	Mean percent coverage (SE)
Native forb	19.75 (1.56)
Non-native forb	2.63 (0.35)
Native grass	1.50 (0.30)
Non-native grass	88.63 (3.03)
Native legume	0.72 (0.38)
Non-native legume	31.86 (3.49)
Native rush	1.50 (0.49)
Native sedge	1.99 (0.36)
Non-native sedge	0.07 (0.04)
Native shrub	0.21 (0.05)
Native tree	1.57 (0.41)
Native vine	4.45(0.76)
Non-native vine	1.34 (0.37)

Table 7. Mean percent coverage of vegetation within growth forms in uplands and lowlands during fall and spring, 2010–2012

	Vegetation growth form	Mean percent coverage (SE)	
		Upland[a]	Lowland[b]
Fall survey periods	Native forb	7.80 (1.53)*	49.64 (7.94)*
	Non-native forb	2.54 (0.54)	2.22 (0.46)
	Native grass	1.84 (0.47)*	4.93 (0.94)*
	Non-native grass	134.51 (8.77)	115.60 (9.01)
	Native legume	0.02 (0.02)*	5.62 (2.57)*
	Non-native legume	6.79 (2.87)	7.16 (4.17)
	Native rush	0.03 (0.03)*	3.11 (1.06)*
	Native sedge	0.33 (0.11)	0.89 (0.25)
	Non-native sedge	0.21 (0.17)	0.91 (0.36)
	Native shrub	0.52 (0.40)	0.34 (0.11)
	Native tree	0.69 (0.23)	1.88 (0.48)
	Native vine	12.02 (4.09)	2.49 (0.76)
	Non-native vine	2.10 (1.03)	0.92 (0.48)
Spring survey periods	Native forb*	20.10 (2.72)*	47.45 (7.21)*
	Non-native forb	3.83 (0.96)	8.07 (1.52)
	Native grass	2.08 (0.75)	5.87 (1.27)
	Non-native grass	159.13 (9.81)	127.51 (7.42)
	Native legume*	0.00 (0.00)*	4.12 (1.94)*
	Non-native legume*	84.02 (7.43)*	42.31 (5.25)*
	Native rush	0.21 (0.09)*	10.68 (2.58)*
	Native sedge	1.51 (0.47)*	7.17 (1.30)*
	Native shrub	0.19 (0.13)	0.66 (0.29)
	Native tree	1.30 (0.39)	5.13 (1.70)
	Native vine	5.92 (1.48)	5.02 (1.42)
	Non-native vine	2.39 (1.03)	1.02 (0.37)

[a] N = 5

[b] N = 5

*Percent coverage differed significantly between upland and lowland ($P \leq 0.05$).

Table 8. Mean percent coverage of vegetation in different height categories in uplands and lowlands

	Height category	Elevation	Mean (SEM)
Fall survey period	<18 in.	Lowland[a]	125.22 (11.49)
		Upland[b]	126.24 (11.49)
	18–36 in.	Lowland	69.20 (4.42)
		Upland	53.20 (4.42)
	>36 in.	Lowland	17.18 (3.21)
		Upland	6.64 (3.21)
Spring survey period	<18 in.	Lowland	216.79 (9.74)
		Upland	226.96 (9.74)
	18–36 in.	Lowland	49.15 (4.69)
		Upland	50.08 (4.69)
	>36 in.	Lowland	28.63 (3.90)
		Upland	16.15 (3.90)

[a]Lowland N = 5, riparian areas.
[b]Upland N = 5, hills, slopes, well-drained soils.

Table 9. Comparison of mean percent coverage of vegetation within height categories among sites, years, treatments, elevations, and interactions during fall seasons

Source	DF	< 18 inches F Value	Pr > F	18 to 36 inches F Value	Pr > F	> 36 inches F Value	Pr > F
SITE[a]	1	5.48	0.0249*	0.30	0.5847	0.95	0.3375
YEAR[b]	1	17.87	0.0002*	5.54	0.0241*	7.60	0.0091*
TRT[c]	2	0.41	0.6679	0.22	0.8020	0.15	0.8592
ELEVATION[d]	1	0.01	0.9194	7.23	0.0108*	3.09	0.0875
SITE*YEAR	1	0.24	0.6248	0.32	0.5770	0.47	0.4986
YEAR*TRT	2	0.20	0.8162	0.23	0.7986	0.02	0.9790
SITE*TRT	2	0.60	0.5523	0.20	0.8161	0.02	0.9848
SITE*ELEVATION	1	0.01	0.9215	4.48	0.0413*	3.86	0.0573‡
YEAR*ELEVATION	1	0.09	0.7624	7.16	0.0112*	0.51	0.4817
ELEVATION*TRT	2	0.06	0.9378	0.31	0.7344	0.00	0.9990
SITE*YEAR*TRT	2	0.30	0.7404	0.21	0.8078	0.02	0.9832
SITE*YEAR*ELEVATION	1	0.93	0.3410	4.26	0.0462*	1.85	0.1827
YEAR*ELEVATION*TRT	2	0.41	0.6661	0.30	0.7428	0.10	0.9052
SITE*ELEVATION*TRT	2	0.43	0.6512	1.19	0.3153	0.06	0.9379
SITE*YEAR*ELEVATION*TRT	2	0.15	0.8632	1.24	0.3016	0.08	0.9239

*Denotes significant differences at alpha level = 0.05.
‡ Not significant at alpha level = 0.05 (however for practical purposes it is close).
[a] Indicates upland sites (N=5) vs. lowland sites (N=5).
[b] Over the two-year study period 2010-2012.
[c] TRT=Treatments – mowed, reduced mowed, reduced mowed-seeded.
[d] Upland vs. lowland riparian elevations.

Table 10. Mean stem density of woody plants in uplands and lowlands during fall and spring, 2010–2012

	Woody species category	Elevation	Mean (SEM) stems/acre
Fall survey	Combined native and non-native	Lowland[a]	1,937.47 (802.39)
		Upland[b]	4,355.47 (802.39)
	Native	Lowland	1,719.64 (799.56)
		Upland	4,133.20 (799.56)
	Non-native	Lowland	494.81 (137.98)
		Upland	516.67 (137.98)
Spring survey	Combined native and non-native	Lowland	4725.51 (822.32)
		Upland	3,392.09 (822.32)
	Native	Lowland	4,404.86 (804.83)
		Upland	2,961.56 (804.83)
	Non-native	Lowland	698.98 (209.53)
		Upland	841.19 (209.49)

[a]Lowland N = 5, riparian areas.
[b]Upland N = 5, hills, slopes, well-drained soils.

Table 11. Number of white-tailed deer observed during spotlight counts from January 2011 to January 2012

Date	Spotlight Count	Deer Sighted	Deer/Mile
Jan-19-2011	1	19	0.66
Jan-28-2011	2	42	1.45
Jan-29-2011	3	33	1.14
Feb-10-2011	1	2	0.07
Feb-17-2011	2	36	1.24
Feb-18-2011	3	34	1.17
Mar-3-2011	1	66	2.28
Mar-23-2011	2	35	1.21
Apr-7-2011	1	42	1.45
Apr-21-2011	2	35	1.21
May-21-2011	1	27	0.93
May-29-2011	2	20	0.69
Jun-23-2011	1	19	0.66
Jun-24-2011	2	13	0.45
Jul-27-2011	1	11	0.38
Jul-29-2011	2	8	0.28
Aug-9-2011	1	23	0.79
Aug-30-2011	2	25	0.86
Sep-18-2011	1	18	0.62
Sep-22-2011	2	11	0.38
Oct-13-2011	1	3	0.10
Oct-27-2011	2	12	0.41
Oct-28-2011	3	46	1.59
Nov-17-2011	1	18	0.62
Nov-30-2011	2	19	0.66
Dec-7-2011	1	13	0.45
Jan-17-2012	1	34	1.17
Jan-20-2012	2	26	0.90
Jan-31-2012	3	33	1.14

Table 12. Summary of responses to public perception survey

Topic of Survey Question	Responses N = 129						Mean Score
	No Response (NA)	Dislike (0–1)	(2–4)	Neutral (5)	(6–8)	Like (9–10)	
	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	
Aesthetics Perception (Appearance of Right of Ways)							
Native wildflowers on right of ways (Question 6a)	0	0	4	2	27	96	9.1
Native grass on right of ways (Question 6b)	0	15	34	14	30	36	5.7
Mowed right of ways (Question 6c)	0	9	31	13	29	47	6.4
Mowing with visible litter on right of ways (Question 6f)	0	121	6	1	1	0	0.3

Table 12 (continued)

Topic of Survey Question	Responses N = 129						Mean Score
	No Response (NA)	Strongly Oppose (1)	Oppose (2)	Neutral (3)	Support (4)	Strongly Support (5)	
	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	
Mowing Perception (Management of Roadsides: Current and Future Mowing Regimes on Right of Ways)							
Support tall vegetation if it discourages wildlife (Question 22)	0	5	9	24	31	60	4.0
Support reduced mowing to save taxpayer money (Question 23)	0	8	16	23	34	48	3.8
Support reduced mowing to promote native wildflowers (Question 24)	0	3	9	17	40	60	4.1
Support reduced mowing to decrease invasive plant spread (Question 26)	0	11	9	25	34	50	3.8
Support reduced mowing to increase tourism (Question 27)	0	6	2	24	35	62	4.1

Table 12 (continued)

Topic of Survey Question	Responses N = 129						Mean Score
	No Response (NA)	Rare (0–1)	(2–4)	Neutral (5)	(6–8)	Often (9–10)	
	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	Number of Respondents	
Wildlife Perception (Wildlife-Vehicle Issues on Roads and Right of Ways)							
Concerns about wildlife along right of ways (Question 16)	0	5	17	10	40	57	7.4
Involved in wildlife-vehicle accident (Question 17)	0	50	43	11	15	10	3.0
Concerns about wildlife-vehicle accident (Question 18)	3	11	18	6	34	57	7.1
Accidents beneficial to economy (Question 19)	2	13	9	17	29	59	7.1
Wildlife attracted to taller vegetation (Question 20)	1	10	14	18	47	39	6.6
Favor reduced mowing to decrease accidents (Question 21)	1	10	18	23	32	45	6.5

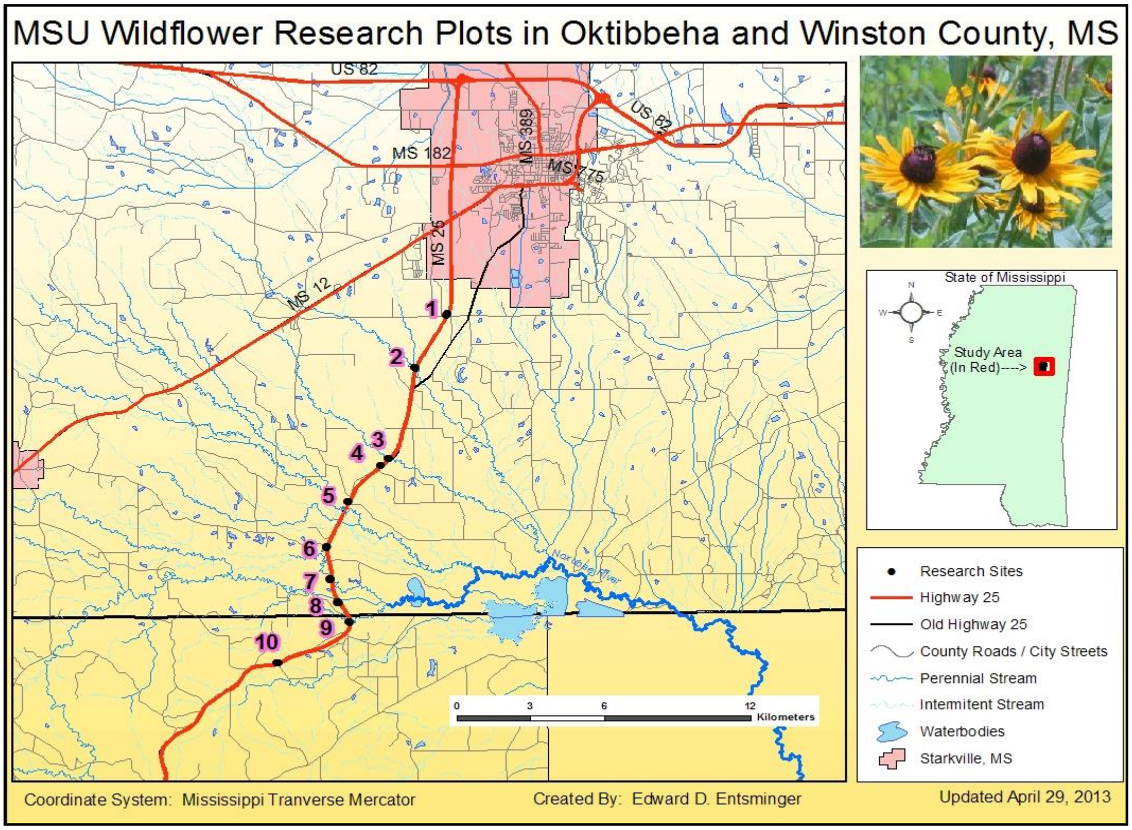


Figure 1. Map showing research plots along Hwy 25

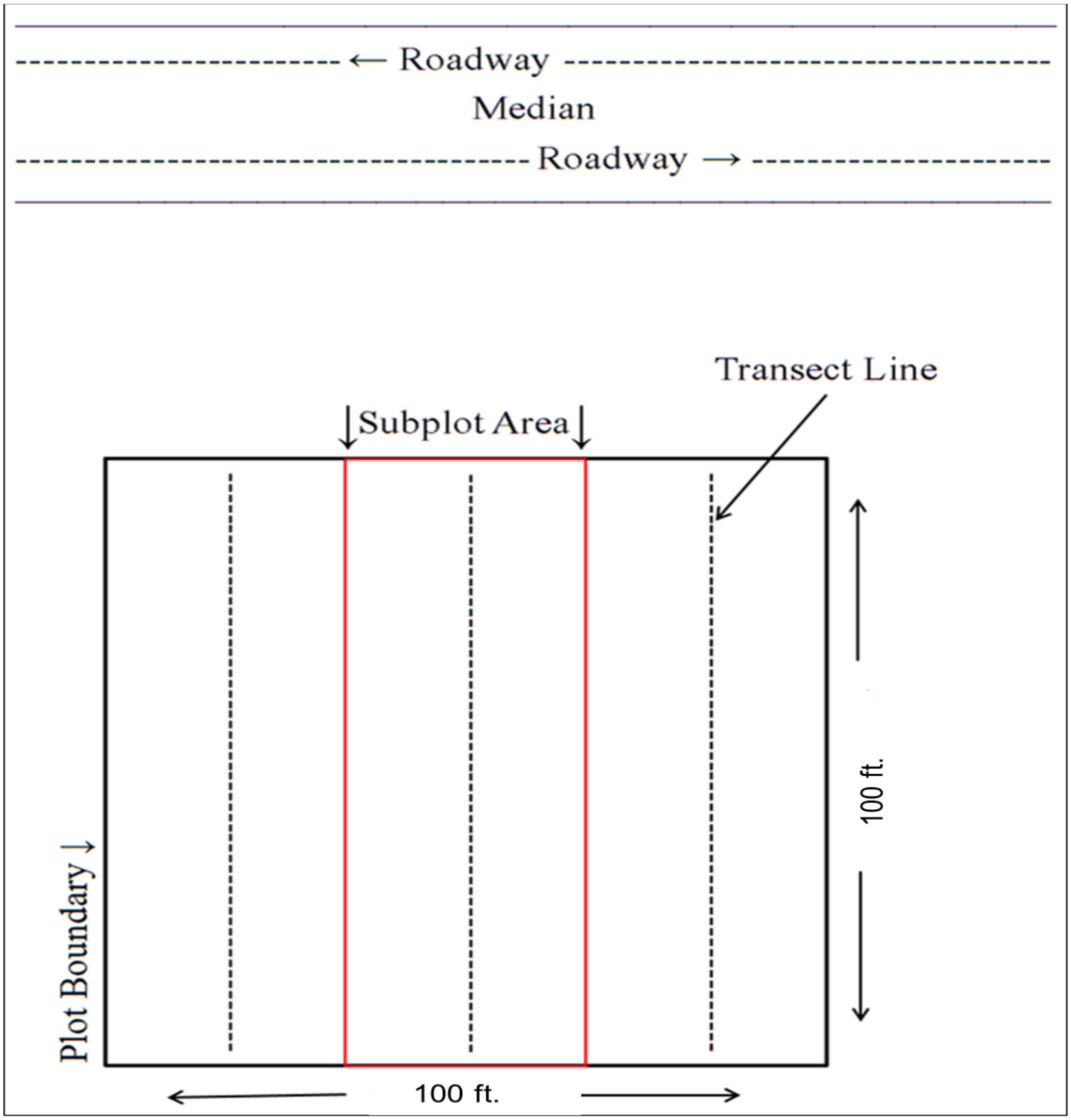


Figure 2. Plot and subplot design for estimation of plant community characteristics using line transect methodology

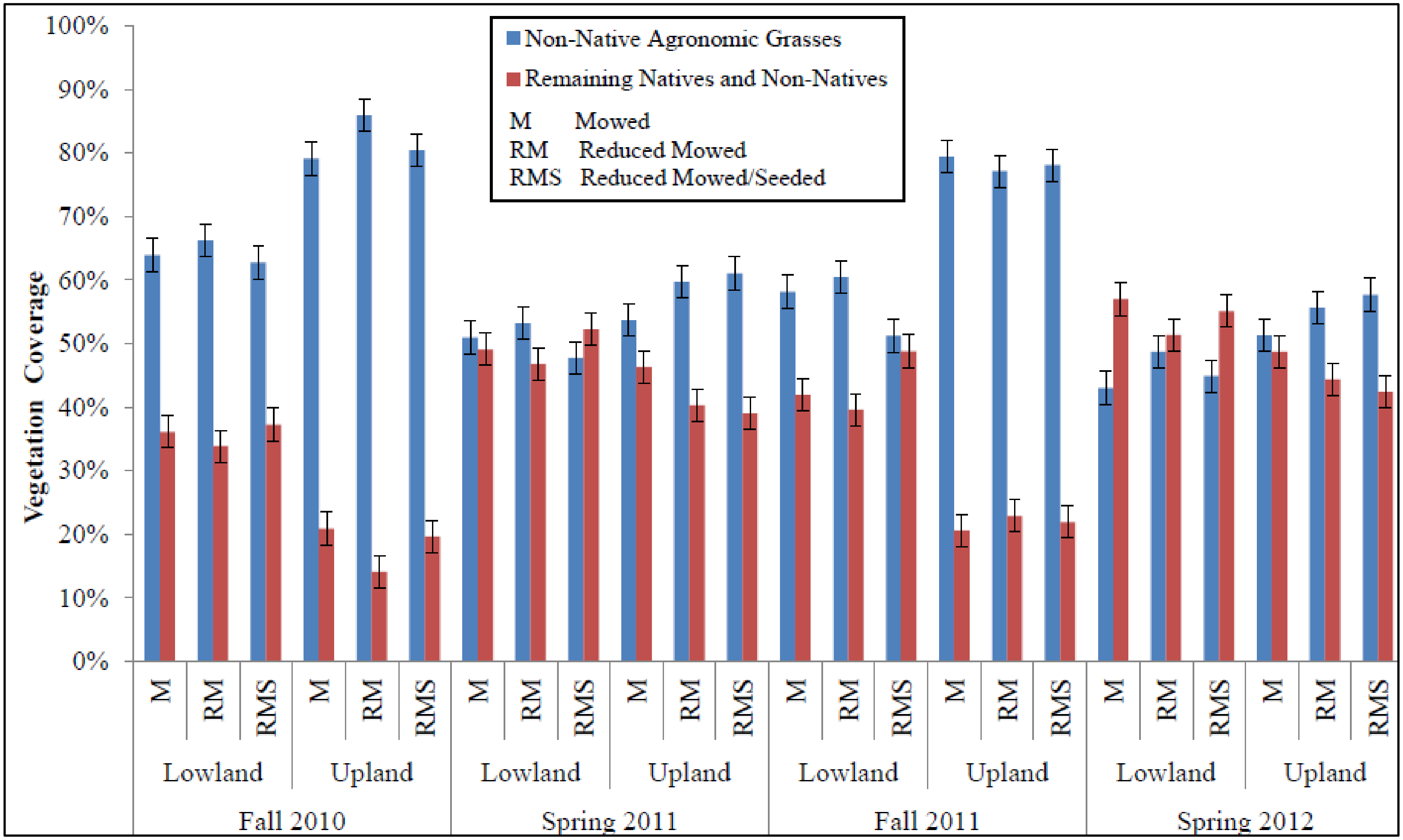


Figure 3. Mean percent coverage of non-native agronomic grasses and remaining native and non-native plant species by treatment, elevation, and season

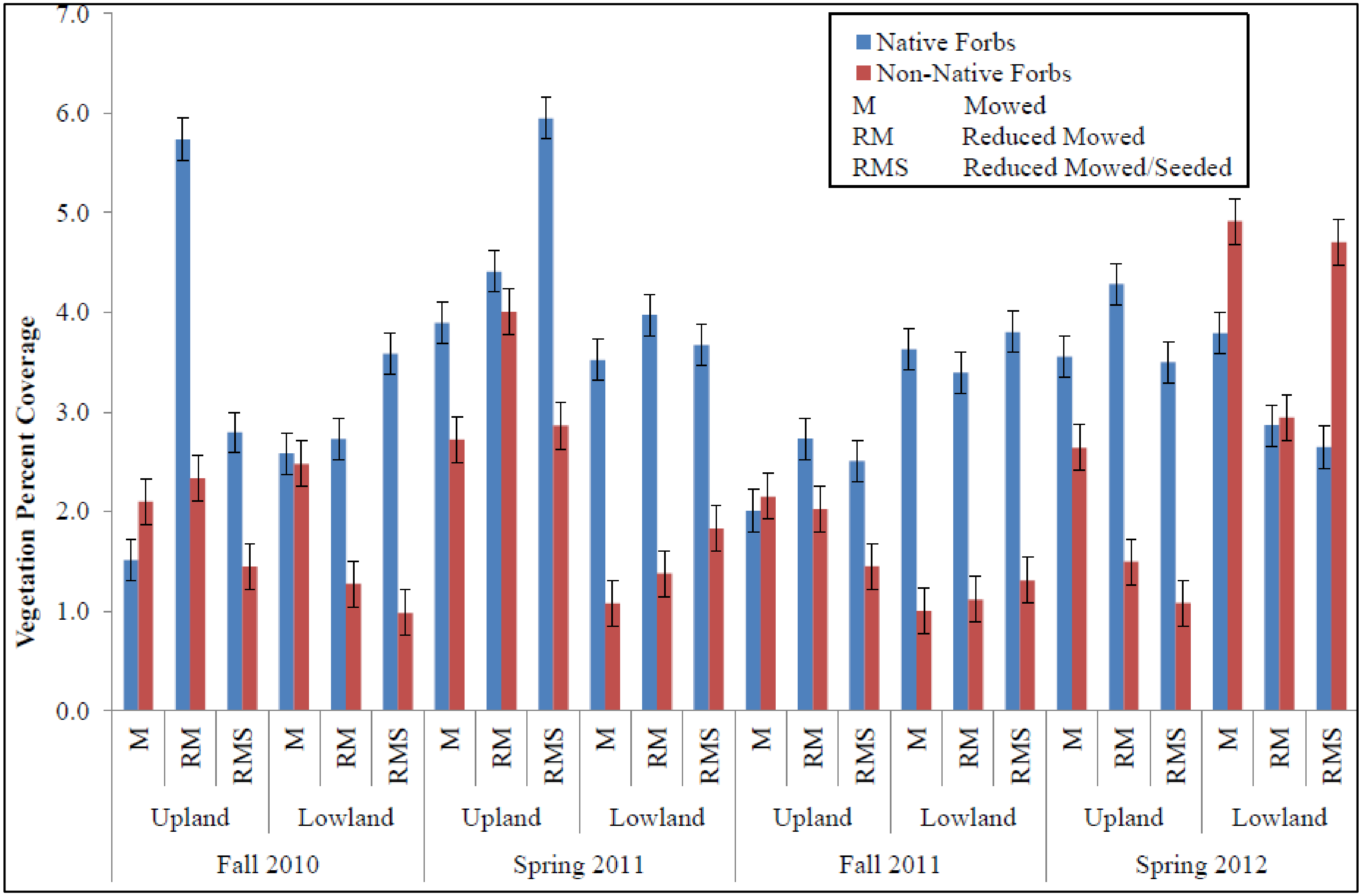


Figure 4. Mean percent coverage of native and non-native forbs by treatment, elevation, and season

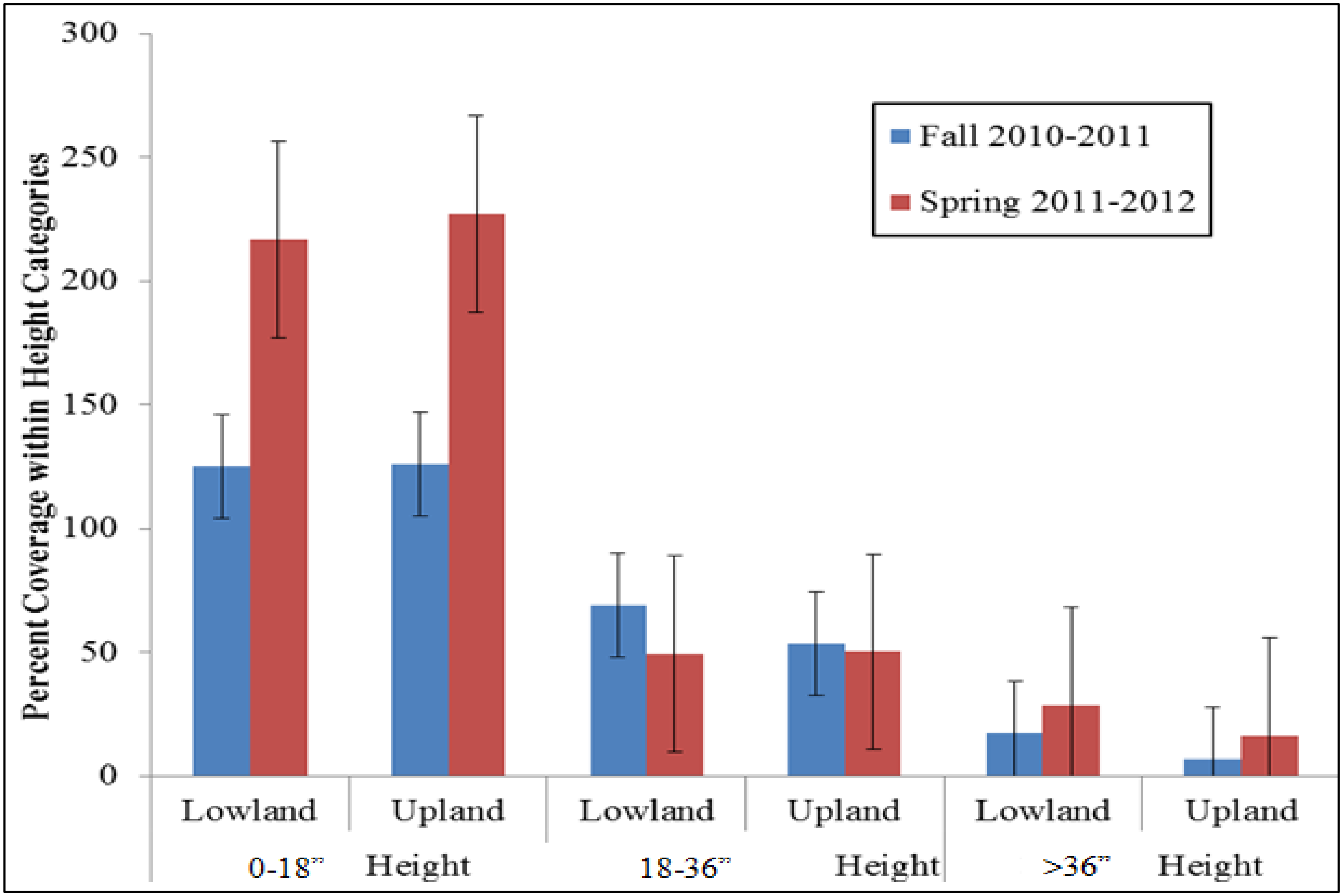


Figure 5. Mean percent coverage of vegetation within height categories during fall and spring

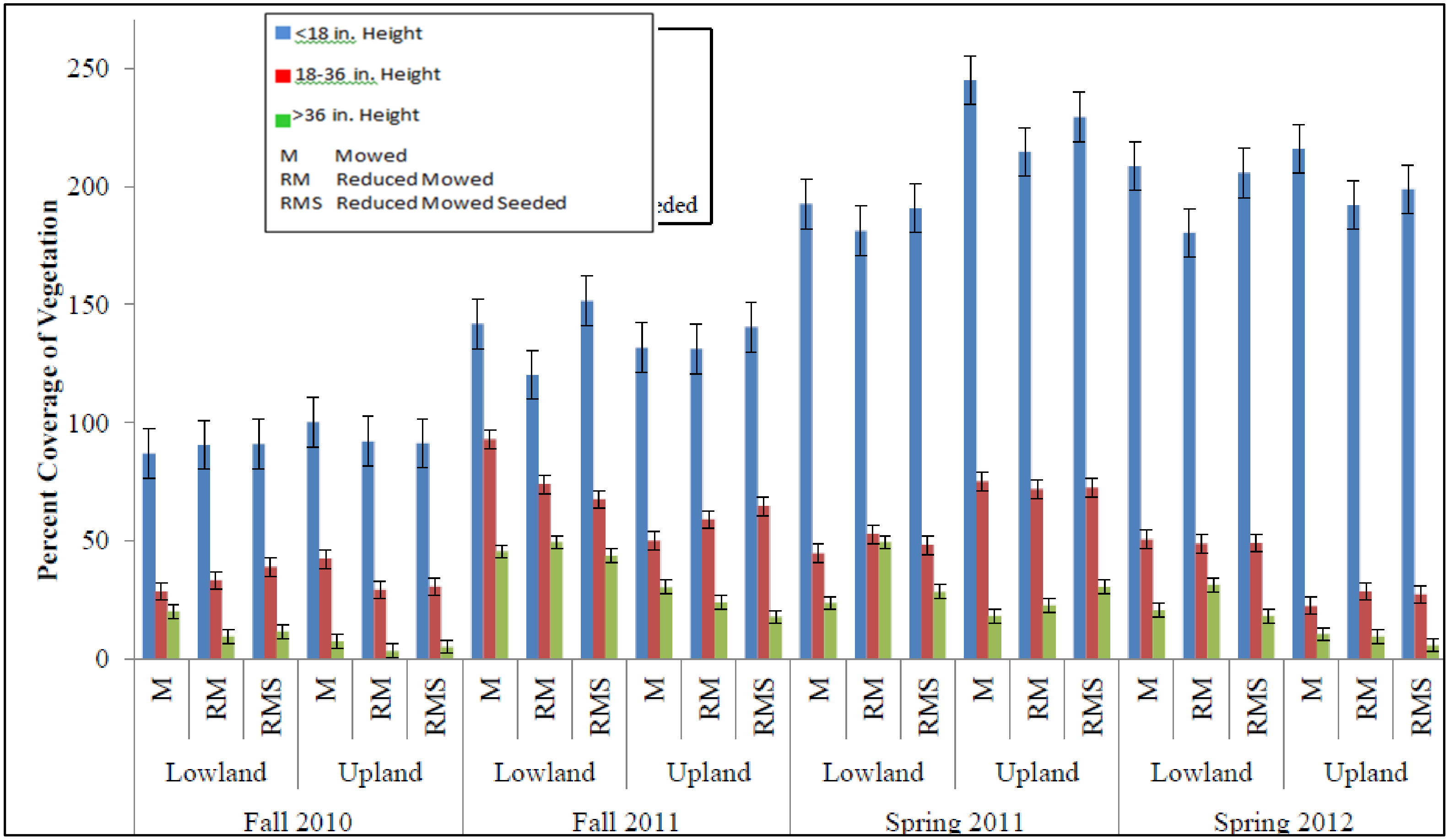


Figure 6. Percent coverage of vegetation within height categories by treatment, elevation, and season

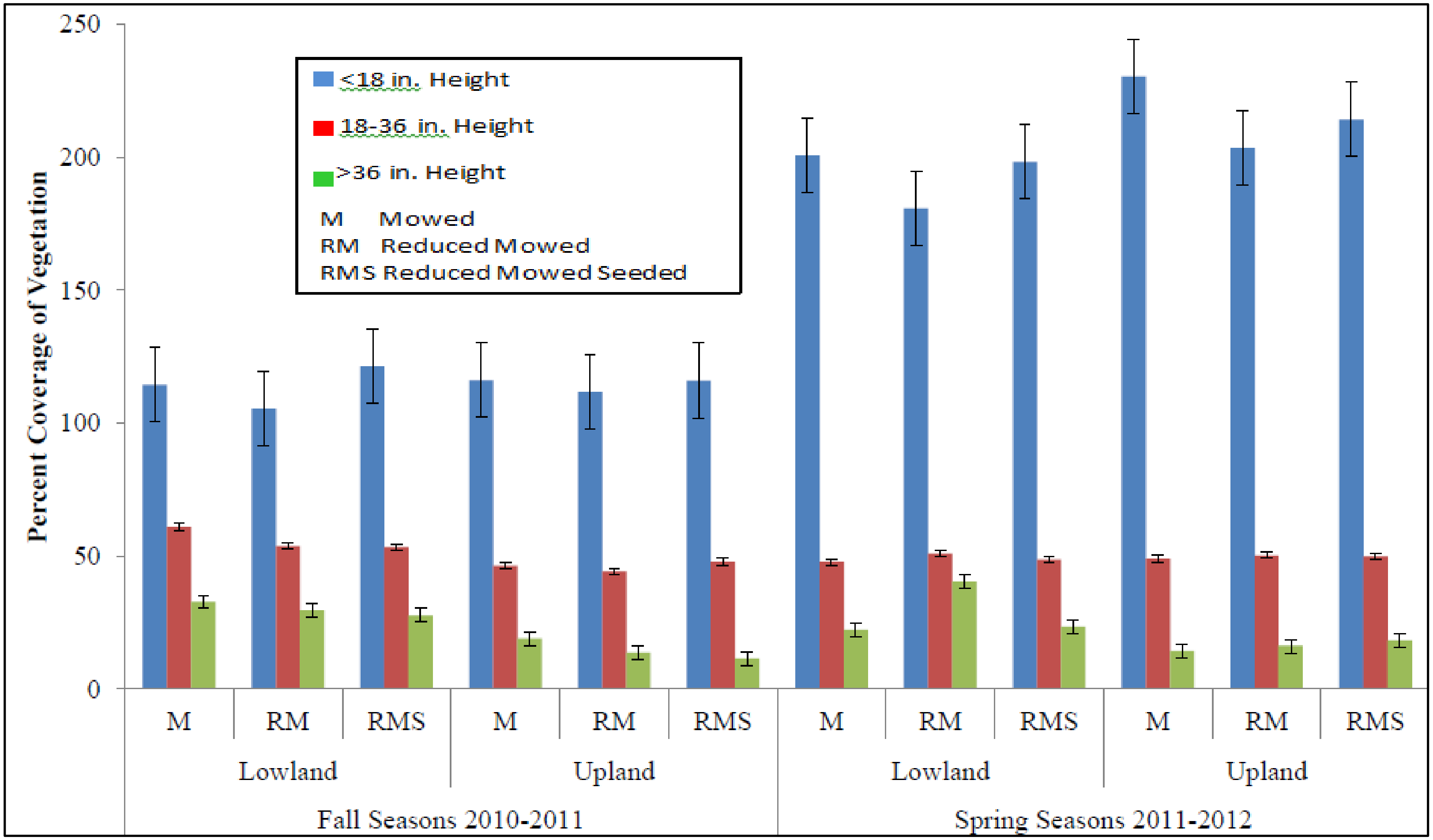


Figure 7. Vegetation percent coverage in height categories, treatments, elevations, and seasons

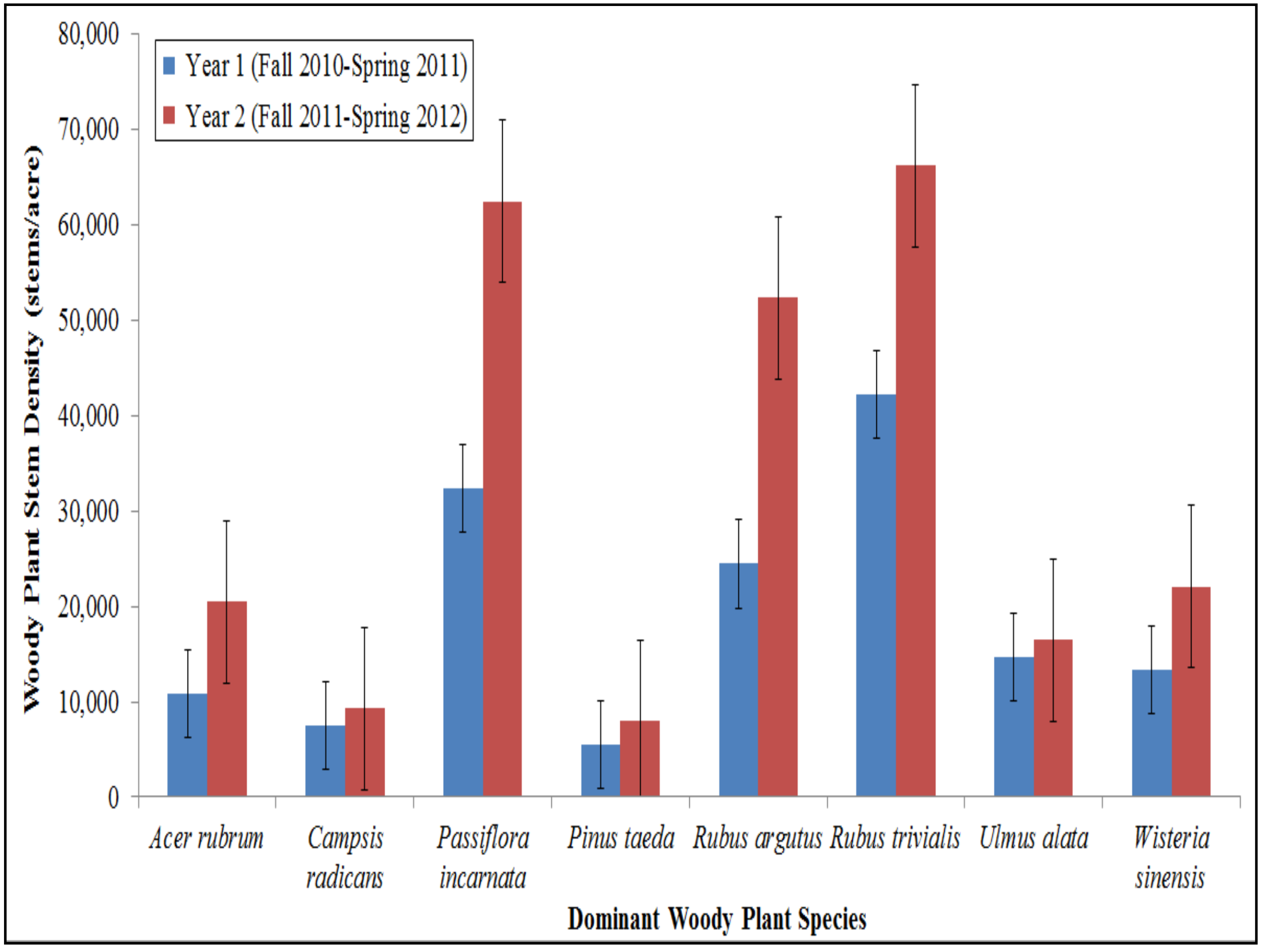


Figure 8. Mean stem density of the most common woody plant species during years 1 and 2

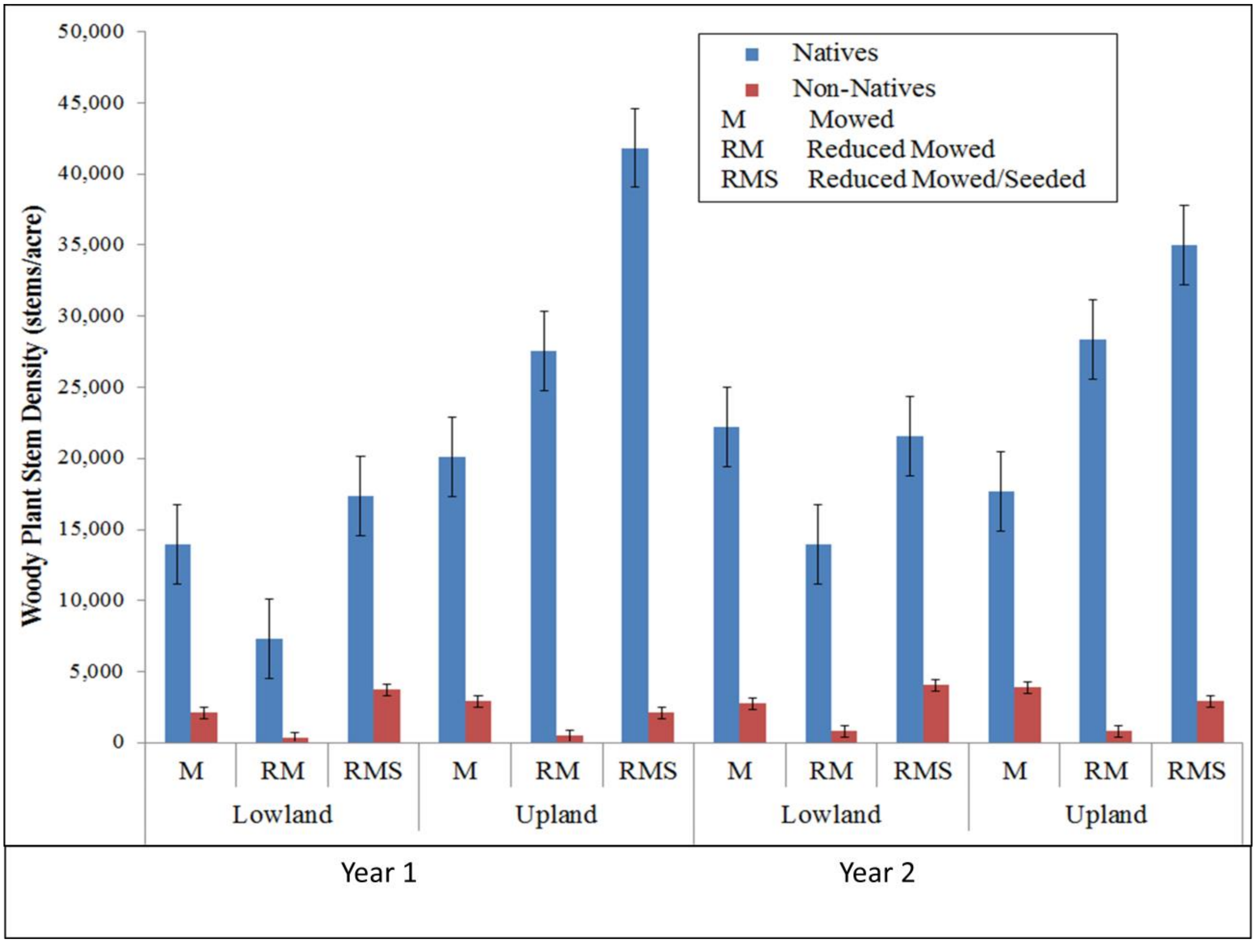


Figure 9. Mean stem density of woody plants in treatments, elevations, and years (2010 and 2012)

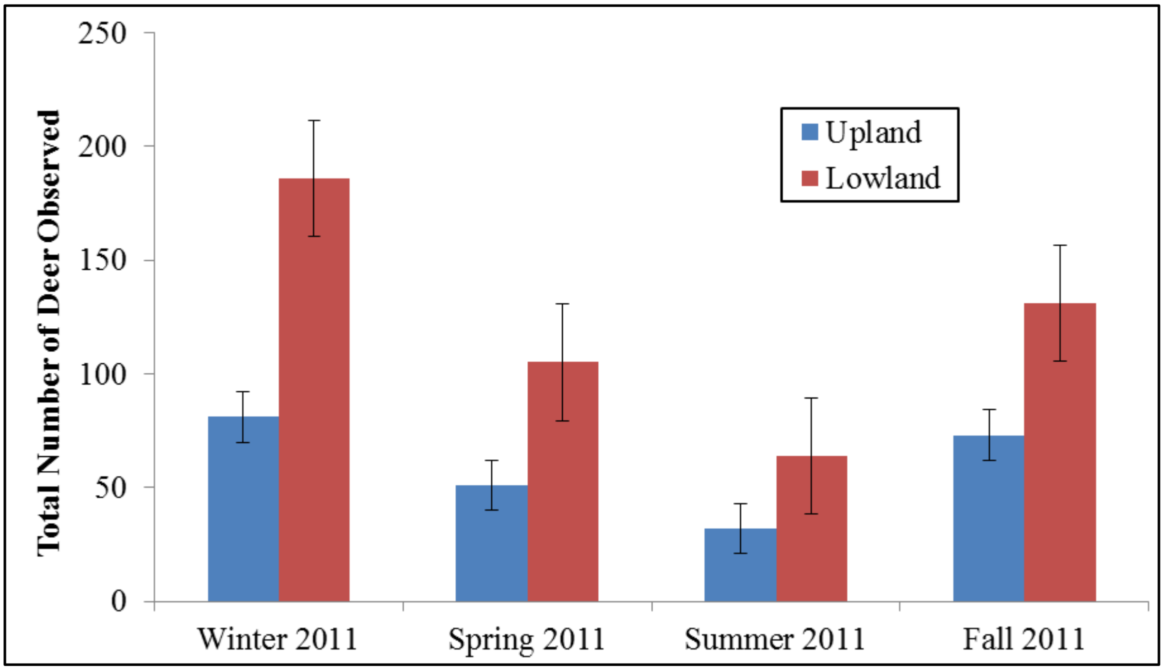


Figure 10. Number of white-tailed deer (*Odocoileus virginianus*) observed by season and elevation along the Highway 25 ROW

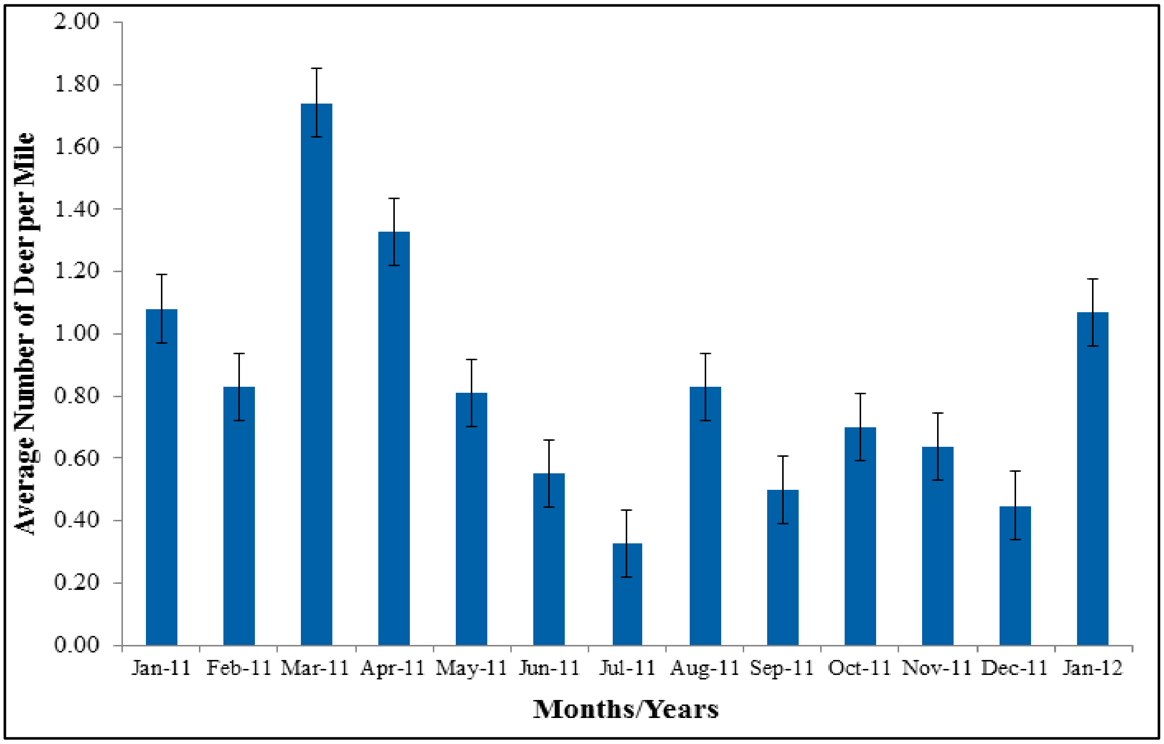


Figure 11. Mean number of white-tailed deer (*Odocoileus virginianus*) observed per mile along the Highway 25 ROW

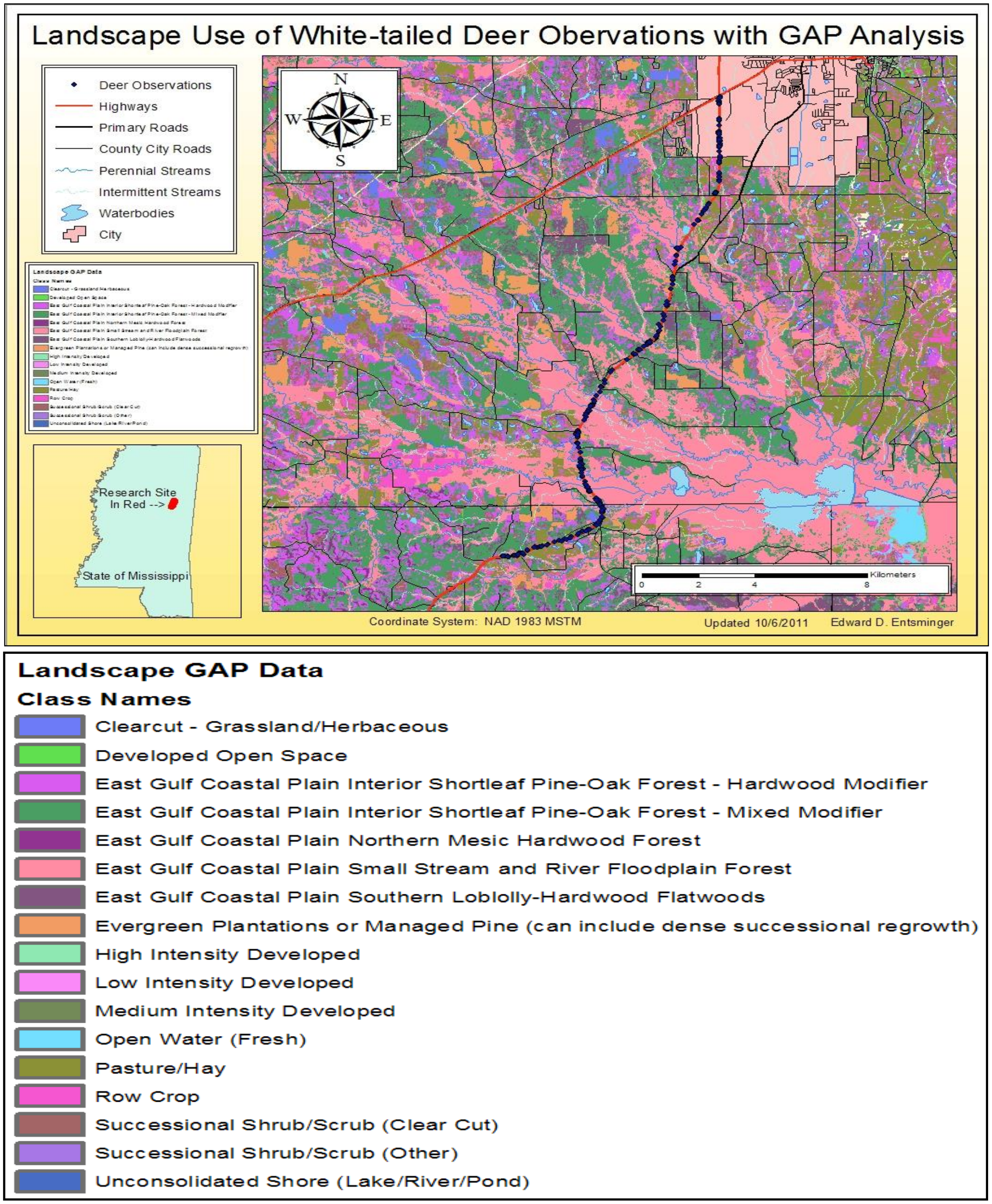


Figure 12. GPS points overlay into ArcMap GAP where white-tailed deer were observed during 2011–2012

Appendix B: Public Survey on Roadside Right of Ways in Mississippi

Mississippi State University, College of Forest Resources

This public survey is intended to promote and help guide Mississippi State University (MSU) research and to provide the Mississippi Department of Transportation (MDOT) alternative ways of mowing, while incorporating the public's view on native wildflowers, wildlife, mowing, litter and saving taxpayers money.

Demographic

The section below is basic personal information about the surveyor

1. Gender: Circle one Male Female
2. Age: 18-24 25-34 35-44 45-54 55-64 65+
3. Race: White___ Black___ Hispanic___ Asian___ Other____
4. How often does your family participate in activities involving the outdoors and natural nature events (i.e. hiking, fishing, riding bikes, nature walks, etc.)?
   Never _____
   A few times per year _____
   A few times per month _____
   Every week _______

Highway Perception

The section below is about the frequency the surveyor drives on highways or interstates. Please Circle the number that best represents your perception of highways

Rank: 0 (Rare) to 10 (Often)

5. How often do you drive on Interstates and/or Highways?
   0 1 2 3 4 5 6 7 8 9 10

Aesthetics Perception

The section below is about the aesthetics along the roadsides and the public's perception of it. Please Circle the number that best represents your perception about roadside aesthetics.

Rank: 0 (Dislike) to 10 (Like)

<u>Wildflowers</u>

6. How aesthetically pleasing (attractive/beautiful) is each picture:

   a. Native Wildflowers

0 1 2 3 4 5 6 7 8 9 10

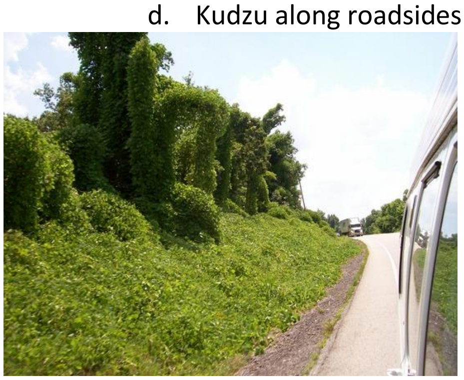
b. Native Grasses

0 1 2 3 4 5 6 7 8 9 10

c. Mowed Right of Way

0 1 2 3 4 5 6 7 8 9 10

d. Kudzu along roadsides



0 1 2 3 4 5 6 7 8 9 10

e. Cogongrass along roadsides

0 1 2 3 4 5 6 7 8 9 10

f. Trashy Ditch

0 1 2 3 4 5 6 7 8 9 10

7. Do you enjoy a natural looking roadside with native grasses, wildflowers and butterflies?
   0 1 2 3 4 5 6 7 8 9 10
8. Would you like to see wildflowers on Mississippi roadsides like Texas, North Carolina, Florida, Ohio, Indiana and California have?
   0 1 2 3 4 5 6 7 8 9 10
9. How likely would you use a wildflower guide on MDOT's website?
   0 1 2 3 4 5 6 7 8 9 10
10. How likely would you purchase wildflower seeds for your yard that you see growing on the Right of Ways (ROW's)?
    0 1 2 3 4 5 6 7 8 9 10

Mowing

11. Do you prefer manicured (mowed) roadsides?
    0 1 2 3 4 5 6 7 8 9 10

12. How often have you complained to the Mississippi Department of Transportation (MDOT) about their roadside management?
    0 1 2 3 4 5 6 7 8 9 10

Trash/Litter

13. How much does trash on the roadsides bother you after mowing?
    0 1 2 3 4 5 6 7 8 9 10

14. How much would you enjoy taller natural looking native grasses if they better conceal trash and litter?
    0 1 2 3 4 5 6 7 8 9 10

15. Rank each picture below on how well you like seeing this along the roadsides.

a. 

0 1 2 3 4 5 6 7 8 9 10

b. 

0 1 2 3 4 5 6 7 8 9 10

c. 

0 1 2 3 4 5 6 7 8 9 10

Wildlife Perception

This section below is about the wildlife perceptions along Mississippi's highways and roads. Please Circle the number that best represents your perception of wildlife along roadsides.

Rank: 0 (Rare) to 10 (Often)

16. Do you worry about wildlife on the road or near the roadway right of way?
    0 1 2 3 4 5 6 7 8 9 10

17. How often have you or a relative (family member) had accident involving a deer anywhere on roads?
    0 1 2 3 4 5 6 7 8 9 10

18. When driving at night times how often do you worry about hitting a deer on the road?
    0 1 2 3 4 5 6 7 8 9 10

19. Vehicle-deer collisions are beneficial to the economy (i.e. vehicle repairs, etc.). How much does it bother you that there are people that do not want to reduce vehicle-deer collisions?
    0 1 2 3 4 5 6 7 8 9 10

20. How often do you think deer and other wildlife will be attracted to the roadsides with taller vegetation?
    0 1 2 3 4 5 6 7 8 9 10

21. With over 1 million deer-vehicle collisions occurring ever year in the United States, how much would you favor reduced mowing to decrease these accidents?
    0 1 2 3 4 5 6 7 8 9 10

Mowing Perception

This section below is about supporting Mississippi Department of Transportation's mowing cycles. Please circle the number that best represents your perception of mowing along roadsides.

Ranking: SS=Strongly Support, S=Support, N=Neutral, O=Oppose, SO= Strongly Oppose

22. Would you support taller vegetation along the roadsides if it discouraged deer due to poor tasting plants?
    SS S N O SO
23. Would you support reduced mowing management strategies to save taxpayers money?
    SS S N O SO
24. Would you support reduced mowing management strategies to promote native wildflowers?
    SS S N O SO
25. Would you support reduced mowing to encourage native plants that are good for the environment?
    SS S N O SO
26. Would you support reduced mowing to decrease introduced invasive plants which degrade the environment?
    SS S N O SO

27. Would you support reduced mowing if wildflowers along our highways increased tourism?
SS S N O SO
28. Would you support mowing only one time a year in the fall to allow native wildflower and grass seeds to propagate?
SS S N O SO

Short Answer

This section below is about general question about your knowledge and overall perception of taking this survey.

29. How many times do you think MDOT mows the highways every year? _________

30. What companies/businesses benefit from vehicle-deer accidents?

____

31. **Rank** the following **1st to 4th** in terms of what you think is **best use of tax dollars**:
Repairing Roads/Bridges _____
Building New Roads _____
Mowing Roadsides _____
Picking up Trash along Roadsides _____

32. Any additional comments that you would like to share about roadside maintenance or this survey:____
____
____
____
____