PLANT COMMUNITY RESPONSE TO THE MANAGEMENT OF AN INVASIVE TREE

Lauren S. Pile, G. Geoff Wang, Joan L. Walker, and Patricia A. Layton

Abstract—We designed several treatments to directly control an invasive tree, Chinese tallow [*Triadica sebifera* (L.) Small] on Parris Island Marine Corps Recruit Depot located in Beaufort, SC. We examined the response of the plant community to four treatment series: 1) control (C), 2) mastication (M), 3) fire (F), and 4) combination of mastication and fire (MF). We found that mastication significantly reduced midstory density of all species. However, without fire, midstory density increased to levels similar to those without mastication within 2 years. The MF treatment reduced midstory density over the course of the study, resulting in an increase in important oak species. The MF treatment also increased ground flora richness, without reducing the richness of regenerating tree species. Our results show that MF resulted in a positive response from the native community.

INTRODUCTION

Forest ecosystems are under increasing stress from environmental change, including invasion by nonnative species that can disrupt important ecological functions and services. Nonnative species invasions may interfere with maintaining desired vegetation types by altering post-disturbance succession and keeping communities in persistent undesirable states (D'Antonio and Chambers 2006), and the capacity of an ecological community to resist invasion is an important ecosystem service (Foster and others 2015). Invasive species management approaches should be designed and implemented with consideration of the processes that have historically characterized the ecological system as these may be important to building resistance in the community. Often, maintaining or restoring the structure and ecosystem processes known to favor resident species can be used to increase community resilience and resistance and thereby reduce invasion potential (D'Antonio and Chambers 2006). However, it is important to understand how invasive species management that includes changing community structure and re-establishing ecological processes impacts native species diversity.

The southeastern maritime forest has been historically characterized by a fire return interval from between 2 and 26 years, depending on the topographic situation and ignition sources (Frost 2005). On islands, the combination of lightning and burning by Native Americans may have produced a fire return interval of 5 to 7 years (Frost 2004). Increased fire frequency in maritime forests also increases herbaceous diversity (Frost 2005). Fire suppression and logging have led to the conversion of two-layered forests with open understories to nearly impenetrable thickets of dense multistoried woody vegetation with essentially no herbaceous plants (Frost 2005), similar to the conditions seen in this study prior to treatment. Fire is also an important component of managing southern U.S. pine forests with open-stand structures and herbaceous understories. At Parris Island Marine Corps Recruit Depot (referred to as "Parris Island" hereafter), slash pine plantations were established in the 1970s and managed infrequently with fire resulting in dense, shrub-dominated understories that have been readily invaded by Chinese tallow [*Triadica sebifera* (L.) Small] (Pile and others 2017a), an aggressive invader of coastal forests that is considered sensitive to repeated growing season prescribed fire (Bruce and others 1997, Grace and others 2005).

The objective of our study was to determine the community response to treatments for the control of Chinese tallow. Specifically, we tested the response of native species to treatment effects by measuring their abundance and establishment prior to and following each treatment as well as the cumulative treatment effect. Treatments were designed to reduce the density of Chinese tallow and to create open-stand forest

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structure with the use of prescribed fire to enhance and promote native species adapted to frequent surface fire regimes. We applied four treatment types, including: 1) a control (C) with herbicide applied only to target Chinese tallow replicating prior management actions at Parris Island*;* 2) a fire (F) treatment with herbicide applied to Chinese tallow, followed by a growing season prescribed fire; 3) a mastication (M) treatment to reduce midstory density followed by an application of herbicide to target regeneration of Chinese tallow; and 4) a combined mastication and fire (MF) treatment which was similar to the M treatment, but with the addition of a growing season prescribed fire. We hypothesized that: 1) mastication would effectively reduce shrub density, resulting in increased ground layer richness and woody species regeneration by increasing available resources; 2) mastication would promote fire behavior and spread by increasing surface fuel loading and air flow; 3) fire alone would reduce shrub density, but not to the extent of the mastication treatment; and 4) the combination of mastication and fire would have longer-lasting effects on reducing shrub density while also favoring native, fire-adapted herbaceous species.

METHODS

Study Site and Background

The study was conducted at Parris Island located in Beaufort County, SC. Parris Island began management to control Chinese tallow in 2001 using herbicide. In 2011, we designed a research project to investigate several treatments to control Chinese tallow with an emphasis on its physiology (Pile and others 2017b). Specifically, we were interested in testing Chinese tallow response to treatments that included prescribed fire, as this species is suspected to be intolerant to repeated growing season prescribed fires (Grace and others 2005).

Parris Island is located on the Southeastern Coastal Plain ecoregion (EPA 2013), with relatively flat topography ranging from 0 to 7 m above mean sea level. The area is characterized by mild winters and hot summers, with soils that are generally described as fine sands to fine loamy sands. The island is comprised of 3257 ha, of which 608 are managed forest lands that are dominated by mature slash pine (*Pinus elliottii* Engelm.) plantations and natural mixed maritime hardwood forests. The hardwood forest component includes live oak (*Quercus virginiana* Mill.), Darlington oak (*Q hemisphaerica* W. Bartam ex Willd.), cherrybark oak (*Q. pagoda* Raf.), water oak (*Q. nigra* L.), green ash (*Fraxinus pennsylvanica* Marshall), sweetgum (*Liquidambar styraciflua* L.), and red maple (*Acer rubrum* L.). Prior to treatment, a dense midstory of wax myrtle [*Morella cerifera* (L.) Small] and yaupon (*Ilex vomitoria* Aiton.) with a sparse understory of herbaceous plants represented the forest understory. Nonnative, invasive species other than Chinese tallow were also present on Parris Island prior to treatment {i.e., tree of heaven [*Ailanthus altissima* (Mill.) Swingle], chinaberry [*Melia azedarach* L.], lantana [*Lantana camara* L.], Japanese honeysuckle [*Lonicera japonica* Thunb.], and Japanese stiltgrass [*Microstegium vimineum* (Trin.) A. Camus]} but were not in significant densities to require specific control efforts. However, by reducing understory density and restoring fire as an ecological process we believed these treatments would indirectly reduce establishment and further recruitment of these nonnative invasive species.

Study Design

This study was conducted with a randomized, complete block design, blocked by forest stand with eight replicates and four treatment combinations, resulting in 32 experimental units. Treatment areas ranged from 0.5 to 2 ha in size. Mastication was applied with a Caterpillar model HM315 roller chopper with carbide teeth in the M and MF treatment areas in May of 2013. Mastication was followed in late summer of the same year by a targeted foliar application of 2.5 percent v/v Garlon 4 Ultra ® herbicide and water to kill any regrowth (i.e., basal sprouts, stump sprouts, root sprouts) or seedling recruitment of Chinese tallow. For the treatments that did not have mastication (F and C), in the winter of 2013, a basal bark herbicide application of 25 percent Garlon 4 Ultra ® v/v with basal paraffin oil was applied to the lower portion of all stems <15 cm diameter at breast height (DBH) of Chinese tallow. Stems >15 cm DBH received the same application rate but applied by the "hack and squirt" injection method. Prescribed fire treatments (F and MF) were conducted in May of 2015. Fires were conducted as backing fires with strip head fires approximately every 15 m burning into the backing fire. The average air temperature during prescribed burns was 28 ± 0.7 °C with average relative humidity of 66 ± 2.5 percent. The average dead ground fuel moisture was 17.5 ± 1 percent. The average percent area burned was 71 ± 6 percent within the sample plot and average fire temperature was 196 ± 17 °C.

Sampling Units

We established a 20 m x 40 m sample plot in each treatment area to determine the effect of treatments on the forest plant community. All trees >3 cm DBH were measured and recorded to species (referred to hereafter as "trees"). In four randomly selected 10 m x 10 m subplots, all saplings or shrubs >1.4 m tall but <3 cm DBH were measured and recorded to species (referred to hereafter as "midstory"). In the middle of each 10 m x 10 m subplot, a 1 m x 1 m quadrat was established (eight total), and all tree regeneration and ground flora were identified and recorded by Braun-Blanquet's cover class (referred to hereafter as "regeneration" and "ground flora," respectively) (Westhoff and Van Der Maarel 1978).

A pretreatment survey was conducted in the summer of 2012 and two post-treatment resurveys were conducted in the summers of 2014 and 2015 (3 months post-fire). Ground flora were divided into habit functional types as forbs, graminiods, subshrubs, and vines.

Data Analysis

Trees, midstory, regeneration, and ground flora were analyzed and reported separately to determine the effect of treatments on forest structure and composition. The effect of treatment combination on native species density (stems/ha), basal area (m^2/ha), coverage of woody regeneration (percent), coverage of ground flora by species and habit functional type (percent), and species richness of woody regeneration and ground flora, were compared across survey years. Percent coverage was determined as the mid-point between each cover class and was averaged over the entire experimental unit. Mixed model analysis of variance (ANOVA) was conducted using treatment, block, and year as main effects. Year and treatment were fixed effects, block was included as a random effect in the model, and all interactions were tested. In addition, we made within-year comparisons by developing a model to test the effect on the same metrics by containing terms for treatment and block, with block as a random effect. Follow up comparisons between treatments using Tukey's HSD when the ANOVA models were significant.

Density (stems/ha), basal area (m^2/ha), and percent coverage of regeneration and ground flora were used to determine the relative effect of treatment on each species or habit functional type. We calculated relative abundance indices (relative density, relative basal area, and relative percent coverage) by plot for each species in 2012 (prior to treatment) and 2015 (final survey year). We then determined percent change (% by subtracting the relative abundance in 2015 from the relative abundance index in 2012 for each species:

$$[\%\Delta = (XSp_i\ 15/X\ TOT_{15}) - (XSp_i\ 12/X\ TOT_{12})] \quad (1)$$

where

$XSp_i 15$ = the index of interest for the ith species in 2015

$XTOT_{15}$ = the total of that index value for all species in the plot in 2015 less the values in 2012.

The percent change by species was averaged by treatment type. We developed a model to determine the relative change by including treatment and block as a random factor. We used linear contrasts to determine the effects of the mastication treatment (MF and M versus F and C), the fire treatment (MF and F versus M and C), and the combined mastication and fire treatment (MF versus all other treatment types).

Data were analyzed using JMP®, Version 11 SAS Institute Inc., Cary, NC and SAS® 9.1.3 SAS Institute Inc., Cary, NC. Data are reported as means and standard errors of the mean. Where appropriate, data were transformed to meet the assumptions of hypothesis testing, but values are reported in original scale to ease interpretation. A p-value ≤0.05 was considered significant.

RESULTS AND DISCUSSION

Mastication

The mastication treatment was effective in two ways: it reduced the density of the Chinese tallow, and it reduced the density of understory shrubs. While mastication is not a natural disturbance, its application aids in the transition to a different disturbance type, frequent fire. In recent years, mastication has become a widely used tool to relocate vertical fuels to the ground prior to prescribed fire (Kreye and others 2014). However, plant response and recovery from mastication may depend on a range of factors (Kreye and others 2014). Mastication treatments in our study significantly reduced tree density, midstory basal area, and midstory density (table 1). Mastication also had a negative impact on tree-sized wax myrtle (table 2) and midstory slash pine (table 3) and increased the number of tree-sized oaks, which is probably attributed to more growing space for these species following the reduction in shrubs (table 2). The regeneration of slash pine increased following mastication, which is consistent with enhanced germination from exposed mineral soil for this species (Lohrey and Kossuth 1990). However, the regeneration coverage of yaupon and water oak decreased.

Prescribed Fire

Our goal was to reduce the density of Chinese tallow, a species believed to be sensitive to growing season prescribed fires (Grace 1998), while promoting the native species that are adapted to this disturbance, and thereby creating open-stand structures and a fire-dependent feedback loop. However, prescribed burning alone did not have a discernable impact on native species density or abundance. Prescribed burning did not affect midstory basal area or midstory density (table 1). However, the regeneration coverage of slash pine (table 4) and subshrubs (table 5) decreased following treatment. Based on our findings, a single prescribed fire will not effectively reduce shrub densities and promote understory diversity. However, desired results may not have been achieved due to wet conditions causing the fire not to burn as hot as intended (Pile and others 2017b). Also, the final survey was conducted 3 months following the prescribed fire limiting our ability to make accurate predictions of longer-term community response following this treatment.

Table 1—Treatment means, standard errors, and linear contrasts of overall treatment effects on basal area and density of trees and midstory stems recorded at Parris Island, SC

	Trees[a]		Midstory[b]	
Treatment	BA (m^2/ha)	Density (trees/ha)	BA (m^2/ha)	Density (trees/ha)
C	32.8 ± 2.8	2000 ± 236	1.7 ± 0.3	8510 ± 1510
F	31.0 ± 3.1	1387 ± 246	1.7 ± 0.3	7137 ± 1567
M	26.7 ± 2.9	1026 ± 237	0.8 ± 0.3	6099 ± 1523
MF	30.7 ± 2.9	1043 ± 237	0.9 ± 0.3	5135 ± 1523
	p = 0.49	**p < 0.001**	**p = 0.01**	**p < 0.01**
2012	32.2 ± 1.7	1807 ± 212	2.0 ± 0.2	10513 ± 1425
2014	29.0 ± 1.7	1155 ± 212	1.1 ± 0.2	4606 ± 1425
2015	29.6 ± 1.7	1131 ± 212	0.8 ± 0.2	5042 ± 5042
	p < 0.01	**p < 0.001**	**p < 0.001**	**p < 0.001**
		Overall treatment effect		
M (M + MF)	p = 0.28	**p < 0.001**	**p = 0.001**	**p < 0.01**
F (F + MF)	p = 0.71	p = 0.06	p = 0.93	p = 0.06
MF	p = 0.87	**p = 0.02**	**p = 0.046**	**p < 0.01**

P-values in **bold** indicate a significant result based on an alpha of 0.05.
BA = basal area; C= control; F = fire; M = mastication; MF = combination of mastication and fire.
[a] Trees are <3 cm DBH.
[b] Midstory stems are <3 cm DBH and >1.4 m tall.

Table 2—Overall treatment effect based on linear contrasts for means, standard errors, and test statistics of the percent change in relative density (trees/ha) from 2012 to 2015 for the most commonly recorded tree species[a]

Species	M		F		MF	
Acer rubrum	0.07 ± 0.05	0.23	-0.03 ± 0.04	0.41	-0.00 ± 0.06	0.99
Fraxinus pennsylvanica	1.11 ± 0.97	0.27	-0.97 ± 0.98	0.34	-0.47 ± 1.12	0.68
Ilex vomitoria	-3.86 ± 3.78	0.32	-3.40 ± 3.83	0.39	-0.80 ± 4.36	0.86
Juniperus virginiana var. *silicicola*	0.52 ± 0.41	0.21	-0.37 ± 0.41	0.37	-0.08 ± 0.47	0.87
Liquidambar styraciflua	-2.47 ± 1.64	0.15	-2.50 ± 1.65	0.14	-3.02 ± 1.89	0.12
Morella cerifera	**-10.2 ± 4.46**	**0.03**	0.99 ± 4.50	0.83	-6.15 ± 5.13	0.24
Pinus elloittii	13.2 ± 8.19	0.12	-2.65 ± 8.29	0.75	-1.26 ± 9.43	0.90
Quercus hemisphaerica	1.68 ± 0.90	0.08	-0.17 ± 0.91	0.85	1.03 ± 1.04	0.33
Quercus nigra	**4.00 ± 1.86**	**0.04**	3.03 ± 1.88	0.12	**6.65 ± 2.14**	**0.01**
Quercus pagoda	**1.45 ± 0.67**	**0.04**	-0.02 ± 0.67	0.98	1.05 ± 0.77	0.19
Quercus virginiana	**3.21 ± 1.39**	**0.03**	0.65 ± 1.40	0.65	3.13 ± 1.60	0.06

Values in **bold** indicate significant differences based on an alpha of 0.05.
M = mastication; F = fire; MF = combination of mastication and fire.
[a] Trees are >3 cm DBH.

Table 3—Overall treatment effect based on linear contrasts for the means, standard errors, and test statistics of the percent change in relative density (trees/ha) from 2012 to 2015 for midstory species[a]

Species	M		F		MF	
Baccharis halimifolia	0.01 ± 0.27	0.96	-0.42 ± 0.21	0.06	-0.47 ± 0.32	0.15
Callicarpa americana	0.67 ± 1.53	0.67	0.72 ± 1.54	0.65	0.50 ± 1.76	0.78
Ilex vomitoria	-2.69 ± 15.4	0.86	-9.08 ± 15.58	0.57	-14.2 ± 17.7	0.43
Juniperus virginiana var. *silicicola*	-0.26 ± 0.20	0.19	0.22 ± 0.20	0.27	-0.17 ± 0.23	0.45
Lantana camara	0.81 ± 1.32	0.55	0.86 ± 1.34	0.52	2.20 ± 1.53	0.16
Liquidambar styraciflua	1.46 ± 3.10	0.64	1.17 ± 3.13	0.71	4.72 ± 3.57	0.20
Morella cerifera	2.88 ± 8.32	0.73	2.98 ± 8.42	0.73	-11.4 ± 9.58	0.25
Pinus elliottii	**-18.5 ± 9.66**	**0.04**	20.15 ± 9.76	0.05	8.11 ± 11.1	0.47
Quercus hemisphaerica	-0.03 ± 0.02	0.23	-0.00 ± 0.02	0.69	-0.00 ± 0.03	0.82
Quercus nigra	0.27 ± 0.43	0.55	0.37 ± 0.44	0.40	0.62 ± 0.50	0.23
Quercus pagoda	-0.04 ± 0.09	0.64	-0.13 ± 0.09	0.17	-0.00 ± 0.11	0.94
Quercus virginiana	-0.22 ± 0.14	0.13	-0.07 ± 0.14	0.64	-0.19 ± 0.16	0.24

Values in **bold** indicate significant differences based on an alpha of 0.05.
M = mastication; F = fire; MF = combination of mastication and fire.
[a] Midstory stems are <3 cm DBH and >1.4 m tall.

Table 4—Change in relative cover of regenerating woody species from 2012 to 2015 survey years by overall treatment effect

	Treatment effects					
Species	M		F		MF	
Acer rubrum	-0.7 ± 0.8	0.43	-0.9 ± 0.8	0.29	-0.6 ± 0.9	0.54
Baccharis halimifolia	0.3 ± 0.3	0.33	-0.3 ± 0.3	0.33	0.2 ± 0.3	0.57
Callicarpa americana	1.7 ± 1.8	0.36	-1.4 ± 1.9	0.44	-1.2 ± 2.1	0.59
Celtis laevigata	0.2 ± 0.4	0.66	0.6 ± 0.4	0.16	0.5 ± 0.5	0.27
Fraxinus pennsylvanica	-0.1 ± 0.1	0.61	0.2 ± 0.1	0.09	0.1 ± 0.1	0.48
Ilex vomitoria	**-15.5 ± 7.4**	**0.05**	6.6 ± 7.5	0.39	-5.4 ± 8.6	0.54
Juniperus virginiana var. *silicicola*	-	0.99	-	0.71	-	0.90
Lantana camara	-0.1 ± 0.1	0.66	0.1 ± 0.1	0.40	-	0.91
Liquidambar styraciflua	0.5 ± 0.7	0.52	-0.6 ± 0.7	0.43	0.4 ± 0.8	0.65
Morella cerifera	-0.3 ± 6.7	0.97	5.6 ± 6.8	0.42	2.3 ± 7.8	0.77
Pinus elliottii	**20.3 ± 6.8**	**0.01**	**-17.8 ± 6.9**	**0.02**	1.7 ± 7.9	0.83
Prunus serotina	-0.4 ± 0.6	0.55	0.7 ± 0.6	0.28	-0.5 ± 0.7	0.49
Quercus hemisphaerica	-	0.39	-	0.39	-	0.61
Quercus nigra	**-1.2 ± 0.5**	**0.05**	0.3 ± 0.6	0.65	-0.6 ± 0.6	0.32
Quercus pagoda	-	0.39	-	0.39	-	0.61
Quercus virginiana	0.7 ± 1.0	0.54	0.7 ± 1.0	0.50	1.8 ± 1.2	0.14

Relative percent cover values were calculated as the proportion of each species by plot and by year (2012 and 2015), with percent change determined as the difference in proportions between 2015 and 2012 survey years by species and averaged across treatments by species.

Differences in relative distributions were analyzed with an ANOVA and Tukey's HSD with significant differences indicated in **bold** based on an alpha of 0.05.

M = mastication; F = fire; MF = combination of mastication and fire.

Table 5—Mean (± SE) overall treatment effects on percent change in relative cover of ground flora habit functional type between 2012 and 2015

	Treatment effects					
	M		F		MF	
Forbs	7.4 ± 6.1	0.24	3.2 ± 6.1	0.61	4.1 ± 7.0	0.57
Graminoids	3.4 ± 5.9	0.57	3.0 ± 5.9	0.61	5.9 ± 6.8	0.40
Subshrubs	-10.4 ± 7.9	0.20	**-18.2 ± 8.0**	**0.03**	**-27.1 ± 9.1**	**<0.01**
Vines	-8.1 ± 8.6	0.36	16.0 ± 8.6	0.08	9.2 ± 9.9	0.36

Values in **bold** indicate significant differences based on an alpha of 0.05.

M = mastication; F = fire; MF = combination of mastication and fire.

Mastication and Prescribed Fire Combination

The purpose of our combined mastication and fire treatment was to quickly alter forest structure to an open canopy with an intention to create a herbaceous understory, reminiscent of historical maritime forest structure and processes. Adding frequent fire was intended to increase species diversity and function while also increasing community resistance to invasion by species not well-adapted to frequent fires. However, our approach is not characterized as restoration because these sites have a long history of human disturbance (Pile and others 2017a) with the majority of stands represented by mature slash pine plantations. Restoration to pre-European settlement would be nearly impossible and outside the scope of management goals. Instead, we intended to promote the historic disturbance (i.e., frequent surface fires) that inhibits the invader (Funk and others 2008) while also increasing desirable native species, including native oak species, and thereby potentially increasing the community resistance to future invasion.

We found that when mastication and fire were combined (MF) there was a significant reduction in tree density (-428 ± 173 stems/ha; p = 0.02), midstory density (-2113 ± 1003; p = 0.04), and midstory basal area (-0.6 ± 0.3 m^2/ha; p = 0.04). There was also an increase in tree-sized water oak density (table 2), ground flora richness (1.5 ± 0.6; p = 0.03; fig. 1), and a decrease in subshrubs (table 5). Prescribed fire with mastication as an intermediary treatment was effective at maintaining reduced shrub density when compared to mastication alone. The increase in rapid-growing, long-lived, and fire-tolerant species, such as slash pine and water oak, may also help to reduce the competitiveness of Chinese tallow by occupying growing space. When the mastication treatment was not followed by prescribed fire, shrub density increased and ground layer richness remained constant.

Our results are similar to those of Kane and others (2010), where mastication treatments alone reduced midstory density but did not increase ground layer richness. However, when mastication was combined with prescribed fire, native species richness increased by 150 percent compared to the control (Kane and others 2010). Increased ground layer richness may also help to impede establishment of Chinese tallow, by reducing available resources and may aid in carrying repeated surface fires. Siemann and Rogers (2003) reported reduced above-ground competition in grasslands increased the survival and growth of Chinese tallow. In addition, mastication reduced the height of the very dense wax myrtle and yaupon midstory to levels below 1.4 m tall, and the application of prescribed fire kept these fast growing species near the ground, also increasing important surface fuels. When yaupon remains near the ground surface it is known to promote surface fire spread in communities with frequent fire regimes (Mann and Fischer 1987, Villarrubia and Chambers 1978,) and may be important for maintaining this type of disturbance regime especially in areas where fine fuels are sparse.

While frequent surface fires may keep Chinese tallow at juvenile stages, resulting in a reduction of invader density over the long term, a short, fire-free period will be necessary to recruit the regeneration of species such as slash pine to sapling-sized class when it is less sensitive to fire. Planting of native tree species, such as longleaf pine (*P. palustris* Mill.) that are adapted to frequent surface fire regimes, even at juvenile stages, would allow for the continued application of frequent prescribed burning, thus increasing the competitiveness of native species adapted to this disturbance regime while

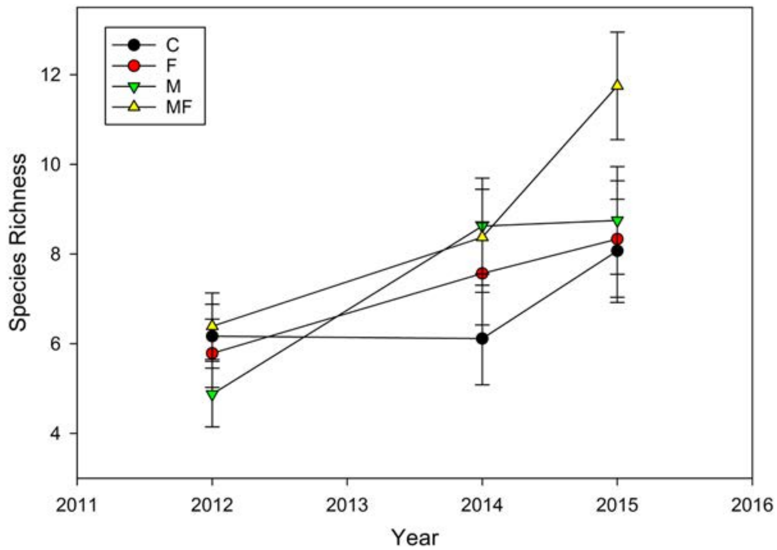

Figure 1—Change in mean (± SE) ground layer herbaceous richness by treatment type (C = control; F = fire; M = mastication; MF = combination of mastication and fire) and survey year. Mastication occurred in the spring of 2013 and prescribed fire in the spring of 2015.

ensuring Chinese tallow does not reach reproductive maturity or reduced sensitivity to fire during fire-free periods. Additionally, enrichment planting with native herbaceous species may be necessary to increase the functional diversity of frequent fire-evolved species that may be absent from the seed bank after a long history of human manipulation.

CONCLUSION

We found that, by using a management approach that included both mastication and prescribed fire, along with herbicide to target the invader, we were able to maintain a reduced midstory density, increase ground flora richness, and create a forest structure that is reminiscent of what historically characterized this ecological community. However, or results are limited to the immediate effects of the prescribed fire treatment. Repeated prescribed burning and continued monitoring are needed to determine if frequent burning after the MF treatment will continue to reduce Chinese tallow and positively impact native species. Future studies will also be needed to test for increased community resistance to Chinese tallow invasion under these treatment regimes.

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