DEVELOPING SUCCESSFUL MANAGEMENT STRATEGIES FOR INVASIVE PLANT SPECIES AT TOWNSEND BOMBING RANGE, GEORGIA

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ABSTRACT

Nonnative, invasive plant species threaten the ecological and military values provided by forests at Townsend Bombing Range in southeastern Georgia. To inform effective management of invasive plants, installation-wide transect surveys were conducted in the summer of 2022 to determine the presence and abundance of invasive plant species in multiple land-cover classes. Based on these surveys, densities of major invasive plant species were greater in stand edges than in stand interiors. Japanese climbing fern (*Lygodium japonicum*) and Chinese tallow (*Triadica sebifera*) were concentrated on the edges of hardwood forest stands and managed pine (*Pinus* spp.) stands, respectively. Control methods for recorded species will be tested to develop targeted, effective management of high-priority invasive plants.

INTRODUCTION

Nonnative, invasive plant species are altering the composition and function of ecosystems throughout the Southern United States (Pile and others 2017b, Webster and others 2006). Invasive plants impact forest productivity and ecosystem services, making invasive species management essential in silviculture and ecological restoration (Webster and others 2006, Weidlich and others 2020). Invasive plants can also interfere with land management for military training on installations by impeding access and increasing fire risks. Townsend Bombing Range, an installation in southeastern Georgia, is managed to preserve its military mission while conserving natural resources through ecologically appropriate land management practices (DOD 2016). The impacts of invasive plant species threaten the ecological and military values provided by Townsend Bombing Range and impede conservation and restoration of the natural resources it holds. By outcompeting native plant species, invasive plants can reduce native plant growth and diversity and necessitate increasingly high management costs (Camarillo and others 2015, Miller and others 2010, Pile and other 2017b, Wang and others 2012). These species can also alter ecosystem functions such as fire regimes, interfering with the installation's ability to manage wildfire risk. For example, Japanese climbing fern (*Lygodium japonicum*) can increase the risk of high-intensity crown fires by acting as a ladder fuel (Minogue and others 2016), while Chinese tallow (*Triadica sebifera*) can suppress the use of prescribed fire for fuel management (Grace and others 2005; Pile and others 2017b, 2017c).

To sustain the ecological and military values provided by forests at Townsend Bombing Range, this project was initiated to develop an effective management plan for invasive plant species present on this land. A thorough understanding of the identity, abundance, and location of invasive plants is necessary to inform successful

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management. An updated inventory of invasive plants would facilitate the identification of the highest-priority invasive species and the development of targeted management strategies to control them. To this end, we developed and implemented field surveys to inventory the abundance and distribution of invasive plant species across the installation.

MATERIALS AND METHODS

Study Site

This study took place at Townsend Bombing Range, an installation located in Long and McIntosh Counties, GA, and used for military training by U.S. Marine Corps Air Station Beaufort. Townsend Bombing Range lies within the Southern Coastal Plain ecoregion (EPA 2022) and is adjacent to the Altamaha River. The study area comprises approximately 13 692 ha after the original 2097-ha range was expanded in 2017. To represent the diversity of the focal landscape, the study area was divided into four land-cover classes: managed pine (*Pinus* spp.) stands, hardwood forest stands, impact areas, and fields. Managed pine stands consisted primarily of former industrial forest lands that were managed for pine production before their acquisition in 2017. Hardwood stands consisted of mixed upland and bottomland hardwood forests. Impact areas were actively used for air-to-ground military training and fields were open, nonforested land.

Surveys

Transect surveys were conducted in the summer of 2022. Starting points of transects were established within the four defined land-cover classes. We attempted a stratified random sampling method based on the land-cover classes, although this was limited in practice by a lack of accurate land-cover data prior to the surveys. Randomly located survey starting points were moved to the nearest road for easier access. Originating at each survey starting point, we paced 250 m into the interior of each stand perpendicular to the road. We then paced 250 m parallel to the road, 250 m to return to the road, and 250 m along the road to return to the starting point. This created a square perimeter of four 250-m transects at 90-degree angles to one another. The width of transects varied based on vegetation density. Transects in recently burned, mature pine stands were 10 m wide, while transects in denser areas were 5 m wide. This choice of transect width ensured that invasive plants could be easily detected while traveling efficiently along each transect. When an invasive plant was encountered, we recorded coordinates and either the estimated coverage area for fern, shrub, and vine species or the number of stems and largest stem diameter for tree species.

Data Analysis

Invasive plants may be more abundant along roads and forest edges due to increased propagule pressure and disturbance (Fan and others 2021, Huebner and Tobin 2006, Iverson and others 2019). To account for this potential edge effect, survey results were analyzed separately for the edge and interior of each land-cover class. First, a buffer was created at the edges of each stand beginning at the road boundary and extending 50 m into the stand. This 50-m buffer was classified as edge, and the remaining area in the core of each stand was classified as interior. All survey data that was collected within the 50-m edge of a stand was then separated from data collected in the stand interior. Survey transects that extended across both the edge and interior of a stand were divided into two segments, and edge and interior segments were considered separately.

Edge and interior density estimates of each plant species were calculated across each land-cover class. The total abundance of each plant species in stand edges and stand interiors was summed for each class. Based on the growth form of the plant species, abundance was calculated as either the coverage area for fern, shrub, and vine species or the number of stems for tree species. These totals were then divided by the total sampled area in stand edges or stand interiors for each land-cover class to produce density estimates for the entire study area.

RESULTS AND DISCUSSION

Five invasive plant species were recorded in transect surveys across 186.7 ha in 2022 (table 1). Japanese climbing fern and Chinese tallow were the most commonly recorded species, and two or fewer observations of mimosa (*Albizia julibrissin*), thorny olive (*Elaeagnus pungens*), and Callery pear (*Pyrus calleryana*) were recorded. Every recorded invasive plant species was observed in managed pine stands, and every species except thorny olive and Callery pear was observed in hardwood stands. None of the species were observed in impact areas or fields.

Density estimation revealed important trends in the abundance and distribution of different plant species both within and among stands of different land-cover classes. Overall, installation-wide density estimates for plant species with more than two observations were greater in stand edges than in stand interiors (figs. 1 and 2). Forests in the study area are dissected by a network of roads, and distance from roads is an important driver of forest invasibility by creating pathways for propagules to enter ecosystems (Fan and others 2021, Vieira and others 2014, Wang and others 2011). Japanese climbing fern was found almost exclusively on the edges of hardwood forest stands (fig. 1). Japanese climbing fern can establish dense populations in diverse forest types, including planted pine stands, bottomland hardwood-cypress (*Taxodium distichum*) forests, and longleaf pine (*Pinus palustris*) forests (Bohn and others 2011, Minogue and others 2010, Van Loan 2006), so the current distribution of Japanese climbing fern in the study area may be a result of its recent establishment rather than ecological limitations.

Table 1—Invasive plant species recorded at Townsend Bombing Range, GA, from transect surveys in summer 2022

Common name	Scientific name	Number of observations
Mimosa	*Albizia julibrissin*	2
Thorny olive	*Elaeagnus pungens*	1
Japanese climbing fern	*Lygodium japonicum*	11
Callery pear	*Pyrus calleryana*	1
Chinese tallow	*Triadica sebifera*	13

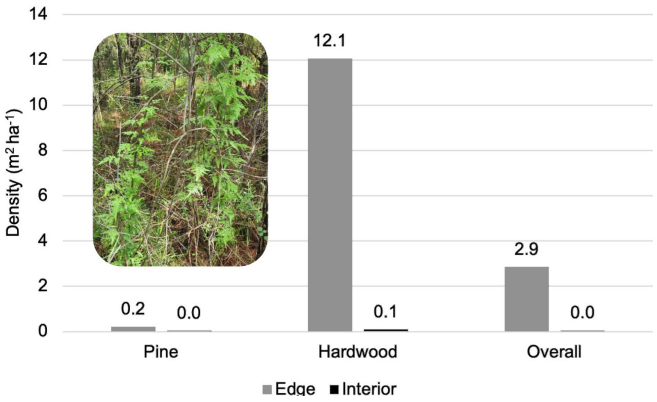

Figure 1—Density estimates of Japanese climbing fern (*Lygodium japonicum*) in the edge and interior of managed pine and hardwood forest stands. (Photo courtesy of Trisha Markus, Clemson University)

Chinese tallow, the most abundant invasive tree species recorded at Townsend Bombing Range, was heavily concentrated on the edges of managed pine stands (fig. 2). Many pine stands at Townsend Bombing Range are regenerating following harvesting and planting, and high light availability and soil disturbance in such stands may favor invasive plant establishment. Management activities such as harvests and thinnings can promote the establishment of invasive trees by altering resource availability and competition with native plants (Iverson and others 2019, Lockwood and others 2013, Pile and others 2017a, Rebbeck and others 2017). Chinese tallow is tolerant of a wide range of environmental conditions and has a prolific reproductive capacity (Pile and others 2017b), so further dispersal of this species into other land-cover types is likely despite its limited current distribution.

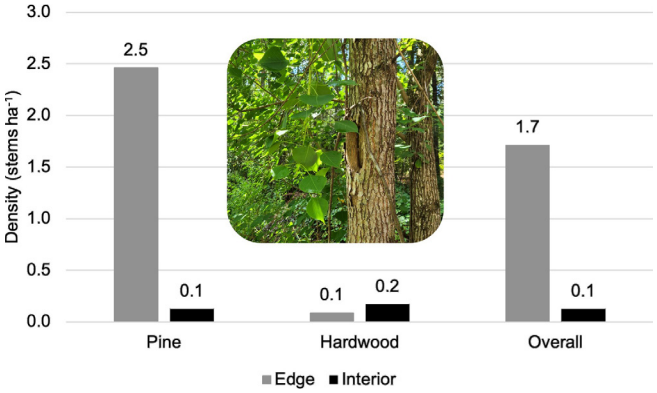

Figure 2—Stem density estimates of Chinese tallow (*Triadica sebifera*) in the edge and interior of managed pine and hardwood forest stands. (Photo courtesy of Trisha Markus, Clemson University)

CONCLUSIONS

Dominant and emerging invasive plant species identified at Townsend Bombing Range will have increasingly negative ecological and operational impacts if not effectively managed. While successful management of invasive plant species can be challenging to achieve (Weidlich and others 2020), a number of potential control options are available for these species (Miller and others 2013). Survey results characterized the ecology, abundance, and distribution of important invasive species in the study area, and this information can inform the judicious use of multiple strategies, including mechanical control, chemical control, and prescribed fire, for their management. Populations of many species detected in transect surveys appear to be currently present in the study area at low densities or small spatial extents. Continued monitoring, especially along stand edges, would support early detection and rapid response to eradicate such populations or maintain small populations below a damaging level. To inform an integrated pest management plan for invasive plant species, control methods identified for established species will be tested in the field to determine their effectiveness. By developing targeted, effective management techniques for high-priority species, this work will inform the sustained, successful management of invasive plants at Townsend Bombing Range.

ACKNOWLEDGMENTS

This project was funded by the U.S. Department of Defense. We thank Brandon Pritchett (Townsend Bombing Range), Christopher Petersen (Naval Facilities Engineering Systems Command), and range control personnel for assistance. We also thank Robert Jetton and Kelly Oten for providing helpful comments that improved this manuscript.

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