

COMMUNITY AND ECOSYSTEM CONSEQUENCES OF *MICROSTEGIUM VIMINEUM* INVASIONS IN EASTERN FORESTS

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ABSTRACT

Over the past two decades, biological invasions have come to the forefront as a major factor driving global environmental change. Introduced species can reduce biodiversity, inhibit the natural process of succession, and alter ecosystem functions such as nutrient and carbon cycling. There is an urgent need to understand the effects of invasions on native systems in order to prioritize species for research and management, to motivate local citizens and governments to take action, and to inform policymakers and land managers. In addition, because invaders are unique species being introduced into a novel environment, the study of biological invasions can provide important opportunities for understanding basic ecological and evolutionary processes. Much of the work on the effects of invasions has been observational, which makes it difficult to determine if the invaders are actually causing differences in invaded communities or if native and invasive species are simply responding differentially to changing environmental conditions. To properly quantify the effects of invaders, experimental methods such as removal or addition of invasive species are needed.

Across much of the eastern U.S., forests are rapidly being invaded by the non-native grass *Microstegium vimineum* (Japanese stiltgrass). This grass was unintentionally introduced in the early 1900s, but has only recently been recognized as a widespread invader. It colonizes roadsides, trails, and disturbed areas, but can also invade intact forests. I have conducted two experiments to test for community and ecosystem effects of *Microstegium* invasions. In the

first experiment, I identified eight sites in southern Indiana with widespread and dense *Microstegium* invasions. I then established 40 plots at each site and randomly applied one of the following four treatments to each plot: (1) reference plots; (2) hand-weeding (HW); (3) grass-specific post-emergent herbicide (POST); or (4) grass-specific post-emergent herbicide plus pre-emergent herbicide (POST + PRE). After 2 years, we saw an overall positive response in native community biomass in removal plots compared to reference plots, regardless of the treatment used to remove *Microstegium*. However, there were significant differences in native herbaceous diversity and tree regeneration among the removal treatments. Removal of *Microstegium* using hand-weeding or POST resulted in positive responses in diversity, whereas POST + PRE did not allow for increased native diversity. Similarly, more than twice as many tree seedlings colonized the POST plots than the reference plots. There was no increase in tree regeneration under the HW or POST + PRE removal treatments. These results suggest that use of a post-emergent grass-specific herbicide is an effective tool for managing *Microstegium* invasions. Furthermore, the positive responses in native species biomass and diversity and in tree regeneration when *Microstegium* was removed suggest that invasions were suppressing native species.

In the second experiment, we added *Microstegium* to individual field plots and compared native herbaceous species, tree species, and arthropod responses between invaded and control plots. We established 32 plots (5.25 m x 5.25 m) and planted 9 species of native

tree saplings in half of the plots. To test if the effects of invasion depended on tree life history stage, we planted the same 9 species of trees as seed in the other 16 plots. We also added 12 native herbaceous species to all plots. After the plots were established, we randomly seeded half of the plots with *Microstegium*. After 2 years, invaded plots had dramatically reduced native herbaceous biomass and diversity. Invasion also reduced the success of small-seeded tree species such as box elder and sweetgum, but did not affect large-seeded tree species such as black walnut and shellbark hickory. *Microstegium* invasion also caused declines in the abundance and diversity of arthropods and reduced the survival of two tick species. Ongoing work also suggests invasions are altering nitrogen cycling and decomposition processes. In sum, this experiment has demonstrated that *Microstegium* can have remarkable consequences for native biodiversity, tree regeneration, and ecosystem processes.

Additional ongoing work on *Microstegium* includes investigations of the interaction between fire and invasions and the process of pathogen accumulation on invasive populations. Initial results have shown that fire intensity is significantly increased in invaded areas with greater peak fire temperatures, taller flame heights, and a greater percentage of the area burned, possibly due to reduced green fuel loads. Further research on fire and *Microstegium* will determine how invasion dynamics and native species, including tree regeneration, are affected by fires and the timing of fires. In separate work, we recently found a previously undescribed fungal pathogen on invading *Microstegium* and identified it as a *Bipolaris* sp. We have also isolated more than a dozen other microbes that are possible pathogens on *Microstegium*. The accumulation of pathogens on *Microstegium* would suggest that the release of *Microstegium* from natural enemies may be temporary.