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Optimal spatial management of an invasive plant using a model with above- and below-ground components

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Abstract Invasive species can disrupt and damage their non-native habitats and are often the focus of control efforts. Motivated by considering the control of kudzu (*Pueria montana*) by grazers, we model plant growth with above- and below-ground components where grazing pressure is applied in discrete pulses. We compare two strategies, one that manages for eradication and one that minimizes above-ground biomass to maximize a site's aesthetic and recreational value (beautification). We then consider the spatial allocation of a limited budget to protect a prioritized target patch from invasion from neighboring patches. Optimal management for the beautification goal and eradication goal are similar when budgets are limited and when the initial invasion size is small. Management diverges when budgets or initial invasion size are large. As such, smaller management efforts have less of an imperative to carefully define their management goal. Additionally, our model suggests the ability of the invading plant to respond after control or disturbance, and not overall growth rate, is the important factor when considering differences in optimal management strategies between different goals. Non-target patches were controlled more often when budgets were larger, initial invasion sizes on the target patch were small, and growth rates were low. This pattern suggests that controlling even small non-target patches is only economically favorable when continued control of the target patch passes a threshold of diminishing returns, counter to classic results where small satellite populations are controlled first to prevent new growth.

Keywords Biological invasions · Eradication · Spatial modeling · Defensive management · Kudzu · Weed control

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Introduction

Invasive species are widely recognized agents of global change (Vitousek et al. 1997) with environmental impacts from the loss of species diversity, habitat, and ecosystem function (Hooper et al. 2005; Pejchar and Mooney 2009), and economic impacts from loss of ecosystem services, tourism dollars, and costs of control (Olson 2006; Pimental et al. 2005; Vilà et al. 2011). A wide variety of organizations engage in managing invasive species impacts, from large state governments accountable for a network of