Spatial Distribution and Scaling of Impacts of Invasive Grasses

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Plant invasion is typically viewed as a continuous process by which propagules disperse to a suitable environment where the outcome of competition favors the invasive species. However, dispersal, competition outcome, and the environment are often highly dynamic and vary over space at multiple scales. Because dispersal, competition, and environmental impacts of invasive species occur within spatial neighborhoods or "kernels," the total impact and dynamics of invasions depend on the spatial distribution of plant density. Some kernels are restricted to a few cm around the plant or plant patch (e.g., seedling interaction, soil microbial impacts, thatch production), whereas others can reach 10^3 m from plants, patches or fields (e.g. long-distance dispersal, water quality effects, nutrient redistribution by herbivores). Thus, total impact of an invasive species depends on the interaction between each kernel and the spatial distribution of the species. Medusahead (mh) is an invasive annual grass present in roughly 20 California counties. We are evaluating mh distribution and kernels across multiple scales within the California Central Valley. Severe mh infestations appear concentrated within regions of 10^8-10^9 m^2. Within such regions, mh exhibits a fractal distribution across a large range of spatial resolutions (down to $10^{-1}m^2$). This indicates that regional characteristics may set the potential "envelope" for severe invasion, but processes with small kernels affect invasion over a large proportion of the area within such regions. We describe a novel method to take into account spatial distribution across scales of space to generate estimates of impact and to forecast rate of invasion.

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