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The effects of disturbance, fire, and elephants on savanna woodlands

The extent to which ecological systems are experiencing disturbance and change in function and structure is critical for the long-term conservation of biological diversity. The savanna, the dominant ecosystem of sub-Saharan Africa, is characterized by the coexistence of a variety of woody plants and grasses. Vegetation modification from woodland to grassland has most often been attributed to the coupled effects of elephant herbivory and fire. Therefore, to better inform management strategies for woodland savanna ecosystems, the objective of our study was to model the impact of fire and herbivory on tree survival. We used density-dependent, stochastic Lefkovich matrix models to simulate the population dynamics of woody plants in Kruger National Park, Mpumalanga, South Africa. Our model was run on biannual time steps, including wet and dry seasons, for 50 years. Elephant herbivory was assumed to occur every dry season, while the occurrence of fire was stochastic. We tested different frequencies and intensities of fire and herbivory in our model, and also altered the variance of the fire parameters. Preliminary results indicated an average fire return interval of 3-4 years produced an approximately stable population growth. Our sensitivity analysis showed that under baseline conditions adult tree survival was the most important factor affecting population growth rates. We also found that different fire regimes, varying intensities of disturbance, and even altering the variance of these parameters can profoundly affect the pattern of savanna structure over time. Therefore, our results indicate that savanna woodland structure is sensitive to both the frequency and intensity of disturbance which has important management implications.