Modeling Elephant/Vegetation Dynamics for Adaptive Management in Southern African Ecosystems

GREG KIKER

Biological systems at all levels of organization, from cells to ecosystems, are highly complex in that their behavior arises from numerous and heterogeneous interacting parts linked in detailed networks. A fundamental question for managers of these complex systems is: What ecosystem elements contribute to resilience in biological systems? With this complexity in mind, elephant and vegetation management in southern Africa has been described as a "wicked" problem where solutions defy simplistic notions and problem contexts continually shift with evolving social expectations and adaptive learning.

For the past year, I have been on a Fulbright Scholarship in South Africa working with the University of Kwa-Zulu-Natal (UKZN) and South African National Parks (SANParks) to apply coupled elephant-vegetation models to ecosystems within the Kruger National Park (KNP) and Addo Elephant National Park (AENP). The objectives of this research include the following: (1) develop benchmark data sets for model experiments in the KNP and AENP; (2) apply to these ecosystems, two elephant/vegetation models of different complexity; (3) conduct model and decision analysis using each elephant/vegetation model to explore outputs with respect to different elephant management scenarios.

A primary goal of this research is to test the robustness of model predictions when different assumptions are made about what is ecologically important. A key dynamic of the KNP ecosystem that is of great concern for park management is the exploration of elephant effects that cause the vegetation to 'flip' from one state dominated by woodlands, to a state dominated by shrubs and grasses. Within the AENP, managers and scientists are concerned about high biodiversity areas newly opened to elephant populations and potential fragmentation of the succulent thicket ecosystem. Both of these issues relate to ecosystem resilience where abrupt transitions can have cascading effects on biodiversity and human welfare. We use the two different modeling approaches to help determine the degree of agreement among the two models in where these transitions are expected to occur, and use subsequent statistical analysis techniques to tease out key differences in model assumptions that may account for any evident divergence in projections.

Another fundamental aspect of my model analysis is in the simulation of human-elephant interactions via management-advised scenarios. These modeling scenarios have been designed with the direct input of SANParks managers to focus on different human-elephant interactions such as non-consumptive tourism, consumptive uses and critical resource conflicts (local water/human/elephant interactions). We are conducting different scenario simulations for the KNP and AENP which have quite different elephant management challenges in terms of elephant populations, ecosystems and the amount space available for expansion. Many of these management plans have a spatial focus towards critical and limiting resources (e.g. water availability in the dry season) as well as options for multiple proactive and reactive management responses towards water access, fire timing and elephant population/reproductive controls.

The results of our elephant/vegetation simulations show that managing these systems is a complex and challenging job, with no easy answers. There is a great and continuing need for adaptive learning at the ecosystem and institutional scales. Our models can play a useful role in this process to strengthen and protect these critical ecosystems.

Gregory A Kiker is an Associate Professor in the Department of Agricultural & Biological Engineering.