

# Why are trees taking over our grasslands?

## Prof. David Ward

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Woody plant encroachment is one of the most widespread land-cover changes in many countries. Essentially, an open grassland gets converted to a woodland in a very short period. This results in a multi-species grass sward being converted into a monoculture of shrubs or trees. This change presents a livelihood problem for many livestock ranchers whose animals are mostly grazers (eat grasses). Together with David Saltz, we studied the causes of woody plant encroachment in Namibia. We found that as trees got larger, they got further apart and the variability in distance among trees got smaller. This implied that intraspecific competition was acting, and any tree that was too close to another tree would be eliminated. This led to the development of a theoretical model by a post-doctoral fellow of David's, Kerstin Wiegand. This model was called the "honeycomb rippling" model, which is a subset of patch dynamics theory. I have continued this research, focusing on the mechanisms behind woody plant encroachment, the consequences for carbon sequestration in soils, and the effects of woody plant encroachment on the conservation of elephants. I have investigated the mechanisms behind woody plant encroachment at a variety of spatial scales and in habitats from deserts to humid grasslands (gradient from 150 – 1500 mm mean annual rainfall). In arid areas, rainfall is unsurprisingly the most important factor, followed by the availability of nutrients. When there are more nutrients available, grasses become more competitive, and outcompete trees. When there is heavy grazing, trees may encroach under ideal conditions. In more mesic areas, passage through an animal, the presence of tree seeds in dung, grazing and fire are equally important. In humid grasslands, shade is the most important factor when there is no grass. Overall, grass competition is the most important factor limiting tree encroachment across all environments. Another factor that is also important is increasing global carbon dioxide levels. We also found that there was a negative correlation between the amount of carbon stored in soils and mean annual rainfall, consistent with studies performed in the deserts of the United States. With regard to conservation, we found that species that are palatable to elephants are disappearing, and are being replaced by unpalatable woody encroachers, reducing the carrying capacity. I am currently studying the causes of encroachment by the eastern red cedar, *Juniperus virginiana*, in the United States, along with former Mitrani student Gil Bohrer (now a professor at Ohio State University), among others. Here too shade is an important constraint on encroachment, but competition with grasses also plays an important role.

