Prickly-pear invasion in the Kruger National Park

Reconstructing the history of *Opuntia stricta* invasion in the Kruger National Park over the last fifty years provides an insight into the dynamics of its invasion

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A dense stand of sour prickly-pear, *Opuntia stricta*, near Skukuza. Photo: Llewellyn C. Foxcroft.

The sour prickly-pear *Opuntia stricta* was first recorded in the Kruger National Park (KNP) in about 1950, when it was reported as a garden ornamental. Originally from south-eastern USA, the plant has spread and become invasive over large parts of Spain, Australia and South Africa. Unfortunately this pattern has also been observed in the Kruger National Park, where elephants and baboons eat the fruit and thus spread the seeds. The prickly-pear has invaded about 60 000 ha around Skukuza.

Many factors influence the way invasive alien plants are spread and distributed. Despite advances in knowledge of how to control invasions, explicit models based on geographical distribution elude scientists. Reconstructing invasion episodes is a useful way to determine the role of the various factors involved in the spread of a plant. In an attempt to develop an understanding of the processes involved in the prickly-pear invasion, I teamed up with colleague Sandra Mac Fadyen of the KNP GIS department, Prof. Dave Richardson (from the Centre for Invasion Biology at Stellenbosch University) and Dr Mathieu Rouget (from the Biodiversity Planning Unit, SANBI) to undertake a study to reconstruct the history of the sour prickly-pear invasion over fifty years in order to explain invasion rates and patterns of spread, and to explore the role of 'propagule pressure' (seed supply and proximity), in the invading population.

Data was collected from November 2000 to November 2003 with a Global Positioning Unit (GPS), amassing about 20 000 plant records and covering 66 000 ha. Additional data collected included the size of the plants and the habitat in which they were recorded. Data from the KNP geographic information system (GIS) section, as well as satellite image analysis, provided a range of environmental parameters to allow us to examine the spread of the plant. All the data was then converted to 1-ha grid cells, to avoid the possibility of under-sampling of small plants in the dense undergrowth, as well as to make the various data layers compatible for analysis.

In order to determine the role and effect of the proximity of the seed source (propagule pressure), we had to determine the patches most likely acting as sources of propagules. We assumed that propagule pressure would be related to the distance to such patches and that more plants would be found closer to these patches and less further away. The density of prickly-pear cladodes (the prickly pear 'leaves') in each of the 1-ha grid cells was the best available substitute for ageing the stands of prickly pear, and thus was used in reconstructing the invasion process. In reconstructing the 'chrono-sequence' we ranked each cell by cladode density and divided the cells into six categories.

To determine which factors were most influential in shaping the invasion, we used tree-based statistical models that split the data into sub-sets of similar groups so we could analyse and interpret the degree to which each variable was influencing the current distribution patterns of the plant.

Results

Only three environmental variables help to explain *O. stricta* presence or absence: habitat classes as defined from satellite imagery, distance from water sources and soil form. However, when we added the number of times an area had burned over the last 48 years, our ability to explain the pattern was substantially improved. Propagule pressure however was a much better predictor of the plants distribution, which indicates that *O. stricta* is highly likely to occur at sites within 8 km of the primary invasion areas. The weak correlation between the environmental variables and plant distribution was not unexpected, as the plant exhibits an ability to grow in a wide variety of habitats. The correlation between the large clumps (which act as sources of seeds) and the distribution of the plants is useful in understanding the mechanisms behind the invasion of *O. stricta*. As we know that elephant and baboons eat the fruit spreading the seeds, we can assume they played a key role in the current distribution of the densest stands.

This has important implications for management. It underscores the importance of finding and managing the outlying patches of prickly-pear as quickly as possible in order to prevent fruit production and further invasion. Management of invasive plant species such as prickly-pear whose dynamics are clearly driven by propagule pressure and where environmental factors play less of a role, is much more challenging than for species where distribution and abundance follow patterns that can be predicted from environmental factors.

Two figures in PowerPoint showing data and variables used in the study, and reconstructed distribution patterns at different stages are available on request from the editor at voget@kingsley.co.za.