The likely persistence of *Acacia carneorum* (needle wattle) in light of fragmentation in the Australian arid-zone, A.L. Marsh

Fragmentation is considered one of the most ubiquitous and serious environmental threats to the long-term survival of plant species world-wide. It acts to segregate large areas of natural habitat into isolated patches located within a matrix of modified landscape with a low biomass and structural density. The resultant changes in a species population structure render it susceptible to a range of ecological and genetic processes, reducing its likely persistence. Many plant species within Australia's arid zone environments are in imminent danger of local or complete extinction with predicted climate change expected to compound the situation. The effects of fragmentation, including reduced health and population sizes and lack of connectivity between the remnant patches, has produced a habitat of seemingly degraded and extinction-prone species. While we know that the needle wattle, *Acacia carneorum*, populations in the Australian arid zone exist in vulnerable communities and is currently experiencing the effects of fragmentation, little has been known about the degree of fragmentation, which remnant populations were connected in the past, or the health status of current distributions, much less how climate change will impact the future of the species. The overall objective of this project was to investigate the vulnerability and adaptive potential of *Acacia carneorum*, to climate change. Given that the persistence of a fragmented species is linked to their remnant population size, health assessment indicators and spatial modelling techniques were used to investigate environmental factors constraining population size, historically compare the size of populations with their location within suitable surrounding habitat, and assess population size and viability.

Soil was investigated as an environmental fragmentation pressure constraining both the distribution and size of *Acacia carneorum* populations. Satellite multispectral imagery was classified to broadly map the primary soil types of the area, and soil particle size analysis was used to determine soil composition of dunes supporting populations. It was found that soil composition supporting existing populations was homogeneous, providing evidence that soil acts as a fragmentation driver for this species, possibly reducing its past ability to generate new populations and constraining the potential size of current populations.

Spatial analysis techniques were used to determine the area of potential habitat in which the species is located. Existing distributions were mapped using a maximum likelihood algorithm applied to satellite multispectral imagery based on five landscape classes. Historical locations of population extents were mapped from historical aerial photography. Landscape metrics were calculated for all patches for all time periods. Spatial modelling was used to compare the characteristics of past population patches to current potential suitable habitat to gain an understanding of how the distribution and size of these areas may influence a population's persistence under climate change. It was found that suitable potential habitat of *Acacia carneorum* occurs across an extensive sand dune configuration and that the locations and extents of current populations were found to largely conform to these landforms. Furthermore, it was found that current and historical large populations were generally located in large suitable habitat patches whilst small populations were constrained to small patches. This provided evidence that *Acacia carneorum* occupies only a small proportion of its potentially suitable habitat and furthermore that this constrains the size and distribution of current and historical populations. The viability of *Acacia carneorum* populations was assessed based on their physical remnant size. However, a standard demographic assessment of *Acacia carneorum* populations could not be used due to its long-lived biology with episodic recruitment. Therefore to assess population viability Auld's (1993) survey was used as a basis for comparison, reassessing Auld's predictions of limited recruitment in this species by quantifying size distributions of population. This was used to compare the viability of large and small populations based on their reproductive effort (percent of adult population flowering), demographic structure (height, canopy area, canopy cover and stem area) and photosynthetic capacity (chlorophyll fluorescence and leaf chlorophyll content), correlated with the spectral index NDVI. It was found that whilst large populations contained a significantly higher proportion of juveniles to adults, a higher proportion of the population flowering and higher mean NDVI values, the remaining parameters demonstrated significant no difference between the viability of large and small populations. Overall, with increased recruitment and a greater proportion of recruits reaching adulthood compared to Auld's (1993) survey the *Acacia carneorum* populations appear to have remained viable to date.

This study demonstrates that whilst the likely persistence of *Acacia carneorum* populations within the Australian arid-zone are clearly threatened by fragmentation, they have appeared to remain largely viable, but are unlikely to survive under modelled climate change scenarios. Future assessments of population viability such as genetic testing will be able to infer past landscape patterns and connectivity furthering our knowledge as to likely persistence of this species within Kinchega National Park. Management authorities may need to consider conservation measures to assist in their survival including regeneration, genetic rescue or assisted migration. Patterns of genetic diversity and gene flow can also infer past connectivity and landscape patterns, revealing more about the historical heterogeneity of *Acacia carneorum* populations.

Since the distribution of *Acacia carneorum* appears to be limited by soil composition, revealed in this study to be influencing its current spatial heterogeneity, future work should extend the spatial modelling approach used to determine other areas which may support suitable conditions exist both within Kinchega National Park and within western NSW, and physical soil composition analyses to determine other possible colonization areas. These areas can subsequently be targeted as potential sites for assisted migration, in-situ or ex-situ regeneration if management authorities deem this as an appropriate management strategy.