Utilising adaptive management practices in the conservation of a Declared Rare *Acacia* species

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Introduction

Of the estimated 8,000 species in the Southwest Botanical Province of Western Australia, about 25% are either under threat or have poorly known conservation status, with a third of the 564 *Acacia* taxa in the region considered in this category (Yates and Broadhurst 2002). *Acacia chapmanii* subsp. *australis* R.S.Cowan and Maslin is typical of many of these species. It has an aging population with little recruitment, is confined to narrow linear remnants on road and rail reserves, and has patches of limited extent in one managed reserve. As little was specifically known about the biology of *A. chapmanii*, strategies for assisting population recovery were based on general characteristics of *Acacia* population biology and likely landscape processes in the area it occupies. The strategy developed was a stepped process using an adaptive management approach based on a scientific model with replicated trial plots and controls (Blumstein 2007). An adaptive management approach enables decisions to be made on management strategies as soon as conclusive results are evident.

After elimination of factors such as *Phytophthora cinnamomi* and rising saline water tables, the most likely factor contributing to decline appears to be lack of disturbance, such as fire, with no recorded fire in over 20 years. As many *Acacia* taxa in the transitional rainfall zone of southwest Western Australia are stimulated to germinate by the heat of a fire, the initial experiment utilized a control burn of small plots designed to have minimal impact on the majority of the community in which the species occurs. No herbivore impact was measured as all plots were fenced.

Initial results following monitoring of the germination response for *A. chapmanii*, both from the soil seedbank as well as from planted seed showed no seedlings surviving in unburnt plots. The success of seedling survival from the soil seedbank in burnt plots led to the decision in 2005 to measure ecosystem scale behaviour on this community following a normal autumn Department of Environment and Conservation (DEC) fuel reduction burn, which more closely resembles a wildfire. This research was designed to measure whether regeneration of *A. chapmanii*, and other species, was similar to the first burn and the influence of herbivory on seedling survival.

Materials and Methods

Study species and site

A. chapmanii subsp. australis is a compact rounded shrub to over one metre in height, and is declared rare flora in Western Australia (Wildlife Conservation (Rare Flora) Notice 2006 (2)). The species is known from four populations across a 17 km range near Bolgart, approximately 120 km north-east of Perth. The population in the Drummond Nature Reserve chosen as the experimental site is mostly in kwongan heathland, with patches of *Eucalyptus wandoo*.

2004 burn experiment

Six plots (3 x 3 m) containing several *A. chapmanii* shrubs were chosen at random within the population, with three burnt on 27 April 2004 and three left as unburnt controls. Whilst a soil seedbank was expected, nothing was known about seed density in the soil. Forty-nine *Acacia* seeds were planted to a depth of 5 mm in each plot with their planting positions determined using a 60 cm square perspex template, so the location of any seedlings could be associated with their planting position. After the burn, all plots were fenced to exclude grazing. Monitoring was conducted on the central 2 x 2 m area within the plot with a 0.5 m perimeter forming a buffer to avoid fence effects. Counts of seedling presence were undertaken in July 2004 and seedling survival assessed a further seven times to 11 April 2005 and also in the spring of 2005, 2006 and autumn 2007.

2005 burn experiment

As regeneration after the 2004 fire was successful, the next step was to investigate if grazing influenced regeneration. A further nine plots (3 x 3 m) containing adult shrubs were chosen at random within the population. A normal DEC fuel reduction burn was conducted to include six plots on 25 May 2005, leaving three as unburnt and unfenced controls. Three burnt plots were fenced to exclude grazing. The three unburnt plots fenced in 2004 were used as fenced controls. The density of *Acacia chapmanii* was assessed in the spring of 2005 and 2006 and autumn 2007 in order to quantify seed germination and seedling survival.

Results

As with similar *Acacia* species, fire kills adult *A. chapmanii* but stimulates seed germination (Yates and Broadhurst 2002). After the 2004 fire the mean initial seedling density in burnt plots was 17.6 m^{-2} but no seedlings derived from soil-stored seed were recorded in unburnt plots. Monthly monitoring over the first 12 months showed 43% of planted seed and 50% of soilbank seed that initially germinated, survived to seedling stage.

After the 2005 fire, seedling emergence was in the same order as after the 2004 fire. However, seedling survival in open burnt plots was much lower than in fenced plots. Despite many adult *A. chapmanii* plants being moribund in the reserve, there was an abundance of soil stored seed. Seedlings tended to be clumped near ant nests indicating seeds are collected by ants. This was confirmed by observations of ants collecting seeds with eliasomes from open legumes on the plants and removing seeds with eliasomes attached from experimental seed cafeterias.

Although the mature phyllodes of the shrub are very tough with an acicular, spinose tip, on seedlings the phyllodes are relatively soft making the seedling a soft grazing target. The assessment in the burnt plots in the autumn of 2007 showed the mean density of seedlings was 4.0 ± 3.0 seedlings m^{-2} in fenced plots and 0.1 ± 0.1 seedlings m^{-2} in unfenced plots. No seedlings were present in unburnt plots. There was a patchy distribution of regeneration as evident in the large standard error due to poor seedling emergence and establishment under the canopy of a *Eucalyptus wandoo.*

Discussion

Prior to this research, the size class structure, levels of canopy deaths and an absence of juveniles indicated all populations of *A. chapmanii* were in decline. Utilising an adaptive management approach when required to make conservation decisions on rare species substantially reduces risk whilst increasing our understanding of managed ecosystems (Wilhere 2002). Analysis of the data can identify cause and effect relationships between management actions and ecological outcomes, with responses to a range of treatments pointing the way to an optimal policy.

A.chapmanii is killed by fire and therefore relies on seed for survival, with the hard seededness requiring fire related germination cues to break dormancy. In unfenced burnt plots herbivore impact was high on both *A. chapmanii* seedlings and other regenerating species with scat counts indicating kangaroos as the culprits. Only an occasional seedling in unfenced burnt plots survived into its second year. Weeds were largely absent in the experimental population, but in other populations such as on road verges that have been invaded by exotic grasses and broad leafed herbs, weeds may impact on seedling establishment (Buist et al. 2002).

The availability of viable seed does not appear to be responsible for the absence of recruitment. Factors associated with seed germination and seedling establishment appear to be more likely factors associated with population decline. Reduced fire frequencies mean populations that become moribund due to natural aging of the plants cannot recruit new seedlings. Once fire occurs regeneration is cued, however the burnt areas become a focus for animals attracted to the succulent regenerating new growth. Grazing severely reduces seedling survival and exclusion of grazers from newly burnt areas is necessary to ensure sufficient seedlings survive to replace adult plants. Carefully managed fire regimes and in-situ management will be required to ensure the persistence of stable populations of *A. chapmanii.*

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