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AERIALLY SURVEYING MESQUITE *(Prosopis* spp.) IN THE PILBARA

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INTRODUCTION

Mesquite is one of 20 Weeds of National Significance in Australia, identified for its invasiveness, impacts on the environment, high potential for spread across a wide landscape and the socioeconomic impacts within communities it inhabits. The history and establishment of populations in Australia is not well documented, however records of plantings and herbarium samples have been dated back to the early 1880's (van Klinken & Campbell, 2001). Introductions in Western Australia occurred in the late 1920's, predominately around homesteads and water points in the arid rangelands regions.

In 2004, the Pilbara Mesquite Management Committee (PMMC) recognised the requirement for accurate maps of mesquite infestation locations and densities. Mesquite infestations extend across five pastoral stations in the region, with over 200,000 ha of sparse to dense infestations. Stakeholders identified that if strategic and effective control programs were going to be further implemented across the Pilbara, it was of priority importance that infestations be accurately mapped prior to funds being committed. An innovative aerial survey was developed and implemented on Mardie Station, where the single largest population of mesquite exists in Australia.

A technical version of this study has been published by van Klinken *et al.* (2007).

METHODOLOGY

Survey parameters

The survey was conducted using an R44 helicopter and a team consisting of a pilot, navigator and two surveyors. The survey was flown at a height of 200 feet and a minimum speed of 60 knots. Survey grid cells for the collection of data were constant at 617 m long and 300 m wide (18.51 hectares). These parameters indicated the appropriate levels at which mesquite could be correctly identified from the air.

Data capture

Pastoral lease maps were overlayed with a survey grid, and these were transferred to a handheld PDA using Intergraph OnDemand for Geomedia™. The PDA was connected to a Bluetooth GPS receiver, which provided, in conjunction with the base map, real-time accurate locations of the helicopter and ensured the correct grid lines were being followed. A tracklog of flight paths were collected to match recorded data with cells surveyed. A four-way communication system ensured that constant contact was maintained.

Prior to a survey session, surveyors were flow along a ground calibration plot to mark individuals 300m visual swath from the helicopter with tape on the window. For each session, a predetermined group of grid cells was selected to survey, and each flight line within this group was called a run. The helicopter flew each run, with the navigator ensuring the correct line was followed. The surveyors assessed each grid cell on their side of the helicopter, and recorded observations manually. The navigator indicated to the surveyors when each cell had finished. Grid cells were consecutively assessed.

Recording categories
The surveyors were able to count accurately a maximum of 70 plants/grid cell. A density class system was used to record plant levels above this population; scattered (<20% cover, crowns well separated), mid-dense (20-50% cover, crowns clearly separated), medium (50-70% cover, crowns touching or slight separation) and dense (70-100% cover, majority of crowns touching or overlapping).

Map production
Run data from the PDA was inputted into a GIS program and the manually recorded survey results were converted to centroids and added to the grid. The counts of mesquite were grouped into four categories for ease of presentation; single plant, 2-9 plants, 10-29 plants and 30-70 plants.

Survey validation
Ground validation studies were conducted for areas where between 0 and 70 plants/cell were surveyed. From a vehicle, counts of adult plants were taken within a 50 or 100 m band from each side of the vehicle, depending on visibility. Aerial validation studies were undertaken where canopy covers were originally recorded, and involved reassessing 94 grid cells at the completion of the survey with different observers.

SURVEY RESULTS
A continuous total survey area of 216,655 ha was completed over 56.5 hours of helicopter survey time. Mesquite was present across 70,909 ha of the total survey area, which equates to approximately 29% of the cells surveyed (Table 1; Figure 1).

Table 1. Breakdown of classes of mesquite identified across the total survey area

Cover class	Area (ha)	Area (%)
No mesquite	153,680	71%
Counts (1-70 plants/grid cell)	34,577	16%
Scattered (< 20% cover)	13,838	6%
Mid-dense (20-50% cover)	8,325	4%
Medium & dense (> 50% cover)	6,235	3%

APPLICATIONS FOR MANAGEMENT
Cost of program
The cost of the aerial survey program and associated mapping was $112,324, or $0.50/ha. The major expenditure items included helicopter hire (68 hours at $596.50/hour dry) and labour (879 hours at $60/hour). Figures include the time spent setting up the survey (maps converted and put onto PDA, fuel dumps), completing the actual survey (including labour costs of the pilot, two navigators and four spotters for crew rotation, helicopter hire including ferry), data processing and map production. The figures are calculated in $AUD, and are reflective of the costs in 2004.

Accuracy of the survey
The mesquite distribution mapped during the aerial survey agreed with anecdotal observations and basic hand-drawn maps produced by pastoralists and local Biosecurity Officers from the Department of Agriculture and Food WA.

The validation of the aerial survey accuracy was mixed. There was 98.9% agreement in the accuracy of mesquite recorded in a particular grid cell in the survey and following validation. However, canopy cover estimates were poor; only 32% of validations reflected the same cover class as in the initial survey. It is suspected that both a lack of clear descriptors and the variation between individual surveyors was responsible for this poor result. The impacts of this will be most notable when future surveys attempt to detect the thickening of the population over time.

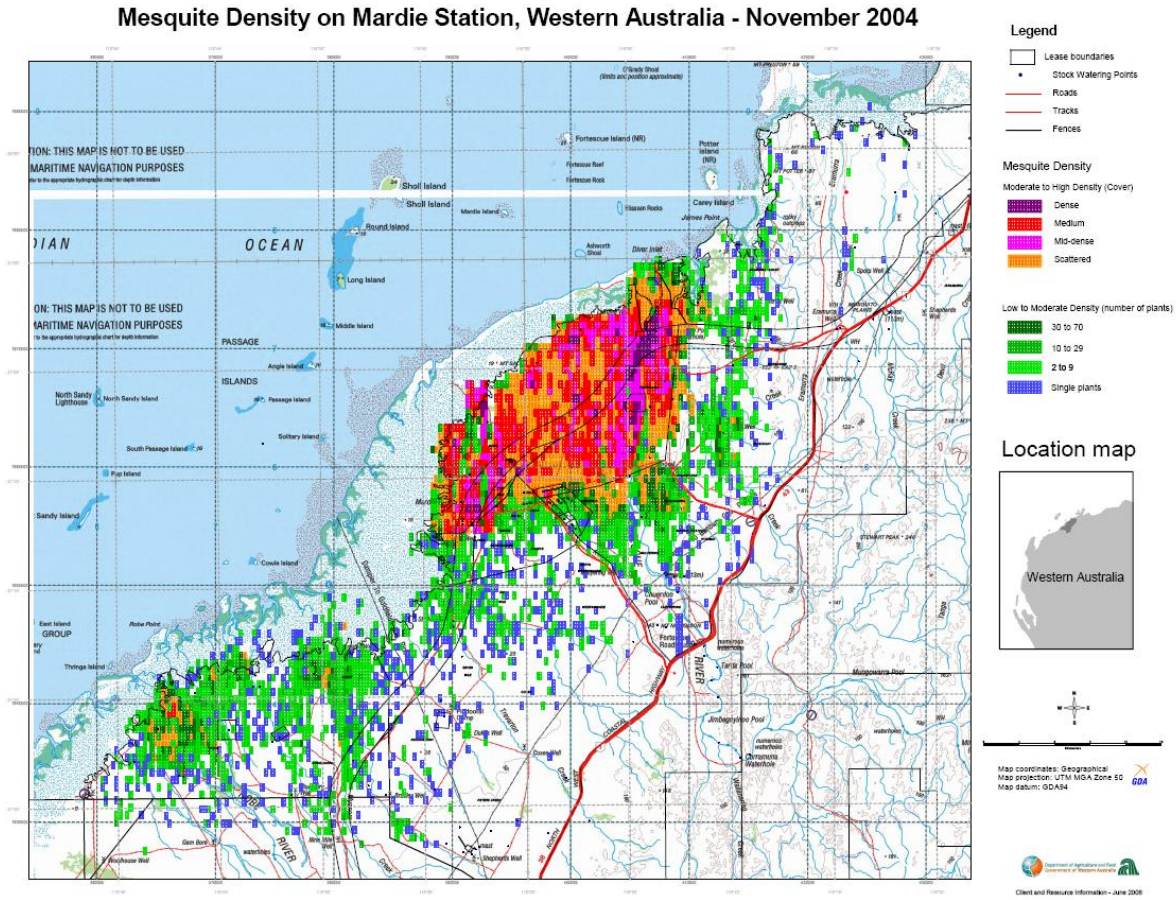

Figure 1. Distribution of mesquite on Mardie Station, as produced by the aerial survey in 2004

Ground validation of grid cell counts between 0 and 70 mesquite plants agreed closely with the data collected during the aerial survey. In the 0 plants/grid cell category, 15 grid cells were ground validated with 15 adult plants detected (range of 0 to 3 plants/grid cell). It is expected these plants were not recorded due to confusion or obstruction by other vegetation. Where 1-70 plants/grid cell were detected by the aerial survey, an average of 27 plants/grid cell were recorded across 8 grid cells validated.

The success of the aerial mapping program at identifying counts of mesquite populations is positive, as it provides a comprehensive and accurate picture of where mesquite is within the outlying areas.

Implications for pastoral management

When the map produced from the aerial survey is overlayed on the pasture potential map of Mardie Station, it becomes evident that mesquite has invaded and thickened mostly on areas of very high pasture potential – namely the Fortescue River floodplains. This means the some of the most valuable pastures available for grazing stock have been overtaken by dense of mesquite, reducing the carrying capacity in this 30,000 ha area.

The strong correlation between the rapid invasion and thickening of mesquite and its preference for highly productive landscapes leads to the general conclusions that the most at-risk habitats are those which have a high to very high pasture potential (van Klinken, pers.com 2008). This is potentially 12,465 km^2 (6.6%) of the Pilbara (Payne & Mitchell, 2002), and would include much of the coastal Pilbara pastoral region and associated inland river floodplains. A commitment for long-term strategic management and control of current populations is essential in ensuring that these areas remain mesquite-free.

One of the most important results from the aerial survey map was the identification of a satellite infestation of mesquite developing on the Robe River. Whilst it was known that this area was populated by a significant number of isolated mesquite plants, the true extent and density of the infestation was not realised until after the mapping exercise. Of primary concern was the fact that this infestation was rapidly progressing in a parallel way to how the core infestation on the Fortescue River developed, and that there were currently no measures in place to stop the spread of this infestation.

Following the production of the map, it was decided that the Robe River region required immediate action to contain the infestation to its present location, and a plan was developed for the long-term management and control of this significant population of mesquite. A fence was erected in the most appropriate location where the majority of the infestation was enclosed, and any mesquite which was outside of this containment boundary was feasibly able to be controlled in the short-term.

Additionally, the fence provided a barrier to the rapid movement of plants east of the current infestation, as cattle (primary vectors) were able to be contained in the 20,800 ha paddock. This area now has its own set of cattle processing yards and adjoining holding paddocks. This provides the facilities for withholding stock prior to movement from within the infested area, ensuring mesquite seed has passed through their digestive system and won't be spread further.

Developing strategic control programs using weed maps

The surveyed map has proved especially important in developing strategic and effective control programs for mesquite. The map provides an accurate picture of mesquite distribution, particularly at low densities. This has allowed for a targeted on-ground chemical control program to be implemented, ensuring that all of the remote plants are treated. It has allowed us to develop a mechanical control program in the higher-density areas, targeting the outer edges first and working towards the core of the infestation.

FUTURE USE OF THE AERIAL SURVEY TECHNIQUE

The benefits of having completed this relatively low-cost mapping exercise have been immeasurable in the development of infrastructure to contain and control mesquite and its vectors, and in developing feasible strategies for the successful control of this weed. The technique does, however, require some improvement to strengthen the validation between cover levels of plants in the more dense areas. As the method used to complete the survey is repeatable, future surveys will allow us to accurately gauge the successfulness of control programs and infrastructure implemented (Anderson *et al*. 2006). It will also provide an effective long-term management tool, identifying new priority areas for action and investment.

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