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Maximising Woodland Bird Diversity in Brigalow Belt Forests

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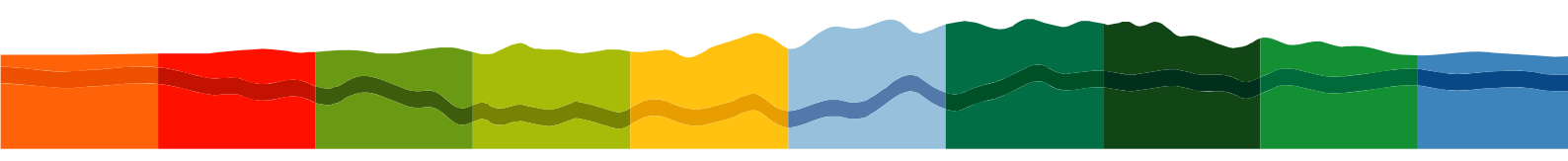

MAXIMISING WOODLAND BIRD DIVERSITY IN BRIGALOW BELT FORESTS (USQ12)

Final condensed report for Land and Water Australia

July, 2008

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1. PROJECT TITLE: Maximising Woodland Bird Diversity in Brigalow Belt Forests

2. PROJECT OBJECTIVES:

The Brigalow Belt is a national biodiversity hotspot, and its extensive forests and woodlands are potentially significant refugia for fragmentation-sensitive birds, but our understanding of optimal management for biodiversity conservation and the specific threats facing woodland birds in the area is limited. In particular, management of the aggressive noisy miner is a major challenge throughout the region, despite the species typically being associated with fragmented landscapes. This project aimed to determine the interactions among fire, grazing and habitat structure, and their influence on noisy miner presence and woodland bird assemblages, in order to develop sound land management principles and intuitive, user-friendly decision-support tools with the potential for application across the Brigalow Belt region. The project objectives were to:

1) Substantially increase our understanding of biodiversity, specifically woodland bird ecology, in subtropical woodland environments by identifying the impact of extensive habitat management and noisy miner invasion on avian assemblages of Brigalow Belt woodlands;
2) Develop and refine existing strategies for improving habitat restoration for biodiversity in Brigalow Belt forests and woodlands, particularly during transition from production into conservation tenures;
3) Improve biodiversity management of the forest and woodland vegetation of Carnarvon Station and the broader Brigalow Belt woodlands through the development and communication of strategies for the minimization of negative impacts of noisy miners and improvement of habitat quality for woodland birds.

3. SUMMARY OF METHODS:

The project developed network models depicting interactions among vegetation management regimes, vegetation structure and subtropical woodland bird assemblages. The models incorporated empirical data from study sites located across Carnarvon Station Reserve and adjacent Carnarvon National Park (Mt Moffat section). Models were developed with data collected from 49 sites during 2006/07, and then validated with data from 25 of those sites plus 25 additional sites collected during 2007/08.

Survey design and field methods

Bird, vegetation and foliar invertebrate data were collected from sites across Carnarvon Station Reserve and Carnarvon National Park in two stages: 1) an initial 49 sites surveyed three times each in 2006/07 formed the model-building data set; and 2) 25 of those initial sites plus an additional 25 new sites surveyed twice each in 2007/08 which provided the validation data set, to allow both spatial and temporal validation (hereafter referred to validation sites). One final validation survey is scheduled for August 2008, as a prolonged period of adverse weather conditions caused the study sites to be inaccessible for the planned

third validation survey trip. Both sets of sites were stratified by several factors including vegetation type, estimated grazing intensity and density of the shrubby understorey. Sites were located in three main vegetation types: Poplar Box (*Eucalyptus populneus*) woodland, Mountain Coolibah (*E. orgadophila*) woodland, and Silver-leafed or Narrow-leafed Ironbark (*E. melanophloia/E. crebra*) woodland.

Bird survey methods consisted of a standard 20 minute search period while traversing the centre of the 200 m belt transect. Assessments of habitat structure were also performed within each study site, with measured variables including altitude, understorey density (% of shrub cover), ground vegetation cover (% of grass, herb and forb cover), % of leaf litter, and the number of dead/fallen timber, average canopy height, and average tree stem density. Evidence of habitat disturbance was also recorded, including estimates of grazing pressure by feral animals, the time since fire and past clearing activities (presence of even-aged regrowth).

Foliage samples were also collected from the canopy foliage of each site to determine the abundance of sessile invertebrates, particularly lerp, and how this varied with habitat and management factors. This component of the study was an addition to the original study design and was incorporated to add to an understanding of the mechanisms which underlie the distribution of noisy miners, themselves a highly influential determinant of bird distribution. A cutting of canopy foliage was taken from four randomly selected trees within each site during each visit with an extendable foliage pruner. The cut foliage was immediately placed within a plastic zip lock bag and sprayed with insect repellent before sealing the bag. Invertebrates and lerps were retrieved and preserved for later analysis.

Analysis and model development

We investigated the responses of several non-exclusive bird categories: small passerines, small ground foragers, decliners, and farmland birds. In addition, noisy miner abundance was modeled separately. Independent variables included the measured habitat and management variables as well as an index of noisy miner abundance (the residuals from the model of noisy miner abundance constructed using the average parameter estimates; see technical report). Initial data analysis was conducted using a Bayesian Model Averaging (BMA) approach to identify factors influencing avian assemblages. This approach accounts for the uncertainty involved in determining what selection of variables best describe avian responses to habitat structure and disturbance.

Based on the BMA results, predictive Bayesian Belief Network Models (BBNs) were developed using Netica and populated with data collected from study sites. The models depict the ecological relationships between birds and habitat factors within the region, including the response of noisy miners to habitat structure and disturbance history, including prescribed fire and grazing by feral animals. BBNs are effective ways to represent visually the relationships among interacting factors. The Netica software package allows several point-and-click functionalities within BBNs of particular value for land managers: 1) scenario analysis, such as identifying the likely outcome of a change in management; 2) diagnostics, where a preferred outcome is set and the conditions most likely to result in that outcome are identified, and 3) sensitivity analysis, where the factors which most influence the outcome are identified.

Finally, in order to evaluate the spatial and temporal domain within which the BBN was effective, the developed BBN model was validated with data collected from the validation sites (twenty-five of the originally surveyed sites, and twenty-five new sites). Finally, 80 of the 99 cases were randomly selected to populate the final version of the BBN and the remaining 19 used for validation. The results presented here are on the basis of two surveys at each validation site; however, the analysis will be refined with data from a third survey scheduled for August 2008.

4. RESULTS & SIGNIFICANCE

Key results:

- Despite being typically associated with highly fragmented and degraded vegetation, noisy miners were abundant throughout 90% of the study region.
- Small passerines (a category which included several threatened and declining species) were most abundant in sites with high understorey cover, low grazing pressure and few noisy miners.
- Although habitat structure was important in determining small passerine abundance, noisy miner abundance, independent of habitat structure, was the most influential factor.
- Grazing by feral herbivores and an open habitat structure (often indicative of frequent burning) were the most important factors determining noisy miner abundance.
- The ability of the BBNs to correctly predict outcomes for temporally and spatially independent cases was high, confirming the usefulness of the models across a large area.

Practical significance against objectives:

Objective 1. *Substantially increase our understanding of biodiversity, specifically woodland bird ecology, in subtropical woodland environments by identifying the impact of extensive habitat management and noisy miner invasion on avian assemblages of Brigalow Belt woodlands*

Small passerines have received relatively little attention in subtropical Australia compared with the more fragmented landscapes of the temperate agricultural zone. Extensive research has emphasized the negative impacts of habitat fragmentation and clearing, and it is easy to assume that the relatively intact, continuous forests and woodlands of the Brigalow Belt must represent high-quality habitat about which we need not be particularly concerned. However, this research has highlighted that the major mechanism through which fragmentation impacts small passerine populations in fragmented, temperate Australia is equally important throughout the Brigalow Belt woodlands.

Sites without noisy miners had on average 3.5 times more small passerine species and 5.5 times more individuals than sites with noisy miners. Noisy miners are advantaged by habitat disturbance which results in a more open vegetation structure, and this research has demonstrated that such disturbances are facilitating high noisy miner abundances even throughout protected areas in which pastoral activities have long ceased.

In particular, this study has demonstrated how habitat structure, habitat disturbance and management through burning regimes influence avian biodiversity, largely through their interaction with noisy miners. Reducing the complexity and density of vegetation through regular burning regimes, in combination with feral grazing, produces a habitat structure highly suitable for the noisy miner. The avifauna of woodland that is subject to regular burning and grazing therefore consists mostly of large-bodied species tolerant of the noisy miner and few small woodland-dependent species.

Objective 2. *Develop and refine existing strategies for improving habitat restoration for biodiversity in Brigalow Belt forests and woodlands, particularly during transition from production into conservation tenures*

There is a perception that the vegetation of subtropical Australia prior to European intervention had an open, grassy structure, and that managing the vegetation to achieve such a structure should result in multiple conservation outcomes. This research has demonstrated that from the perspective of woodland birds, this is not the case. The denser vegetation which tends to be viewed negatively by both graziers and conservation managers provides an important refuge for small passerines. Fire management must allow for some areas to develop a shrub layer and a general thickening of vegetation. As more open parts of the woodlands are important habitat for grassland species such as bustards, an optimal management strategy would create a mosaic of habitats of varying structural complexity. The expanded project will allow the further refinement of management strategies through fire history analysis.

Although cattle have been removed from the study area as part of the restoration process, the impact of feral grazers is still significant. The reduction in ground cover and understorey density as a result of feral grazing affects many avian species and reduces important nesting materials, shelter and food resources. Feral grazing must be addressed for effective habitat restoration to be achieved in the Brigalow Belt woodlands.

Objective 3. *Improve biodiversity management of the forest and woodland vegetation of Carnarvon Station and the broader Brigalow Belt woodlands through the development and communication of strategies for the minimization of negative impacts of noisy miners and improvement of habitat quality for woodland birds*

The management strategies discussed above have been incorporated in a credible and fully validated predictive Bayesian Belief Network model for avian species responses to habitat alteration within woodlands of the Brigalow Belt, providing a useful communication tool for land managers. The BBN acts as a graphical representation of the current system and has the ability to predict species responses to habitat change under hypothetical management scenarios. This provides land managers the ability to rank hypothetical management actions and to determine the most desirable response. BBNs also have the ability to incorporate new data and information in the form of collected empirical data and/or expert knowledge. Thus the models can constantly be updated in light of new information.

The BBN model is being used to communicate to land managers of both Carnarvon Station Reserve and surrounding regions within the Brigalow Belt of suitable management solutions that will reduce the abundance of the noisy miner and improve habitat quality for woodland species. Considerable interest in the decision tool has been expressed by several land managers and it is anticipated that with the

presentation and dissemination of the model and the key recommendations for woodland management, positive outcomes for woodland birds will be achieved across large parts of the Brigalow Belt.

5. COMMUNICATION AND ADOPTION

Communication

These results, their implications and proposed management solutions were presented at the Australian Ornithological Conference in 2007. This presentation won an award for Best Student Presentation (to Ms. Alison Howes). An abstract has also been accepted for the Veg Futures 2008 conference, to be held in Toowoomba in October. The wider community has been reached through a presentation to the Toowoomba Field Naturalist club, 2008, and through several media articles on the research (see below).

The project has attracted media interest, with articles showcasing the research in the *USQ News* (Jan 2008), *The Chronicle* newspaper (Jan 2008) and in the *Toowoomba Mail* (Jan 2008). Bush Heritage Australia's magazine *Bush Heritage News* featured the project in a feature on its research partners ("Our partners – we couldn't do without them"). An article was also printed in Land and Water Australia's *Thinking Bush* (Mar 2008). On completion of the expanded project, a further media release is planned, and it is envisaged that there will be broad public interest in the outcomes.

The findings of this research and tools developed are of potentially significant value to private and public land managers across subtropical inland Queensland. In order to ensure a broad awareness of and access to the project outcomes and outputs, a workshop is planned which will bring together managers of private conservation and grazing land and public land, as well as representatives of regional NRM organizations and government departments. Originally, this workshop was planned for mid-2008; however, with the extension of the project and expansion of project objectives, the workshop will now be held in early 2009. This will allow a broader suite of final results and decision support tools to be presented. During this workshop, participants will have an opportunity to explore the model and discuss potential further refinement and development. A fact sheet and DVD containing the model and a summary of key management recommendations will be provided.

The extended project

The award of a Land and Water Australia Postgraduate Scholarship to Ms. Alison Howes has allowed the project to be extended for one year (until mid-2009). This extension will allow significant expansion of the original investigation, including the ability to determine the effects on bird assemblages a large-scale intensive feral grazer control program which was rolled out in CSR and CNP in late 2007. The current project has identified that grazing pressure is a strong influence on noisy miner densities and, through this, on small passerines. Therefore, this management intervention allows a real-world test of the model's predictive ability, and allows us to chart the trajectory of bird assemblage and vegetation recovery following a reduction in feral grazing pressure. Collection of field data to allow this project expansion has already commenced, with vegetation surveys in the 2007/2008 site visits being expanded to incorporate measures

of floristic composition and ground-layer biomass. Biomass, vegetation and floristic data will also be collected over the next two survey periods to measure any change in vegetation composition over the course of the study. Finally, fire history mapping for CSR has recently been made available through Bush Heritage Australia. The project will be expanded to incorporate determination of the influence of burning regimes on the distribution of birds and foliar invertebrates across the region.

Potential for further adoption activities

A license for the Netica program is currently required to operate the BBNs, which is a potential limiting factor to its uptake and use by land managers throughout the region. However, the investigators are in discussions over options for increased accessibility of the models through collaboration with the developers of Decision-based Learning Interactive (DBLI). DBLI is an interactive website which allows users to access Bayesian network models, and conduct scenario and sensitivity analyses as well as update models with new information. Through this website, the finalized BBN model could be made more widely available to researchers and land managers, and would constitute a 'living' model which could be constantly refined.

6. COMMERCIAL POTENTIAL

The outcomes of this research are predominantly guidelines and knowledge which allows improved management of woodlands and forests for public good outcomes, specifically, enhancement of biodiversity. The primary output, the decision tool, will be freely distributed to maximize adoption.

7. PUBLICATION TITLES

Two manuscripts based on this research are currently in preparation and will be submitted for peer-review by the end of 2008 (see below). With the extension of this project, another three manuscripts are planned for completion by mid-2009. The PhD thesis is due for submission in August, 2009.

Howes, A. and Maron, M. In prep. Interactions between habitat structure and interspecific competition drive bird assemblages of continuous woodland. For submission to *Biological Conservation*.

Howes, A. and Maron, M. 2007. Using Bayesian belief network models to assist ecological decision making. For submission to *Journal of Applied Ecology.*

8. ADDITIONAL INFORMATION

Full detail of this research can be found in the accompanying Technical Report (Howes, A. and Maron, M. 2008. *Maximising Woodland Bird Diversity in Brigalow Belt Forests: Final Technical Report to Land and Water Australia*. The University of Queensland,Brisbane.