Proceedings

of the

4th NATIONAL MALLEEFOWL FORUM

2011

Renmark, South Australia

S D Gillam (Editor)

Government of South Australia
Department of Environment and Natural Resources

PROCEEDINGS

of the

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Preface

The National Malleefowl Forum, held in Renmark, South Australia from 29th July to 1st August 2011, was realised as an objective within the National Malleefowl Recovery Plan 2007, specifically to facilitate communication between interested groups, landholders and other individuals. This was the fourth such forum, allowing for the review of progress on Malleefowl conservation across Australia.

The forum attracted 29 speakers from a variety of backgrounds presenting on a wide range of topics. Insights were provided on current and recent research into the role of fire in Malleefowl habitat; conservation genetics of Malleefowl; and the possibilities of an Adaptive Management Framework were explained. We heard about long term predator control activities undertaken by individual landholders and community groups; restoration projects occurring both on remnants and at a landscape-scale; and were reminded of the importance of volunteers and volunteer groups in Malleefowl conservation activities.

All of the presentations combined provided a comprehensive overview of achievements since the last Forum in Katanning in 2007, and current research, issues and ongoing projects in Malleefowl conservation.

Opportunity was given throughout the Forum for feedback on how well we are achieving/performing against the National Malleefowl Recovery Plan Objectives, and what else we could be doing. The substantial amount of comments received was taken into account in a review of these Objectives, which are included in this volume under: *Performance Evaluation of the National Recovery Plan.* This is the first time a review of this kind has been undertaken for Malleefowl. A further list of *Forum Resolutions* was also compiled from the feedback received, and is also included in this volume. Both of these reviews of recovery initiatives for Malleefowl provide important guidance to the Recovery Team over the coming years.

The Forum itself and the Proceedings serve as valuable inspiration for the continuing work in Malleefowl conservation.

Malleefowl working its mound, Coorong National Park, SA. Photo: S Gillam

Acknowledgements

The National Recovery Team is grateful to the Forum Organising Committee for coordinating the Forum. Committee members were: Sharon Gillam (Chair), Ann Stokie, Stephen Davies, Erin Sautter, Peter Copley, Benita Dillon, Ellen Ryan-Colton, Peter Ewin and Ray Dayman.

Thanks to Oscar Abdulla from the local Riverland Aboriginal Community and Paul Day from the Renmark/Paringa Council for their opening speeches.

Iluka Resources are gratefully acknowledged in providing the funding for the Forum. Organisations who supported the event include: Mallee Estate Wines – thanks to Jim Markeas and family from Mallee Estate Wines for their generous donation of wines; the Department of Environment and Natural Resources SA – thanks to 'behind the scenes' administrative and finance staff; Janet Pinyon, Michael Schuetze and Marilena Scidone of the Renmark Hotel; and Caryl Michael of the Mallee Fowl Restaurant.

Thanks to everyone who helped with the set-up and running of the event, including Sally and Wally Cail, Erin Sautter, Peter Stokie and Ralph Patford. A big thankyou to Chris Grant for hosting the quiz at the Forum dinner, and to staff who helped with the questions. Thanks to those who assisted with the field trips on the Monday – staff from the DENR Berri Office, volunteers from the Friends of Riverland Parks, Teressa ter Bogt and the McCormick Centre, Fiona and Bob Henderson of Riverland Safari Bus Service, and Alan and Fleur of Renmark River Cruises.

Without the presenters, there would be no Forum. Sincere thanks to all those who presented at the Forum including key-note and general speakers, and all who gave poster presentations.

Many thanks to those who very competently chaired the sessions: Ann Stokie, Peter Sandell, Joe Benshemesh, Peter Copley, Stephen Davies and Vicki Jo Russell. And special thanks to Vicki Jo for her tremendous effort in compiling all comments and feedback from participants and translating them into the final recommendations and summing up the Forum.

And finally, the National Malleefowl Recovery Team gratefully acknowledge all who attended the Forum, and for your continued support in Malleefowl conservation.

4th NATIONAL MALLEEFOWL FORUM

29th July – 1st August 2011
Renmark Hotel, Murray Avenue, Renmark, South Australia

PROGRAM

Friday 29th July

3.30 – 5.00pm Registration, Function Room, Renmark Hotel

5.30 – 7.30pm Pre-forum drinks & nibbles, Function Room, Renmark Hotel.
Welcome by Peter Copley, SA Dept of Environment & Natural Resources; Member National Malleefowl Recovery Team

Saturday 30th July

8.00am Registration

9.00am ***Welcome*** by Peter Sandell, Chair, National Malleefowl Recovery Team; Parks Victoria

9.15am ***Welcome*** on behalf of the local Riverland Aboriginal Community by Oscar Abdulla
Welcome on behalf of the Renmark/Paringa Council by Paul Day, Director Infrastructure & Environmental Services

9.30am ***Aims of the National Forum*** – Peter Sandell

9.45am ***Performance Evaluation of the National Recovery Plan for Malleefowl***
Peter Copley, SA Dept of Environment & Natural Resources; Member National Malleefowl Recovery Team

9.55am ***The national Malleefowl database: making excellence easier***
Keynote: Dr Joe Benshemesh, La Trobe University, Victoria; Member National Malleefowl Recovery Team

10.30 – 11am Morning tea *(30mins)*

State by state round-up: achievements since Katanning

11.00am **Chair:** Ann Stokie, Secretary, Victorian Malleefowl Recovery Group

- ***Malleefowl Conservation in SA: activities from 2007 – 2011***
  Sharon Gillam, SA Dept of Environment & Natural Resources; Member National Malleefowl Recovery Team
- ***Malleefowl monitoring in the SA Murray Darling Basin: 2011 update***
  Dave Setchell, Mallee Eco Services; SA Dept of Environment & Natural Resources Murraylands Region
- ***Activities of WA Malleefowl Network 2009 – 2011***
  Professor Stephen Davies, Curtin & Murdoch Universities WA; Member National Malleefowl Recovery Team
- ***North Central Malleefowl Preservation Group – update***
  Sally Cail, North Central Malleefowl Preservation Group, WA; Member National Malleefowl Recovery Team
- ***To Be or Not to Be – The Future of Malleefowl Conservation***
  Susanne Dennings, Malleefowl Preservation Group, WA

- ***New South Wales update***
  Peter Ewin, NSW Office of Environment & Heritage; Member National Malleefowl Recovery Team
- ***Malleefowl Conservation Action in Victoria 2007 – 2011***
  Peter Stokie, Victorian Malleefowl Recovery Group; Member National Malleefowl Recovery Team

12.00pm Questions for state-wide presenters
12.10pm **Chair:** sum up key issues

12.20 – 1.20pm Lunch *(60mins)*
Poster Presentations
- ***Private landscape restoration for Malleefowl,*** Bernie Fox, Member Victorian Malleefowl Recovery Group
- ***Using Remote Sensor Cameras to gather data on Malleefowl,*** Graeme Tonkin, SA volunteer
- ***Landscape scale surveying for Malleefowl nest sites in western NSW***
  Milton Lewis, Lachlan Catchment Management Authority NSW

Theme: The Role of Fire

Chair: Peter Sandell, Chair, National Malleefowl Recovery Team; Parks Victoria

1.20pm ***Contemporary fire regimes in a fragmented and an unfragmented landscape: implications for persistence of the fire-sensitive Malleefowl***
Keynote: Dr Blair Parsons, Outback Ecology; University of WA; Member National Malleefowl Recovery Team

2.00pm ***The Mallee Fire and Biodiversity Project***
Keynote: Dr Simon Watson, Charles Sturt University NSW

2.40pm **Chair:** Discussion on the role of fire

2.50 – 3.20pm Afternoon tea *(30mins)*

Theme: The Role of Community Groups

Chair: Dr Joe Benshemesh, La Trobe University, Victoria; Member National Malleefowl Recovery Team

3.20pm ***Volunteering – Where would we be without volunteers, and can we keep them?*** Ann Stokie, VMRG

3.40pm ***A landowner's story of Malleefowl conservation in the SA Murray Mallee and the establishment of the Browns Well Landcare Group***
Lew Westbrook, landholder, SA; Chair, Browns Well Landcare Group

4.00pm ***Twenty years of Malleefowl conservation by the Mantung Maggea Land Management Group*** Malcolm Johns, landholder, SA; Member, Mantung Maggea Land Management Group

4.20 – 5.00pm **Chair:** Day's wrap up and discussion

5.15 – 6.15pm **Meeting of the National Malleefowl Recovery Team**

6.45pm Assemble for Forum Dinner
7.00pm Forum Dinner, Function Room, Renmark Hotel. Includes Quiz (3 rounds), to begin between mains & dessert. Stay for fun & prizes

Sunday 31st July

Themes: The Role of Genetics / Adaptive Management

	Chair: Peter Copley, SA Dept of Environment & Natural Resources; Member National Malleefowl Recovery Team
9.00am	***Conservation genetics of Malleefowl*** **Keynote:** Taneal Cope, PhD Student, University of Melbourne
10.00am	***Effects of locust control activities on Malleefowl nesting success*** Ellen Ryan-Colton, SA Dept of Environment & Natural Resources; Member National Malleefowl Recovery Team
10.20 – 10.50am	Morning tea *(30mins)*
10.50 am	***Adaptive management of Malleefowl*** **Keynotes:** Dr Joe Benshemesh, La Trobe University, Victoria, and Dr Michael Bode, University of Melbourne
11.30am	**Chair:** Adaptive management and research priorities discussion

Theme: Remnants and Landscape-scale Restoration Projects

	Chair: Professor Stephen Davies, Curtin & Murdoch Universities WA; Member National Malleefowl Recovery Team
12.00pm	***Distribution of nesting mounds by Malleefowl in remnant habitat in western New South Wales*** Milton Lewis, Lachlan Catchment Management Authority NSW
12.20pm	***Tracking Malleefowl in the Little Desert National Park*** Ralph Patford, Member Victorian Malleefowl Recovery Group
12.40 – 1.30pm	Lunch *(50mins)* **Poster Presentations** • ***Conservation activity in the northern Murray Mallee – where do Malleefowl fit in?*** Chris Grant, SA Dept of Environment & Natural Resources • ***Wedderburn CMN Malleefowl Conservation Activities***, Wendy Murphy, Parks Victoria
1.30pm	***Mallee and Malleefowl Restoration at Monarto Zoological Park*** Vaughan Wilson, Monarto Zoo, Zoos SA
1.50pm	***How Habitat 141 contributes to Malleefowl conservation*** Ben Carr, Habitat 141 Project; Greening Australia Victoria
2.10pm	***Monitoring of Malleefowl in the arid zone ecosystems of Maralinga Tjarutja*** Harald Ehmann, Alinytjara Wilurara Region, SA Dept of Environment & Natural Resources
2.30pm	**Chair:** Discussion on improvements to Malleefowl habitat management and restoration
2.50 – 3.20pm	Afternoon tea *(30mins)*

3.20pm	***Vision Statement, Charter & Guidelines for project applications for Malleefowl Offset Monies*** Stephanie Mitchell, Environmental Advisor, Iluka Resources

Conclusion

3.30pm	**Chair:** Vicki-Jo Russell, Zoos SA
	Review of discussions. Actions and outcomes. Forum resolutions
5.30pm	***Official Close*** by Peter Sandell, Chair, National Malleefowl Recovery Team; Parks Victoria
6.40pm	Bus leaves Renmark Hotel for Malleefowl Restaurant
7.00pm	Optional Dinner, Malleefowl Restaurant, Sturt Highway, Berri.

Monday 1st August

Optional Field Trips

8.00am – 10.00am	**1. River Breakfast Cruise** - $45 pay on boarding
8.00am – 1.00pm	**2. Nature Lovers** - $15 – pay at registration desk on arrival
8.00am – 1.00pm	**3. Wetland Wonders** - $15 – pay at registration desk on arrival

Resolutions of the Forum

Managing Populations

1. Seek opportunities to identify, protect, improve, and re-establish large areas of contiguous habitat for malleefowl over the long term (under MAMF)

Planning and Monitoring for Recovery

2. Collate a list of priority research questions to guide the recovery effort and engage others

3. Secure funding to ensure the uploading and analysis of WA community data is equal to the rest of the country

4. Secure funds and implement a national Malleefowl Adaptive Management Framework (MAMF) for national malleefowl conservation recovery

5. Establish a national fire project under the auspices of the Recovery Team (and MAMF) to consolidate existing information/learning including available traditional burning knowledge, identify priority applied research and opportunities to learn i.e. on the back of government prescribed burning programs and stimulate further research and funding

6. Seek funding to appoint a national Malleefowl Recovery coordinator that reports to the national Recovery Team to drive the application of the MAMF, supports national coordination, drives the Plan's implementation, supports and recruits database coordinators and seeks additional funding for malleefowl conservation nation-wide

7. Prioritise Recovery Team activities and national reporting to be more closely aligned to the national Recovery Plan

8. Reinstate 'Around the Mounds' (or equivalent) to provide project updates, monitoring feedback and show how data is applied to achieve recovery to the malleefowl conservation community in particular volunteers – suggestions received this could be achieved by a newsletter or national website

9. Convene a national remote camera (web cam) working group under the auspices of the Recovery Team to look at existing use, best opportunities to use the technology to further recovery and to establish guidelines for use with minimal impacts on the birds

Engaging communities

10. Establish under the national database a database of interested individuals, volunteer groups and their activities so that groups can better share information and promote their volunteer opportunities

11. Pursue options for links with volunteer organisations to increase access to volunteers particularly for low populated regional areas e.g. city, scouts, CVA

12. Secure resources to enable a further print run of the VMRG Malleefowl Education Kit in a format that can be distributed to other regions

13. Follow up on the Regional NRM Malleefowl Guide and establish working partnerships with all key NRM/CMAs across the malleefowl's range

4th NATIONAL MALLEEFOWL FORUM

PRESENTATIONS - Oral

1. Welcome

Peter Sandell, Chair, National Malleefowl Recovery Team; Environmental Program Manager (Mallee District) Parks Victoria, Mildura, Victoria

It is my privilege to welcome you all to the fourth National Malleefowl Forum, on behalf of the National Malleefowl Recovery Team and the Organising Committee. Each of us here will have different reasons for becoming involved with Malleefowl, but we all have in common a desire to do what we can to conserve this species into the future. Is it the work ethic of Malleefowl that we find so attractive – a species that makes the most of the limited resources in our semi-arid environment? Or is it their poor parenting skills that we identify with?

Whatever it is, volunteers in each of Victoria, South Australia, and Western Australia collectively contributed more than 4000 hours of their own time to the cause of Malleefowl conservation in the past year alone. There is no doubt in my mind that these efforts are having a positive influence on conservation outcomes at a national level.

As you know, the management of public land and hence the vast majority of Malleefowl habitat is the responsibility of state governments, although the Commonwealth gets involved where a species is considered to be threatened nationally. There is a dichotomy in the case of Malleefowl which is considered endangered in some states but only vulnerable nationally. So what are the consequences of this situation?

One implication is that funding for recovery initiatives can be difficult to obtain. This is not to say that the species does not receive government support – it has been the beneficiary of a number of grants from both the Commonwealth and state governments in recent years. But each jurisdiction tends to be variable in their support for the conservation effort.

The Commonwealth funded the recent revision of the National Recovery Plan (in partnership with DENR in South Australia), the initial development of the national database, the multi-regional project with the trend analysis and other outcomes. Hopefully, the development of a framework for adaptive management will also be funded via an ARC Linkage Grant.

There has been considerable progress since the previous national forums in Adelaide (1995), in Mildura (2004), and Katanning (2007). We now have a Federally approved National Recovery Plan, a national manual for monitoring, a national database for storage and interrogation of data, an educational kit to help with extension to schools. Each state has also been proactive with their own activities, such as the 'It's Gnow or Never' documentary produced by the MPG in Western Australia and screened on the ABC last year. These initiatives collectively have put us in a better position in terms of an agreed and strategic approach to national conservation. They have also raised the profile of Malleefowl in the community and with government agencies.

Despite this progress, we need to remain conscious of risks associated with overlapping jurisdictions for a species which has as large a geographical extent as does Malleefowl. A species that is spread from the edge of the Indian Ocean in the west to the outskirts of Bendigo in the south-east, and from near Naracoorte in the south to the southern NT can't be in trouble, can it? Well, yes it can.

It can for a number of reasons, some of which are specific to the Mallee belt. This is a region which historically had a very high level of clearing for cropping and extensive pastoral use in the areas that remained uncleared. The remnant vegetation in many cases is likely to represent marginal habitat for Malleefowl. These areas are projected to become even more marginal as our climate becomes warmer and drier. I am conscious of the advice that Sally Cail provided from the northern Wheatbelt recently. Of the 160 nests they monitor, 13 were active in 2008/09, 11 in 2009/10, and only 3 in 2010/11 after a series of dry years, and particularly low winter and spring rainfall. There has been little or no recorded breeding activity in the grids north of the Murray in the SA Riverland for some years. We would hope that these trends will reverse, but the reality is that the south west of Australia has been relatively dry since the 1970s. If Malleefowl populations decline in the north, how does that change the longer term picture for the species?

Most of us live in the more southerly extent of the range of Malleefowl where changes may not be so obvious. The National Forum provides us with the opportunity to raise our focus from what is happening in our own patch and consider the broader national picture. The bigger picture for me is that the future of Malleefowl depends on their being sufficient large contiguous blocks of suitable habitat within the southern Mallee belt, and that these large blocks (I would suggest 10,000 ha as a minimum size) need to be managed in a way which optimises the prospects for this species. In so doing, we will also be improving the long term prospects for a suite of other species which co-exist with Malleefowl. We need to use our collective energy and skills to communicate this message back through all levels of government, including our NRM bodies which are now vested with considerable land management authority.

Along with the risks we need to be able to look at the opportunities as they present. Areas that are becoming more marginal for cereal cropping may lend themselves to revegetation with mallee eucalypts for the purpose of carbon sequestration. These in turn may become suitable as habitat for Malleefowl and other species.

The Organising Committee for the Forum, led by Sharon Gillam, have put together a stimulating and topical program. They have done a wonderful job. I am personally looking forward to the presentations and the discussions (formal and informal) which will ensue over the next couple of days and I would encourage everyone to make the most of this event.

2. Aims of the National Forum

Peter Sandell, Chair, National Malleefowl Recovery Team; Environmental Program Manager (Mallee District) Parks Victoria, Mildura, Victoria

For inspiration in preparing this address, I visited the national Malleefowl database. I scanned the map showing the distribution of monitoring sites scattered across the Mallee belt. What strikes you is how fragmented are the areas of remnant habitat, and in many cases how small. Take the case of Innes National Park which my wife and I visited at Easter. Malleefowl literally have just a toehold at the bottom of a large peninsula which has otherwise been totally cleared. Then I changed over to the satellite view and the large fire scar in the Big Desert Wilderness Park in Victoria became visible. This exercise highlighted for me the relevance of the themes chosen for this conference to the long term conservation of Malleefowl.

We have known for many years (since Joe did his PhD on the subject) that fire plays a critical role for this species. Monitoring has certainly shed further light on the period post-fire before habitat again becomes suitable for breeding. But not until the Mallee Fire and Biodiversity project of La Trobe and Deakin Universities simultaneously sampled a large number of fire mosaics across mallee habitats in Victoria, N.S.W., and South Australia has it been possible to quantify on a large scale some of the relationships between fire regimes and the presence and abundance of a broader suite of Mallee fauna. Simon Watson will be shedding more light on these relationships later today.

Fragmentation of habitat due to historical clearing is another long term issue. Are we facing the prospect of extinction debt – the future loss of a species due to events in the past; such as fragmentation of habitat? My understanding is that this phenomenon is most likely to be exhibited by long-lived species and those with specialised requirements. Sounds like Malleefowl. Until Taneal Cope embarked on her PhD study, we had no real measure of the risks associated with genetic isolation for this species. I am sure everyone will be most interested in her prognosis.

A key aim of the Forum is for each of us to learn the lessons of recent research and communicate these back within our own regions. Our capacity to apply evidence-based management has been greatly enhanced by the development in recent years of the national database. I expect that Joe's presentation on the database will open our eyes to the potential of this tool.

The role of community groups will continue to be central both from the perspective of collecting evidence through monitoring, and ensuring that land managers take account of that evidence in their management decisions. You should not feel that you do not have influence in this area. In recent times in Victoria, we have been faced with the prospect of burning 5% of our mallee habitats each year as a consequence of the findings of the Victorian Bushfires Royal Commission. There was a groundswell of opposition to this proposition for the mallee, based primarily on the findings from research and monitoring. This has swayed the responsible government agency to amend the burning quota to a more sustainable level.

Because Malleefowl occur over such a vast geographic area, we rarely get the opportunity to meet together as a group. The aim of the National Forum is to support and promote the activities of the large pool of volunteers who are scattered across the southern half of the continent. As convenor of the National Recovery Team for the past 7 years, I am mindful of the fact that our national newsletter 'Around the Mounds', previously produced by the Threatened Species Network, has gone into abeyance in the last few years. This is a matter that we will be addressing in our recovery team meeting tomorrow afternoon. I would encourage volunteers to approach me or other members of the recovery team with suggestions on how your efforts can be better supported. You are the backbone of the conservation effort and this forum is for your benefit.

3. Performance Evaluation of the National Recovery Plan for Malleefowl

Peter Copley, Senior Threatened Species Ecologist, SA Dept of Environment & Natural Resources; Member National Malleefowl Recovery Team

In 2010, the second "National Recovery Plan for Malleefowl, *Leipoa ocellata*", was formally 'made' (signed) by the Federal Environment Minister, under the Commonwealth's *Environment Protection and Biodiversity Conservation Act, 1999*. However this plan had been in working draft forms for several years prior to that formal sign-off occurring, so that in effect, the plan has been in operation since before the last (i.e. third) national Malleefowl forum held at Katanning in Western Australia in 2007.

The objective of this paper was to follow a review or performance evaluation process along similar lines to those conducted for other threatened species recovery plans in South Australia, based;

- firstly, around my personal assessments of performance for each of the specific objectives identified in the national recovery plan for Malleefowl, and
- secondly, to incorporate performance assessment comments invited from attendees at the Fourth National Malleefowl Conservation Forum.

Recovery Plan Objectives

The primary objectives of the second National Recovery Plan for Malleefowl are to:

- secure existing populations across the species' range and
- achieve de-listing of Malleefowl under the EPBC Act within 20 years.

These primary objectives are to be achieved through focussing on delivery against 18 more specific objectives.

Specific Objectives:

Managing populations

1. Reduce permanent habitat loss
2. Reduce the threat of grazing pressure on Malleefowl populations
3. Reduce fire threats
4. Reduce predation
5. Reduce isolation of fragmented populations
6. Promote Malleefowl-friendly agricultural practices
7. Reduce Malleefowl mortality on roads

Planning, research and monitoring

8. Provide information for regional planning
9. Monitor Malleefowl and develop an adaptive management framework
10. Determine the current distribution of Malleefowl
11. Examine population dynamics: longevity, recruitment and parentage
12. Describe habitat requirements that determine Malleefowl abundance
13. Define appropriate genetic units for management of Malleefowl
14. Assess captive breeding and re-introduction of Malleefowl
15. Investigate infertility and agrochemicals

Community involvement and project coordination

16. Facilitate communication between groups
17. Raise public awareness through education and publicity
18. Manage the recovery process

Performance Review Process

Each objective in the recovery plan was assessed against a standard set of "Progress" and "Achievability" scores, indicated by different symbols or numbers of stars. The scores used are:

Progress ratings:

Positive movement	**+**
Steady or no movement	**0**
Negative movement	**-**
Unclear	**?**

Achievability ratings:

Achieved	***
On track	**
Within reach	*
Unlikely	**0**
Unclear	**?**

My personal "best guess" assessments were provided initially, based on South Australian experiences with Malleefowl conservation and research, and on my understanding of activities interstate through membership of the National Malleefowl Recovery Team since its inception. However, in acknowledging the limitations and biases of this approach, I then sought either (i) support for each assessment or (ii) alternative views (both with justifications) from those involved with various relevant activities, to help improve this assessment process. My initial draft review was distributed to forum registrants prior to the forum in an attempt to stimulate discussion and debate, as well as to focus attention on:

(a) where we are getting things right,

(b) where we are perhaps missing the mark, and

(c) where we might need to improve, or drop, particular activities or commence new directions.

PERFORMANCE REVIEW RESULTS

A. MANAGING POPULATIONS

1: Reduce permanent habitat loss

1.1 The total area of Malleefowl habitat protected in reserves, conservation covenants and similar management agreements, increases over the life of the plan.

Progress: **Positive movement** **+**

Achievability: **On track** **

This increase in protection appears to have occurred in WA, SA, Victoria and NSW. For example, in Victoria there have been several private properties with new conservation covenants. However, no statistics have been collated to demonstrate the extent to which this has occurred, either in total, or by reserve type.

Recommendation 1: That the national recovery team formalises some way of reporting against this objective each year.

This trend is likely to occur into the future but almost certainly with diminishing numbers of 'new' land parcels conserved.

1.2 No decline in the known area of occupied or mapped potential Malleefowl habitat over the life of the plan.

Progress:	**Unclear**	**?**
Achievability:	**Unclear**	**?**

There does not appear to have been any collation of data on loss of known or suspected Malleefowl habitat since the recovery plan was first drafted (or over any time-frame for that matter). The data almost certainly exist in people's heads or various databases, and it should be possible to report against this target. A start year and baseline measure would need to be agreed upon as a starting point.

Recommendation 2: That the National Recovery Team formalise some way of reporting against this objective each year, preferably with some annual summary statistics provided back to at least 2007.

If the data are available, this objective should be achievable and "within reach".

2: Reduce the threat of grazing pressure on Malleefowl populations

2.1 Goats and sheep are removed from conservation reserves, or at least kept at low numbers.

Progress:	**Steady or no movement / Positive movement**	**0 / +**
Achievability:	**Within reach**	*****

While there has been some goat control work on Gluepot Reserve in South Australia, there are many areas within the Malleefowl's range where feral goats are an ongoing issue. Feral deer are also an increasing problem in a few conservation reserves.

While there are feral goat (and deer) control programs in conservation reserves in each state, the outlook for ongoing and improved levels of control does not look positive.

Recommendation 3: That the National Recovery Plan find a way for documenting which conservation reserves with Malleefowl within each State currently has feral goats (and/or deer) and which of these are subject to control efforts, and then report against this each year. This may be an issue addressed as part of the ARC Linkage adaptive management project

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2.2 Artificial sources of water in conservation reserves are closed or fenced.

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*****

Closure of artificial waters has happened in a major way on Gluepot and on Calperum and Taylorville Reserves in South Australia and more water closures are proposed on the latter two properties. Similar actions have occurred through the closure of irrigation channels as a result of the Wimmera / Mallee pipeline project.

Recommendation 4: That the National Recovery Team report against this objective each year.

2.3 The area of known Malleefowl habitat protected from stock grazing (e.g. through fencing) increases over the life of the plan.

Progress:	**Positive movement**	**+**
Achievability:	**On track**	******

Significant areas of Malleefowl habitat continue to be fenced as part of various national and State funding schemes. However, as for many other objectives in this plan, there are no readily available statistics to report on the scale of this activity.

Recommendation 5: That the National Recovery Team report against this objective each year.

2.4 Rabbit numbers are reduced where they are abundant in or near Malleefowl habitat.

Progress: **Steady or no movement** **0**

Achievability: **Unlikely** **0**

There does not appear to have been any significant action on this objective and, in fact to the contrary, recent rabbit population increases after the good rains over much of the Malleefowl's range are likely to have negated any such works many times over.

It seems unlikely that reduction of rabbit numbers is a sustainable activity at the scale of areas required to support viable Malleefowl populations. However, strategic rabbit control efforts around a selected number of active Malleefowl 'nesting territories', or broad-scale control in selected years may be adequate to encourage increased recruitment of Malleefowl.

Rabbit control must be considered wherever fox baiting is undertaken.

3: Reduce fire threats

3.1 Fire management plans which consider the habitat requirements of Malleefowl are developed and implemented for all reserves in which Malleefowl occur.

Progress: **Positive movement** **+**

Achievability: **Unlikely** **0**

Increasing numbers of fire management plans are being prepared for areas / reserves occupied by Malleefowl and most of these plans do address issues of risk to Malleefowl. However, the implementation of these plans, especially where pro-active habitat protection burns are proposed, does not occur in many areas or very often. An example of where such plans are implemented for the protection of Malleefowl habitat is the South East of South Australia.

The assessment of achievability (above) is based on the likelihood of resources being provided to implement the conservation-based actions for at least half of the fire management plans for reserves where Malleefowl are known to occur over a 5-year period. In fact, the Victorian Malleefowl Recovery Group has concerns that annual prescribed burn targets, for example in Little Desert National Park (Victoria), has very little unburnt habitat left, yet is a park with ongoing prescribed burn targets.

3.2 Broad-scale agricultural burning is avoided in areas that harbour Malleefowl.

Progress: **Unclear** **?**

Achievability: **Unclear** **?**

It is not clear where this is an issue and who needs to address it.

Recommendation 6: That the National Recovery Team seek clarification on this issue and decide how this needs to be addressed

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3.3 Fires in Malleefowl habitat are mapped and their effects monitored to inform future planning.

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*****

Fire-scar mapping data are now very good in each jurisdiction. However, not all Malleefowl habitat has been identified and mapped in each State and the effects of mapped fires on Malleefowl and their habitats are seldom monitored.

The fire data exist; the Malleefowl habitat data either exist or could be extrapolated. However, analyses of spatial and temporal effects of fires on Malleefowl are not undertaken. The point is, the analyses could be done.

Recommendation: 7: That the National Recovery Team assists the ARC-linkage project to obtain these data and use as a basis for the Adaptive Management planning process.

4: Reduce predation

4.1 Fox control efforts are adequately documented near monitoring sites.

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*****

Fox-baiting data are now recorded in a more systematic manner where this activity occurs on, or in the vicinity, of Malleefowl monitoring sites. However, there is considerable room for improvement, especially in terms of working this in with an active adaptive management monitoring program. This is still proposed for the near future. As the VMRG point out, there is also a need to coordinate any baiting programs across neighbouring properties to improve efficacy and efficiency.

Recommendation 8: That the National Recovery Team assists the ARC Linkage Adaptive Management project team obtain all relevant data about fox baiting efforts for Malleefowl conservation.

4.2 Fox numbers are reduced where Malleefowl densities have declined and fox predation is a likely explanation for such declines.

Progress:	**Unclear**	**?**
Achievability:	**Unclear**	**?**

This objective is still difficult to define realistic activities and targets for. The active Adaptive Management project aims to clarify these issues.

Recommendation 9: That the National Recovery Team assists the ARC Linkage Adaptive Management project team with relevant location, time-frame, spatial coverage, and details of any monitoring associated with this activity.

5: Reduce isolation of fragmented populations

5.1 Habitat links between remnants are increased in priority areas as identified in regional Malleefowl conservation plans.

Progress:	**Unclear**	**?**
Achievability:	**Unclear**	**?**

This objective does not appear to have been addressed.

6: Promote Malleefowl-friendly agricultural practices

6.1 Increased adoption of asynchronous fallowing by crop farmers in areas adjacent to Malleefowl habitat.

Progress:	**Steady or no movement**	**0**
Achievability:	**Unlikely**	**0**

There does not appear to have been any strategic action on this objective. However, there are isolated examples of farmers who do consider the needs of Malleefowl, when they are working in paddocks adjoining known Malleefowl habitat.

7: Reduce Malleefowl mortality on roads

7.1 Occurrence of road kills is recorded each year, patterns analysed and frequency reduced.

Progress:	**Steady or no movement**	**0**
Achievability:	**Unlikely**	**0**

While there have been EPBC Act conditions placed on proposed road upgrade developments likely to increase risks of road mortalities of Malleefowl, no systematic recording system has been established to monitor road kills and, as such, there are no data to analyse for patterns.

Recommendation 10: That the National Recovery Team seeks advice from the ARC Linkage adaptive management project team about how best to access and maintain such information.

7.2 Signs are erected where needed to warn drivers that Malleefowl may be on the road ahead.

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*****

A few road signs have been erected in South Australia, Victoria and Western Australia but there has been no monitoring of their effectiveness. While there are several further areas where more signs could be erected, it would seem prudent to assess their usefulness and to determine site priorities.

Recommendation 11: That the National Recovery Team considers how this objective could be managed effectively.

B. PLANNING, RESEARCH, AND MONITORING

8: Provide information for regional planning

8.1 Regional conservation plans for Malleefowl are prepared.

Progress:	**Steady or no movement**	**0**
Achievability:	**Within reach**	*****

In early 2008, Joe Benshemesh's "Advice to Regional Natural Resources Management Bodies Regarding Management and Monitoring of Malleefowl" for each of the 15 NRM and CMA regions across the Malleefowl's range was printed and forwarded to contacts in each of these regions.

While there have been no regional conservation plans prepared for Malleefowl, per se, there have been increasing incidences of the National Recovery Plan and the National Monitoring Manual being used as a basis for more localized management plans – especially, associated with new mine site operations.

9: Monitor Malleefowl and develop an Adaptive Management framework

9.1 Monitoring data are analysed and reviewed and a national Adaptive Management design is developed through collaboration by 2008.

Progress: **Positive movement** **+**

Achievability: **Within reach** *

Monitoring data for Victoria and South Australia have been reviewed and analysed and more data from Western Australia and New South Wales have been reviewed and are gradually being incorporated into the national database in readiness for development of the Adaptive Management project.

The ARC Linkage Adaptive Management project has recently been funded by ARC and other partners, so the project can now proceed.

9.2 Monitoring continues at existing sites across Australia according to national standards, with:

- **monitoring completed in each state by 1 February each year**
- **data for each monitoring site recorded as described in manual,**
- **data entered in database, and**
- **data provided to Birds Australia in electronic format**

Progress: **Positive movement** **+**

Achievability: **On track** **

While the annual time-frames for completion of these tasks are usually later and nearer June, they are up to date for Victorian and South Australian sites. There are still some issues around catch-up for WA and NSW monitoring data. (The database is not managed by Birds Australia.)

- **monitoring data analysed by state and nationally by 31 May each year**

Progress: **Positive movement** **+**

Achievability: **On track** **

Annual summaries are usually completed by the end of June each year.

Recommendation 12: That the National Recovery Team summarises annual monitoring data and any trends as part of a national report card based upon the Recovery Plan objectives.

- **summary reports distributed to participants by 30 June each year.**

Progress: **Positive movement** **+**

Achievability: **On track** **

This is happening reasonably effectively in most areas, with reports distributed to volunteers in Victoria and South Australia, to National Recovery Team members, and to others with an interest through the VMRG web-site and/or in Western Australia, through the Malleefowl Preservation Group's newsletter, *Malleefowl Matters*. The VMRG also hold an annual reporting-back meeting for their volunteers.

9.3 Effectiveness of fox baiting at increasing Malleefowl breeding density is adequately tested, with a consistent and substantial reduction in fox abundance achieved at the baited grids.

Progress:	**Steady or no movement**	**0**
Achievability:	**Within reach**	*

Effectiveness of fox-baiting is still to be tested. However, this is intended to be a significant aspect of the ARC Linkage Adaptive Management design project.

9.4 The Malleefowl monitoring effort is facilitated, standardised and coordinated at a national level.

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*

This has been a very significant focus of volunteer groups across the range States of the Malleefowl, and the level of facilitation and coordination within each jurisdiction is a credit to all involved. However, seamless facilitation and coordination of a standardized approach across four States and many regions remains an issue while there is no national coordinator/facilitator role.

10: Determine the current distribution of Malleefowl

10.1 The distribution and status of Malleefowl in remote areas is clarified and local involvement is encouraged.

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*

While there has been some progress on this activity, there are still many gaps in survey coverage.

Recommendation 13: That the National Recovery Team define the geographic boundaries for "remote areas" occupied by Malleefowl and establish a baseline distribution map from a set cut-off date, to help identify where the gaps are and priorities need to be set.

10.2 The distribution and status of Malleefowl in settled rural areas is clarified.

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*

There has also been ongoing progress for this activity across much of the malleefowl's known range, although there are almost certainly sites where Malleefowl are assumed to still occur, but may well now be locally extinct.

Recommendation 14: That the National Recovery Team has a biennial call across each of the four States for records of habitat patches where Malleefowl are considered to have become extinct recently. This needs to be managed centrally to ensure standardized approaches and recording.

11: Examine population dynamics: longevity, recruitment and parentage

11.1 The feasibility of automatic recorders for identifying Malleefowl is examined and efficient capture techniques are developed, with a report available by 30 June 2009.

Progress:	**Steady or no movement**	**0**
Achievability:	**Unclear**	**?**

This action did not eventuate, except through the deployment of trip cameras at nest mounds in a few separate locations (see abstracts elsewhere in the Proceedings of this Forum).

Recommendation 15: That the National Recovery Team convenes a trip-photography forum to determine standardized methods for recording and assessing reproductive attributes such as egg-laying intervals, egg-laying periods, and possibly hatching intervals and periods and fledging success. There may also be opportunities for developing identification of individual Malleefowl from analysis of photos.

11.2 The longevity of breeding Malleefowl and the turnover of the breeding population is measured for areas with and without fox control.

Progress:	**Unclear**	**?**
Achievability:	**Unclear**	**?**

Not implemented.

11.3 Recruitment of young into breeding populations is measured for areas with and without fox control.

Progress:	**Unclear**	**?**
Achievability:	**Unclear**	**?**

Not implemented.

12: Describe habitat requirements that determine Malleefowl abundance

12.1 The habitat requirements and preferences of Malleefowl are described, important habitat components are identified, and a habitat suitability model is produced.

Progress:	**Unclear**	**?**
Achievability:	**Unclear**	**?**

Not implemented

13: Define appropriate genetic units for management of Malleefowl

13.1 Genetic structure of Malleefowl populations is determined at a national level, as well as at a local scale to establish current population connectivity.

Progress:	**Positive movement**	**+**
Achievability:	**On track**	******

Taneal Cope's research project addresses this objective; thanks in no small part to all who assisted by collecting feather samples from across the Malleefowl's range.

14: Assess captive breeding and re-introduction of Malleefowl

14.1 Past and current translocation, captive-rearing & breeding programs are reviewed, studbook and husbandry manual produced, & future directions clarified.

Progress:	**Steady or no movement**	**0**
Achievability:	**Within reach**	*

Translocation/reintroduction project details have now been published. A stud book and captive-rearing / husbandry manual were prepared as a basis for the re-introduction trials conducted over many years by Priddel and Wheeler (NSW NP&WS). These still need to be revised and made web-accessible. Current captive management within the zoos system should also be reviewed in light of Taneal Cope's research findings on population genetics.

15: Investigate infertility and agrochemicals

15.1 The extent of infertility of Malleefowl in small reserves is investigated.

Progress:	**Positive movement**	**+**
Achievability:	**Unclear**	**?**

Some measures of egg fertility / infertility have been obtained through Taneal Cope's genetics research project and a few other smaller projects monitoring egg-laying and egg-hatching rates in active nest mounds on some monitoring grids (e.g. see Ellen Ryan-Colton's paper these Proceedings).

Recommendation 16: That the National Recovery Team assesses the importance of establishing a national egg monitoring program, to determine relative fledging success rates regionally and whether there are any significant issues that are not being detected through monitoring of nest mound activity each year.

C. COMMUNITY INVOLVEMENT AND PROJECT COORDINATION

16: Facilitate communication between groups

16.1 A national Malleefowl community forum is held every three years

Progress:	**Positive movement**	**+**
Achievability:	**Achieved**	***

The fourth national Malleefowl forum has occurred at Renmark (SA), and is the basis for these proceedings.

- **and the national newsletter continues to provide a national perspective**

Progress:	**Steady or no movement**	**0**
Achievability:	**Within reach**	*

The national newsletter "Around the Mounds" has not been produced for several years and needs to be either revived or replaced.

Recommendation 17: That the National Recovery Team determines how best to communicate national Malleefowl conservation activities across all four States.

17: Raise public awareness through education and publicity

17.1 Increased public awareness of the Malleefowl recovery effort, beneficial management practices, and the contributions made by community groups.

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*

There has been ongoing raising of public awareness about Malleefowl biology and conservation needs across the four States. This has focused largely on the contributions made by community groups and their many volunteers.

18: Manage the recovery process

18.1 Recovery process is coordinated and managed effectively by the Recovery Team, which:

- **meets at least annually;**

Progress:	**Positive movement**	**+**
Achievability:	**On track**	**

The National Malleefowl Recovery Team has met on a 2-3 times per year basis through phone link-ups. The ongoing success of the national monitoring effort and in achieving the fourth National Malleefowl Conservation Forum is testament to this. Peter Sandell has coordinated and chaired the team, and these meetings, in an efficient and effective manner now for many years. For these efforts the rest of the Recovery Team is extremely grateful. The recent forum in Renmark has provided several issues which the National Recovery Team should now look at addressing. This review paper has also identified a range of issues for the National Recovery Team to consider.

Recommendation 17: That the National Recovery Team considers how best to implement the suggestions from the national forum in Renmark, and that this be framed around a focus on implementing the actions necessary to meet the 18 objectives of the National Recovery Plan.

- **ensures that all key stakeholders are aware of, and support, planned actions, and are kept informed of progress;**

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*

National Recovery Team members inform some, but not all, stakeholders of progress being made with recovery efforts. The national newsletter “Around the Mounds”, which used to keep all interested persons up-to-date, has not been produced now for several years and it, or a new version, needs to be re-instated as soon as possible. In the meantime, the VWRG web-site has acted as the main repository of national Malleefowl project updates.

- **ensures that the results of actions in this plan are assessed, reported and reviewed.**

Progress:	**Positive movement**	**+**
Achievability:	**Within reach**	*

The draft performance review presented here is the first such review undertaken for the current National Malleefowl Recovery Plan. It is now up to the National Recovery Team to guide the improvements and new directions indicated.

Summary of this review

The results of the review suggest that:

- all "Community Involvement and Project Coordination" objectives are achievable (i.e. either achieved, on track, or within reach) and 5/6 of these objectives have been progressed since commencement of Recovery Plan implementation;
- slightly more than half (9/16 or 56%) of the "Planning, Research and Monitoring" objectives have been progressed and most (11/16 or 68%) also appear achievable (on track or within reach);
- unfortunately, progress and achievability for slightly more than half of the "Managing Populations" objectives (8/15) are still unclear, have had little or no progress made in their implementation, or are unlikely to be achievable.

National coordination, facilitation and governance of a more comprehensive system of data and information collation and reporting are required to address the main gaps identified. A re-assessment of the relative importance of some of the Recovery Plan objectives is also required.

Recommendations about how the gaps in implementation of the Recovery Plan can be addressed are included in the assessments above. In the first instance, at least, these will need to be the responsibility of the National Malleefowl Recovery Team.

Acknowledgements

I wish to thank Anne and Peter Stokie, Victorian Malleefowl Recovery Group, for their prompt and significant comments on my first draft review; similarly, Susanne Dennings and the Malleefowl Preservation Group based in WA; Erin Sautter and Sharon Gillam for suggestions and editorial assistance; and the various Forum attendees who provided anecdotes, constructive comments and further suggestions for this review.

Reference

Benshemesh, J. (2007). "National Recovery Plan for Malleefowl, *Leipoa ocellata*". Department for Environment and Heritage; Government of South Australia. 121 pp.

4. The national Malleefowl database: making excellence easier

Keynote: Dr Joe Benshemesh, La Trobe University, Bundoora, Victoria; Member National Malleefowl Recovery Team

Authors: Joe Benshemesh, Margaret Alcorn (Eremaea Pty Ltd), Richard Alcorn (Eremaea Pty Ltd), Peter Stokie (VMRG)

Abstract

The notion of a centralised, national database for monitoring of Malleefowl breeding numbers arose at the Malleefowl forum in Mildura in 2004, and its urgent need was illustrated when monitoring information was collated from across Australia in 2006. Despite everyone's cooperation, the records were surprisingly difficult to track down, and much of the data was also difficult to interpret. Given the enormous effort that volunteers contribute to the monitoring, and the immense importance of these data in conserving Malleefowl, we simply can't afford to allow our data to accumulate unchecked again, or for it to be poorly stored; it is unacceptable that data management is a major weakness of the monitoring system.

The web-based database for Malleefowl monitoring is up and running and addresses these concerns. While the primary rationale for the national database was to centralise data and reduce duplication in data handling, the new database has also been designed to conduct many of the routine tasks that were previously done manually to manage the monitoring processes, and to provide a means for feedback and reporting in a secure environment. Because it's web-based, these services are available to all contributors across Australia with an internet connection, although tight controls ensure the security of data.

In this presentation, we will guide you through the database and show how the system works. While there are many benefits in store for those who collect monitoring data, we will also show how your data are screened and processed 'behind the scenes' each year.

The web-based database is proving to be as popular as it is powerful. It has streamlined data handling, and provided a high degree of transparency and control of people's data. Development of the database is continuing, funded by Government and mining offset grants, while the maintenance costs are currently funded through annual subscriptions by supporting NRMs across Australia.

Introduction

The monitoring data set provides fundamental information on trends in Malleefowl breeding abundance at over one hundred sites across Australia. These data are essential to assessing the conservation status of the species across a range of geographical settings. Critically for this threatened species, monitoring breeding numbers also provides a means of measuring the effects of environment and the effectiveness of management actions on Malleefowl numbers (Benshemesh et al. 2007), and an opportunity to learn how to manage and conserve the species (Nichols and Williams 2006; Benshemesh and Bode, this volume). Without a system in place to measure how Malleefowl are faring and responding to on-ground interventions, management would be blind and impotent.

Monitoring Malleefowl breeding densities in the southern parts of the species' range, where Malleefowl densities are relatively high, is well suited to volunteer involvement and volunteers have made, and continue to make, an enormous contribution to Malleefowl conservation through monitoring programs. In fact, most monitoring that occurs across Australia is undertaken by volunteers, often supported by state departments and NRMs, and in many areas volunteers are responsible for all aspects of organizing and conducting the monitoring, including data storage, vetting and analysis: data management tasks that volunteers are generally not well equipped to take on. Employing project officers to help the volunteer community with these tasks may provide a solution of sorts, but this has not often been possible and is entirely dependant on securing recurrent funding. Moreover, this does little to remedy inefficiencies in data management and may have the downside of making the monitoring program increasingly reliant on paid personnel and vulnerable to the fickle nature of funding approvals. While there are obvious advantages of paid personnel contributing to the monitoring program, especially in regard to resolving technical or other difficult issues, there is also a clear need to make the routine processes involved in monitoring Malleefowl as simple and easy as possible in order to ensure the program's durability and independence. Building these fundamentals into the Malleefowl monitoring program has been the main focus of developments in the monitoring system for a number of years, and the national database is one of the most recent and empowering examples of this approach.

Plans for a national database were outlined at the last Malleefowl forum held at Katanning, WA in 2007 (Benshemesh 2008), but the idea had its beginnings in aspirations voiced at the Malleefowl forum in Mildura in 2004 to standardize, consolidate and analyse the monitoring at a national scale. As the reorganisation of the monitoring program neared completion, the need for a national database became all the more apparent in order to secure the level of organisation that had been achieved and to build capacity among monitoring groups across the nation. Initial funding was secured in 2007 from the Commonwealth Government Department of the Environment and Water Resources to begin development of the national Malleefowl monitoring database (henceforth NMMD), and additional funding has been provided through mining offset grants in Victoria to further its development. Maintenance of the NMMD on the internet (including web-hosting and technical support) is provided through modest annual subscriptions by several NRM/CMA bodies that wish to support the otherwise free services provided by the NMMD and Malleefowl volunteers in their region.

In this paper (and associated presentation at the forum), we provide a guide through the NMMD and show how the system works. While there are many benefits in store for those who collect monitoring data, we also outline how the system works 'behind the scenes' and the sorts of facilities that are available for screening and processing the large volumes of data that are collected each year in an effort to monitor trends in Malleefowl populations.

Why a national database?

Malleefowl monitoring data have been collected in most states since the early 1990s and in some cases earlier, and for most of this time these data were stored locally. Why, then, go to the trouble of constructing a new national database? There are in fact many reasons, the most important of which are provided below:

- <u>Improving data management</u>

Poor data management has been a major problem for the Malleefowl monitoring program, and this was made very evident when previously collected data from across the continent were collated and analysed in 2006 (Benshemesh 2006, Benshemesh et al. 2007). Despite the cooperation of data custodians throughout Australia, the data sets were fragmented and often inaccessible even within individual organisations and regions. Much of the data was still on paper and had never been examined or reviewed. Even where data were entered on local databases, there was often little attempt to correct mistakes that novices may have made, or improve processes. In short, the data that had taken volunteers and departmental staff thousands of hours to collect were neglected, fragmented and in disarray. Major improvements in data management across Australia were clearly needed if the monitoring program was to achieve its central objective of reliably assessing the stability of Malleefowl populations.

The situation was a little different in Victoria where a review of the monitoring program in the mid 1990s (Benshemesh 1997) provided an opportunity to thoroughly vet data, improve processes and develop a purpose-built database to manage monitoring data and produce detailed annual reports. That database was an idiosyncratic juggernaut and while it had been made freely available to other states, it was not user-friendly. Consequently, the developments that occurred in Victoria were not readily transferred to other states.

The NMMD rectifies this geographic inequality by making appropriate processes and systems for managing Malleefowl monitoring data available nationally and without cost to registered users. While modelled on the functionality of the Victorian database, the NMMD is in contrast well-designed, user-friendly, private and secure. It provides a sophisticated means of managing all aspects of the monitoring program and is free from institutional constraints and dependencies, existing in cyberspace under the auspices of the National Malleefowl Recovery Team.

- Maintaining consistency and standards

Numerous volunteer groups and individuals, as well as government and non-government agencies, are involved in the Malleefowl monitoring program around Australia. Even though monitoring standards are now in place (NHT National Malleefowl Monitoring Project 2007), maintaining these standards in the face of this diversity of data collectors is a major challenge. A centralised database can help maintain standards by requiring that the data be represented in a specific form and tracking the performance of groups and individuals that submit data.

- Reducing unnecessary duplication

Data custodians across Australia struggle every year with similar issues of: organising volunteers; downloading, vetting, and summarizing data; reporting back to supporters and filing the data in a secure form. Rather than each state, region or group developing their own ways of achieving these tasks, it makes sense to centralise data and provide to everyone a series of tools and facilities to make these jobs easier. Any improvements to the system would then be available to everyone, and because everyone is using the same system and can learn from each other, institutional knowledge is vested in the community rather than an individual (who might not always be available).

- Increasing transparency and accountability

Information on the processes and results of the monitoring program is required or wanted by a variety of stakeholders. Organisations that support the monitoring effort usually require reporting and confirmation that the provided funds have been put to good use. Volunteers and others expend great effort in collecting the monitoring data and deserve to see it appropriately treated, used and stored. Managers, researchers and stakeholders in general require information on population trends. And data custodians need to know that data are properly managed. A central database can facilitate these diverse requirements by providing tailored information to the various interest groups, and is also uniquely able to place this information in a wider, regional or national context. The timely provision of information to stakeholders will increase the accountability of the monitoring program, help detect errors and problem areas, and encourage participation and investment in the monitoring program.

Outline of the new database: What it can do for you

The new national Malleefowl monitoring database (henceforth NMMD) is designed to be simple to use, secure and 'safe' in the sense that general users can't corrupt data or damage the system. Of course any system can be a bit intimidating at first, but it is important for new users to realise that they can't do anything 'wrong' and that they should feel free to look around inside the database, 'play' and discover how the database might serve them. Understanding how the database works and how it is structured in terms of user access will also alleviate some concerns, and may even entice people who are involved in the monitoring program, but have an aversion to technology, to have a go.

Logon

The NMMD is a secure environment and requires a registered user name and password in order to log on. On the Logon page, some information is available to anyone who accesses this page, including the general public: a short video of Malleefowl working a mound, and a chart showing how much of the expected monitoring data has been 1) loaded onto the database, and 2) adequately processed and finalised for storage. Progress charts are displayed in the interests of accountability so that people who collect the monitoring data can see how the processing of the data in their state or region is progressing, even if they have not logged on to the database.

Roles

The NMMD has three levels of user access, all of which are required to logon using a name and password:

1. Contributor: one who collects data in the field (or contributes in another way)
2. Coordinator: one who uploads contributor's data onto the NMMD and/or organises people for monitoring
3. Ecologist: one who vets data each year

Apart from these three main roles, there is a further role termed the 'administrator', whose sole responsibility is to allocate the above roles to people.

The database automatically recognises the role that has been allocated to each user, and only shows parts of the database that the user is allowed to access and that are relevant to that user. While all registered users have access to the Contributor pages and options, access to Coordinator and Ecologist parts of the database is restricted in the interests of privacy and data security.

Contributor (Access level 1)

Contributors, the role that describes most people involved in the monitoring, are the lifeblood of the monitoring program and have access to:

- Records - Review Cybertracker Records: Data that has been collected in the field can be examined here in the form of a table showing the most important data for each mound at the given site. Note that the actual GPS location of each mound is not shown at this access level, but that the distance from the known position of the mound to where the record was collected (GPS Δ) is displayed instead.

  More detail on a particular mound, and the photograph of the mound taken during the monitoring, can be obtained by clicking 'review' in the table record for each mound. Although contributors are not permitted to change the data (even if they had collected it), they are encouraged to leave notes to alert the coordinator and ecologist of errors or additional information. Ideally, everyone who collects data in the field would examine these data on the database before the data are processed and finalised for the season, and leave a note to point out any errors. But notes should be used sparingly and only where a correction is required.

- Records - Review Mound Photographs: A list of mounds from the selected site will be displayed, and selecting 'photographs' of a mound will display the last five years of photos for that mound (if they exist).

- Kit - Monitoring Forms: This is where you can download information, forms and the most recent version of the Cybertracker sequence.

- Registration - List-Coordinators/Reset Password/Update registration: Users can update their details, change passwords, and obtain a current list of people who have been assigned the role of coordinator and are available to help with queries.

- Maps - Sites and Mounds: Clicking on this link opens a Google Maps page showing the location of registered monitoring sites across Australia. Whether or not a site is shown on the map is controlled by the coordinator so that privacy is protected even among registered users. Clicking on a site that is shown on the map will bring up information about that site, such as the number of mounds routinely monitored, and how many mounds were active the previous season. Links to further information about the site are also provided, including pages showing the history of mound activity at the site, and the history of other animal signs such as prints and scats of various animals noted at mounds.

  Zooming in further, individual mounds at the site are shown colour coded to indicate whether or not they were monitored during the previous season, and whether they were active. For security reasons, we have introduced a random error into the location of each mound, so these maps can't be used to find mounds in the field. Clicking on a mound will bring up a small photo of the mound, and links further information such as a summary of the data collected at last visit, and a photographic history of the mound's activity over the past decade.

- Inspection, Activity and Environment Reports: Nine technical reports available to contributors and have been modelled on the monitoring reports produced in Victoria for over a decade. These reports provide a thorough breakdown of the data collected in terms of the success of the monitoring as an operation, the activity of Malleefowl mounds, and the trends in signs of other animals at mounds (such as fox scats and prints). Users can choose to view reports for any previous season. If selected, the Mound Inspection Report is particularly useful to view the progress of the monitoring in the current season and to see how much of the data has been processed for each site in selected State.

Coordinator (Access level 2)
Coordinators are the main intermediary between the field and the database. In terms of data management, their main role is to extract data from handheld devices and send it through to the database. However, they also have a vital role in managing the large number of volunteers involved in the program and keeping track of each person's contribution, contact information, and experience in the monitoring program.

In order to help Coordinators in their tasks, they have access to various facilities in the NMMD designed to help them upload data and photographs onto the NMMD, register and manage the volunteers involved in the program, and keep track of the amount of time spent by volunteers in various activities involved in monitoring Malleefowl (an important statistic that is of interest to supporters of the monitoring program, especially in regard to grant applications and reports). The database is designed to make these tasks as simple and efficient as possible.

- Upload Cybertracker Data: Uploading data to the NMMD from handheld devices such as the Mobilemappers or Palm devices, and photos from digital cameras, is accomplished in several steps. Data on the handheld devices is first imported into Cybertracker on a PC, from where it is then exported to the NMMD without changes. This is usually a simple and quick operation, allowing data to be viewed on the NMMD by the people who collected it within a day or so of the Coordinator receiving the handheld device.

  On the other hand, photographs take longer because they must be processed before being uploaded onto the NMMD, and is a task currently shared between the Coordinator and Ecologist roles. Processing involves renaming each photograph so that it is recognised by the database and linked to the appropriate mound and season, stamping each photograph with the date and time, and shrinking the photographs down to a reasonable size (about 100kb; space is limited on the NMMD for the thousands of mound photographs each year). We have developed ways to process the photographs efficiently, but it still takes time and consequently there are more likely to be delays in uploading photographs than there are in uploading data.

- Reviewing Data and Photographs: Coordinators can view and leave comments on data in a similar way to Contributors. The main differences are that Coordinators have access to the actual GPS locations, and can see whether the record has been inspected and finalised by the Ecologists. As with Contributors, Coordinators can't change data, they can only leave notes pointing out possible errors.

- Managing documents available for download: as well as being a repository for monitoring data, the NMMD is also a useful place from which Contributors can download documents in a secure environment. Coordinators can upload virtually any files onto the NMMD to make them available to the monitoring community in the 'Kit' area of the Contributor pages. Such documents include the activity history of all the mounds in the site to be monitored (a fascinating reference in the field!), as well as instructions and manuals, safety information and forms, and permits. The most recent version of the Cybertracker monitoring sequence is also available here.

- <u>People management</u>: Volunteers are the critical asset of the monitoring program and managing and keeping private people's contact details, training, experience, and contributions (measured as time), is an important job of Coordinators. The NMMD is designed to help Coordinators keep track of these details as simply as possible. Centralising and securing this information on the NMMD will also facilitate the transfer of the Coordinator roles in each state/region to new people who can then learn the ropes from other Coordinators across the nation. This will provide a more flexible and collaborative solution than the current situation where people who organise the monitoring in each state/region feel isolated and locked in to their responsibilities due to the complexity or ad hoc nature of their local system.

Coordinators also have access to special reports designed for NRM bodies and State organisations that subscribe to the database. These reports provide aggregate information on trends in Malleefowl breeding numbers and signs of other animals at mounds within the region of interest, as well as providing a breakdown of volunteer hours that demonstrates the contribution made by the community to Malleefowl conservation.

Ecologist (access level 3)
Ecologists have unmatched access to the data, and consequently have unmatched responsibility to be diligent and rigorous in their tasks and to annotate any changes they make. The Ecologist tasks require judgement and documentation, and are best accomplished by as few people as possible in order to make them accountable and their judgements consistent.

- <u>Validating data:</u> The Ecologist's primary role on the NMMD is to validate the data, which means to ensure the accuracy and correctness of the monitoring data collected by Contributors. It is the Ecologist's responsibility to check and correct errors, annotate any changes they make, register new mounds and sites, and make changes to the status of individual mounds (such as removing a spurious mound from monitoring lists, or demoting ancient or dubious mound to the five-year monitoring list). In a sense, the Ecologist may be regarded as the data-janitor whose main task each year is to ensure the dataset is clean, accurate and orderly.

  Every mound record must be validated every year. Validating records is a small investment in time compared with actually collecting the data in the field, but it is essential if the data are to be relied upon. Even so, given the thousands of detailed monitoring records that come in each year, the Ecologist's role in validating data would be daunting if it were not for facilities on the NMMD that have been designed to make the job easier.

  The Ecologist's tasks begin after all the records for a particular site have been loaded onto the database and the data collector and coordinator have had a chance to leave comments (if they choose to do so). The Ecologist will usually also wait until the photographs for the site have been processed and loaded onto the database, because these provide valuable information for the vetting process. For these reasons, the Ecologist may wait until the end of the monitoring season before vetting data.

  To understand the Ecologist's process, it important to understand that the original data collected in the field is never actually modified; it is saved in its original condition. Instead, the NMMD makes a copy the data which the Ecologist will work on and validate. The process is termed 'incorporating' as the validated data is incorporated into the final data tables from where it used to generate various types of reports.

  During the incorporating process, the data are automatically subjected to a number of tests, the results of which are inspected by the Ecologist. These tests involve identification of duplicate records (same site and nest number), missing records (expected records but are not represented in the data set, and records that require further scrutiny because they break any one of a dozen or so rules applied to the data. For example a monitoring record will be flagged for further scrutiny if:

    - A comment has been left by the data collector or Coordinator;

- The mound is recorded as active but descriptive data are at odds with the typical characteristics of active mounds (e.g. shape/profile, scraped, no cross-sticks, eggshell, etc);
- The mound is recorded as inactive, but descriptive data are at odds with typical characteristics of inactive mounds (i.e. shape/profile, not scraped, etc);
- It's location is more than 20m from it's expected (registered) location;
- It is a duplicate record, missing, or unregistered mound number for that site;
- The date is outside the current monitoring season;
- The location (Lat/Long) is missing or outside the range of Malleefowl.

The Ecologist mostly works from a table showing all the monitoring records from a site during the current season. Most monitoring records that have been carefully collected in the field pass these tests, in which case they will be automatically validated by the NMMB. However, many mound records are usually flagged for further scrutiny, often for minor issues in which case they may be swiftly validated at the discretion of the Ecologist (e.g. a comment may have been left that does not require further action, or the distance from the expected location may be just outside the 20m rule).

In other cases, such as where the activity status or identity of a mound is in question, Ecologists will open the record to scrutinise the data in full alongside the current photograph of the mound in question. Once again, many cases where rules have been broken are minor and can be quickly resolved; for example, a mound may have been recorded as active but not scraped, but the Ecologist may see from the photograph that the mound was indeed clearly active, and validate the record, perhaps with a short note. In other cases the data may require a minor correction, in which case the Ecologist should always leave an explanatory note.

There are usually some mound records that require more careful scrutiny. The ecologist has at their disposal several tools that are useful. For example, the NMMD will automatically identify the nearest mound to the location recorded with the data, and this is often a great help in cases where the wrong mound number has been recorded. The Ecologist may also compare the current mound photograph with those of previous years, and this will often help sort out issues of uncertain mound identity and/or activity status. For example, if an active mound that had been abandoned early in the season is described as inactive later in the season, its photographic series will often demonstrate that marked changes in mound shape and characteristics over the past year that could only be explained if the mound had been active early in the season.

All records must eventually be validated to be represented in the report tables and available for assessing population trends. While the monitoring system, from field collection to the NMMD, has been designed to provide ample opportunities for cross-checking the validity of data and detection of errors, doubt about the activity status and/or identity of mounds may occasionally occur. The Ecologist must eventually validate these records too, clearly indicating the remaining uncertainty and perhaps advising some remedial action (such as a follow-up check of the mound in the field). Fortunately such cases are nowadays rare.

- Registering sites and mounds: Ecologists are also responsible for the registration of new mounds and sites and managing the registration details, and have various forms and tools to manage these critical details. It is within the registration pages that the monitoring status of individual mounds is set (annual, 5-year or omitted from monitoring lists), and whether or not individual sites are represented on Google Maps.

- Outputting revised monitoring lists: Once the Ecologist has vetted and finalised the data, he/she can output mound locations for the next year's monitoring list from the NMMD in a form suitable for upload onto GPS or Mobilemappers (and similar devices) enabling navigation to mounds.

Overview of Data flow from field to NMMD

The NMMD may seem complex, but it is built around a simple series of steps that involve the collection of data, moving these data from the field to secure storage in the database where it can be efficiently checked and made available to management and research involved in the conservation of Malleefowl. Its many facilities and options are designed to simplify and streamline the essential steps for maintaining an accurate and orderly 'warehouse' of Malleefowl monitoring data.

Understanding how data typically moves from the field to its final version on the database provides a conceptual path through the NMMD, and also shows how the NMMD facilitates all parts of the monitoring process:

1. Organisation of monitoring

The first step is, of course, the organisation of the volunteers and others involved in collecting data in the field. This includes the training of data collectors, as well as allocating individuals to specific sites and providing them with all the information they need or want in order to do the job well. The NMMD already assists coordinators by providing the updated information they need to organise the monitoring at the click of a mouse including: volunteer's details and training, monitoring instructions, maps, lists of mounds to be monitored and locations of these for GPS and Mobilemappers. We are keen to develop the database to further suit the needs of coordinators over the next year.

2. Data collection

The most indispensible part of the monitoring program is the actual data collection, which is mostly done by volunteers. The introduction of Cybertracker on handheld computers (i.e. Palms, Mobilemappers, etc.) made recording data easier in the field and greatly simplified the movement of data from the field to computers. Transcribing thousands of paper monitoring records each year onto computers was a huge task, but one that was mercifully made obsolete by handheld devices. Moreover, because the data entry is closely controlled within Cybertracker, the data are in the correct form and require little verification (unlike data on paper that has to be checked for typographical and transcription errors).

3. Upload

Uploading data is a two-step process. Data are first uploaded by Coordinators to Cybertracker on a PC by physically linking the devices. This usually takes only a few seconds. Then, the data are exported from Cybertracker to a file that can be imported onto the NMMD, which also takes only a few seconds. The NMMD shows the uploaded data in the form of a table that also shows if data are not in the appropriate format (in which case the NMMD won't accept it until errors are corrected). Data from Cybertracker are always in the correct form, which is why even if data was originally collected on paper, it's best to later enter data on a handheld device before uploading to the NMMD.

As outlined above, photos are treated separately, but we may be able to integrate and streamline these processes in the future.

4. Online inspection of data

Once on the NMMD, the Cybertracker data collected in the field becomes available to Contributors and Coordinators for comment. These comments provide a means of Contributors in particular to correct data that they can see was incorrectly recorded. This is not an essential step, but can be very useful for the next step.

5. Validation

The Ecologist now works through the data collected in the field by making a copy ('incorporating the data') and validating all records. All comments left by others are read and considered, and changes are made as required and are carefully documented. For example, comments may indicate that the monitoring status of a particular mound should change from annual monitoring to 5-yearly or even not at all (if it's considered not to be a mound). The Ecologist would consider the mound satisfies the criteria for changed status (these have to do with the condition and height of the mound, and a measure of discretion) and provide a written decision that can be viewed by Contributors. It is at this stage also that missing records are dealt with, first by checking if a photograph exists for the missing record (sometimes people photograph but forget to record old mounds), in which case the Ecologist will create a record for the mound and examine the photo for information on activity, etc. If there is no photograph, the Ecologist will create a record for the missing mound but pronounce the mound as not found.

Once all mound records from a particular site are validated, the data processing is complete: the data are represented in the report tables, stored for later use in management and research, and monitoring lists and locations for the following season are available for download.

Concluding comments

The past few years have seen a number of important developments in monitoring Malleefowl. About a decade ago, GPS became precise enough to enable navigation to mounds, and digital cameras and handheld PDAs became more available. These technologies heralded in a new era of electronics facilitating the monitoring effort and empowered volunteers to take control of the endeavour. One of the most important developments in the monitoring program at this time was to move from recording data on paper to recording on electronic devices in the field, a move that led to substantial improvements in data accuracy and, most importantly, in the efficiency of managing data. The multi-regional project in 2005-7 provided an opportunity to consolidate, standardise and refine the monitoring program further, and volunteer groups and departmental staff involved in the collection of Malleefowl monitoring data from across the range of the species' collaborated in the production of a national monitoring manual (NHT National Malleefowl Monitoring Project 2007) that for the first time detailed mutually agreed upon standards and procedures. For the first time also, the type of data collected in the monitoring program was reviewed (Benshemesh 2007) and combined in a simple database where it was vetted and analysed at a national level (Benshemesh et al. 2007).

These developments have all paved the way for the construction of a purpose-built national database for the Malleefowl monitoring program. Our focus has been on efficiently moving uploaded data through various steps to ensure its validity and completeness, before analysis and archiving. The resulting NMMD is a multi-purpose platform that facilitates many aspects of the monitoring program and provides national data aggregation and management, centralised reporting and active support services for data collectors and managers.

Its many facilities and options in the NMMD are designed to simplify and streamline the essential steps for maintaining an accurate and orderly 'warehouse' of Malleefowl monitoring data. For maximum benefit from the NMMD, it is vital that data are processed and finalised soon after they are collected each year. Timely action by Coordinators and Ecologists will allow errors to be rectified while the field experience is still fresh in people's minds, and will avoid backlogs that become increasingly difficult to deal with. Moreover, prompt processing of data will enable volunteers to see the data they collect and confirm it has been appropriately managed.

The NMMD has also been constructed to ensure the security and, if need be, the privacy of data collected by volunteers and others. The issue of privacy is important because some monitoring sites occur on private land and in some cases the owners or leaseholders may not want the general public (or even government departments) to know the locations of their populations of Malleefowl. Nonetheless, these people often want the trends in their populations to be considered in the local and national effort to conserve Malleefowl, and to have their data securely stored for future reference. The NMMD provides this privacy as access to data is controlled by the people/organisations that collected it. The NMMD exists under the auspices of the National Malleefowl Recovery Team rather than government departments, and is independent and free of organisational constraints. Only aggregated data is reported, and the location of mounds and sites is regarded as confidential.

The independence of the NMMD has allowed great freedom in designing the database and securing its contents, and this has been possible only through funding from government and private sources. However, the drawback of this arrangement is that being outside government infrastructure, the NMMD requires some ongoing funding to pay for server hosting and general maintenance. Fortunately, the National Malleefowl Recovery Team has approached regional NRM/CMA bodies to help cover these costs by annually subscribing to the NMMD in return for aggregate data in the form of reports on the performance of the monitoring and trends in Malleefowl numbers. While one-off grants have paid for the development of the NMMD, the relatively modest subscriptions from concerned NRM bodies provide the ongoing costs that enable users to access the database through the internet.

Future

While we have come a fair way down the track towards developing an appropriate database for the Malleefowl monitoring program, we're not quite finished yet. Our current focus is on facilitating the tasks that Coordinators are mostly concerned with, such as organising people for the monitoring and tracking their experience and contributions. We are also looking at ways in which the database can help organise re-searches of established sites, and process the data collected during such searches. Monitoring sites need to be re-searched every 5-10 years in order to include newly built mounds in the monitoring effort, but searches can be difficult to organise and the ensuing data currently requires more effort to interpret than regular monitoring data. However, the NMMD has the potential to make these re-searches easier by providing GPS directions for search transects, keeping track of the search history of each site, and efficiently vetting, analysing and reporting on the results of each search.

While our focus has necessarily been on the operational aspects of the NMMD, it should also be noted that the end use of the monitoring data has also been considered in the design of the database. By providing reliable and timely information on the trends in populations of Malleefowl and other animals, the NMMD is an important step towards a more dynamic phase in which monitoring may be used not only to establish population trends, but also to assess and improve the effectiveness of management at benefitting Malleefowl conservation. In particular, plans to develop an Adaptive Management program for the hundred or so Malleefowl monitoring sites across Australia, as recommended in the National Malleefowl Recovery Plan (see also Benshemesh and Bode, this volume), has the potential to greatly increase the effectiveness of Malleefowl management. The NMMD will play a central role in adaptive management, and indeed any other attempts to utilise the monitoring data for Malleefowl conservation, and every effort will be made to ensure that the NMMD provides researchers and managers with the data they need to improve the prospects of Malleefowl in the uncertain times ahead.

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5. Malleefowl Conservation in SA: activities from 2007 – 2011

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Abstract

Malleefowl occur across South Australia in isolated mallee remnants, in both public reserves and on private land. In public reserves, the Department of Environment and Natural Resources (DENR) conducts a number of activities that benefit Malleefowl conservation, including prescribed burns, and feral predator and competitor control. Several patches of mallee on private land are protected under Heritage Agreement covenants, which also offer benefits to Malleefowl.

In 1989, DENR commenced the implementation of a Malleefowl survey and monitoring system instigated by Benshemesh (1989) in Victoria. This system now consists of forty sites in four regions across the state, which is largely coordinated by DENR or contracted staff, and monitored by both volunteers and staff. Malleefowl are also tracked in the arid far west corner of SA, using other monitoring methods.

Since 2008, Malleefowl monitoring has dominated conservation activities for this species in South Australia, with all data now collected electronically and entered into the national database. This has remained steady over the last three/four years, with each region in SA continuing to provide monitoring data for the national database, and working through issues as they arise. Across the regions, more volunteers have become involved in the monitoring process, taking up particular sites each season, although still more volunteers are needed.

There is a challenge to maintain coordination of the monitoring at a regional and state level, with uncertainties in continued funding of contractor positions and through changes in DENR support staff positions. Within the scope of regional and National Recovery Plan objectives and the existing staff and volunteer base, there are opportunities to further drive recovery actions for Malleefowl, particularly at the regional level.

Introduction

Malleefowl occur across South Australia in isolated mallee remnants, in both public reserves and on private land. In public reserves, the Department of Environment and Natural Resources (DENR) conducts a number of activities that benefit Malleefowl conservation, including prescribed burns, and feral predator and competitor control. Several patches of mallee on private land are protected under Heritage Agreement covenants, which also offer benefits to Malleefowl.

In 1989, DENR commenced the implementation of a Malleefowl survey and monitoring system instigated by Benshemesh (1989) in Victoria. This system now consists of forty sites in four regions across the state, which is largely coordinated by DENR or contracted staff, and monitored by both volunteers and staff. Malleefowl are also tracked in the far west corner of SA, using other monitoring methods.

In South Australia (SA), the period from 2004 – 2007 saw considerable progress made in conservation initiatives for Malleefowl, including the adoption of the National electronic monitoring method and collecting, validating and converting all historic Malleefowl data to an electronic format. The setup of the National Malleefowl Database provided a central storage area for all data, and opportunities for feedback and reporting. The funding of contract project officer positions in the Murraylands, South East and Adelaide during this period was also a significant development in driving and supporting Malleefowl recovery efforts, utilising volunteer and agency assistance. The two year multi-regional project funded by the Natural Heritage Trust was another highly significant event, providing an enormous opportunity to implement key components of the National Malleefowl Recovery Plan across three states. For SA, this enabled fencing of over 5,260 ha to protect significant Malleefowl habitat; two regional training workshops for volunteers and new grids established. Community groups, individuals and agency staff were actively involved and showed great enthusiasm in furthering Malleefowl conservation initiatives.

The momentum created during this very exciting period (2004 – 2007) continued into 2008, albeit at a steadier pace, with the multi-regional project finished, and central project officer position ended. A good foundation had been set, however, for monitoring the established sites across SA; the prospect of an Adaptive Management Plan in the pipeline to further guide Malleefowl recovery; and funding approved to begin a major research project into Malleefowl genetics. This pace has remained steady over the last three/four years, with each region in SA continuing to provide monitoring data for the national database, and working through issues as they arise.

This paper outlines Malleefowl conservation activities in SA from 2007/08 to 2010/11.

Activities over the past 4 years: 2007/08 to 2010/2011

Monitoring

In 2007, forty monitoring sites, or grids, were operational in SA. These grids are located in representative areas of Malleefowl habitat across the southern half of SA. Table 1 shows the total number of grids within each of the four regions across SA, and how many of those grids were monitored in each of the four breeding seasons since and including 2007. In 2007, five grids were not monitored due to wildfires; and another grid (Murray Bridge Army Range, monitored through the Department of Defence) was not monitored due to lack of funds. In 2008, six grids in the Murraylands were not monitored by Community Land Management (CLM) volunteers due to changes in management under the Australian Landscape Trust; the Murray Bridge Army Range grid was once again not funded; and three grids on Eyre Peninsula (EP) were not monitored due to fire and the lack of coordination/volunteers. One more grid (Mt Boothby) was established in the South East (SE) region, giving that region a total representative sample of five grids, and a statewide total of 41. In 2009 ten sites that were regularly monitored by the CLM group were not and are no longer surveyed, leaving the total number of grids in the Murraylands at 20, and all coordinated by DENR contracted staff. In 2009, 30 out of the 31 grids were monitored – one grid on EP was burnt in 2006 and not surveyed. In the 2010 season, once again all grids except the one involved in a wildfire in 2006 on EP were monitored.

Table 1: Number of grids monitored over 4 Malleefowl breeding seasons in each region in SA.

	2007		2008		2009		2010	
Region	**Monitored**	**Total**	**Monitored**	**Total**	**Monitored**	**Total**	**Monitored**	**Total**
Murraylands	25	30	23	30	20	20	20	20
Eyre Peninsula	4	5	2	5	4	5	4	5
Yorke Peninsula	1	1	1	1	1	1	1	1
South East	4	4	5	5	5	5	5	5
Total	**34**	**40**	**31**	**41**	**30**	**31**	**30**	**31**

Table 2 shows the number of active and inactive mounds within each of the four regions in SA, across the last four breeding seasons from and including 2007. Since 2007, the percentage of active mounds across the regions has risen from 5 to 9 percent, however, it should be stated that this is a generalised observation, as the number of grids monitored per region has varied over the last four years; each of the regions (and grids) has other environmental factors at play; and a marked change in activity in one grid can skew results for that region. For example, the 2-3% increase in breeding activity in the Murraylands has occurred within the grids located south of the River Murray, whilst the grids north of the Murray show little to no breeding activity – rainfall is a significant factor here; one grid on EP showed no breeding activity at all in 2007, while the other three grids remained steady, and that one grid has since resumed its previous ‘average’ breeding activity. Any further deductions in trend should take into account the full history of each grid.

Table 2: Number of active and inactive mounds per region in SA, across 4 Malleefowl breeding seasons.

	2007			2008			2009			2010		
Region	**Inactive**	**Active**	**Total**	**Inactive**	**Active**	**Total**	**Inactive**	**Active**	**Total**	**Inactive**	**Active**	**Total**
Murraylands	557	16 (3%)	573	539	22 (4%)	561	562	21 (4%)	583	548	35 (6%)	583
Eyre Peninsula	166	7 (4%)	173	79	7 (8%)	86	153	14 (8%)	167	163	14 (8%)	177
Yorke Peninsula	38	9 (19%)	47	38	9 (19%)	47	37	10 (21%)	47	37	10 (21%)	47
South East	123	16 (12%)	139	158	27 (15%)	185	156	30 (16%)	186	163	29 (15%)	192
Total	**884**	**48 (5%)**	**932**	**814**	**65 (5%)**	**879**	**908**	**75 (8%)**	**983**	**911**	**88 (9%)**	**999**

Without the energy and enthusiasm shown by volunteers across the regions, many of the recovery initiatives for Malleefowl in SA could not and would not take place. This in particular applies to monitoring. Other activities include the collection of genetic material (mainly feathers) for Taneal Cope’s genetics research project. During the last 4-5 years, dedicated volunteers that have been involved for many years in the monitoring process have steadfastly continued to monitor their sites, albeit at times in challenging conditions. This includes not only the physical challenge of extreme heat which brings with it the threat of fire, but also the disappointment that comes with finding no activity within a grid, or equipment that fails. New volunteers have also become involved in the monitoring process, taking up particular sites each season, although still more volunteers are needed. Table 3 shows the number of volunteer hours for each region in SA over the last four years.

There is a challenge to maintain coordination of the monitoring at a regional and state level, with uncertainties in continued funding of contractor positions and through changes in DENR support staff positions. Whilst annual training to volunteers in SA is available through the Victorian Malleefowl Recovery Group, this is not often a viable option due to time, costs and distances involved. Training is provided by regional coordinators in SA, however, there is a need for improvement in equipment, training methods and data transfer in some regions.

Whilst the focus has been on monitoring the breeding activity of Malleefowl across the regions, many volunteers would like to see some use of the results derived from the monitoring data, and would like to become involved in other Malleefowl recovery activities.

Table 3: Number of volunteer hours per region in SA over the last 4 years.

	Murraylands	South East	Eyre Peninsula	Northern & Yorke	Total hours
2007/08	424.5	204	214	17.5	860
2008/09	599	199	50	21	869
2009/10	483	139	95	32	749
2010/11	511.5	275	110.5	27	924

South East Region

The South East Region of DENR has developed a Regional Action Plan for Malleefowl, which identifies a number of recovery initiatives and which are given a priority score. Many if not all of these recovery actions are mirrored in the National Recovery Plan. As a high priority, annual mound monitoring has been carried out on the grids in the SE over the last four seasons, coordinated by part time Project Officer Vicki Natt. This position has now come to an end as of July 2011. It is anticipated that annual monitoring continue to occur under the auspice of the SE Threatened Species and Habitat Recovery Team, however, the program plan of this unit is under review.

During the last two years (at least), fox baiting has occurred annually in reserves of the Upper SE containing Malleefowl, including Mount Scott Conservation Park (CP) and Gum Lagoon CP. Deer control has also occurred in these parks and others containing Malleefowl, over a number of years.

A grant was secured to erect Malleefowl awareness/warning signs to motorists on the Princes Highway adjacent to the Coorong National Park Grid, and has since been completed. There are plans to install signs on secondary roads running close to Malleefowl habitat and to install interpretive signs at the entrance of several (up to 5) parks that host important Malleefowl populations. This should be completed in 2011.

The Threatened Species and Habitat Recovery Team have worked with the NPWS to implement a burning program to protect Malleefowl habitat. Key Malleefowl-inhabited reserves have been patch-burned over the past four years, including Messent (132 ha 2009, 160 ha 2011), Mt Scott (47 ha 2008) and Gum Lagoon CP's (22 ha 2008, 70 ha 2011). For interest, Messent CP is 11,583 ha, Mt Scott is 1267 ha and Gum Lagoon is 8906 ha in total size. It is important to mosaic burn in these parks to minimise the risk of a catastrophic wildfire resulting in the local extinction of Malleefowl. Such prescribed burning is a high priority in the Action Plan.

The impact of deer on Malleefowl mounds in Gum Lagoon CP is being investigated by a local landholder and DENR Ranger staff. This could be done via sensor cameras.

Several Malleefowl research topics were suggested at a research priority workshop held in DENR SE Region in May 2011. It is hoped that these topics can be addressed in the future, in conjunction with research organisations. This is a medium priority action.

The DENR SE Region also held a workshop to identify priority conservation projects in the SE. Two of these were directly related to Malleefowl conservation, including purchasing an addition to Mt Scott CP and linking Bangham CP to Little Desert NP in Victoria. It is also planned to identify other areas in the SE that can be prioritised for restoration which will also benefit Malleefowl conservation in the future. Key areas of existing and predicted Malleefowl habitat are mapped in the Biodiversity Plan for the SE (Croft *et al.* 1999). This is a low priority in the Action Plan.

Yorke Peninsula Region

Malleefowl occur within remnant coastal mallee woodland communities on southern Yorke Peninsula. A mound monitoring grid was established on Innes National Park in 1992 (Grid 11; 2.6km^2). This grid was monitored somewhat sporadically up to 2005, however, is now in full operation under the National Monitoring regime. Between 1992 and 2005, the average number of active mounds observed was 6.2 (range = 5 to 8). As with many areas across southern Australia, the Yorke Peninsula was affected by low rainfall patterns for much of 2000 to 2009. In 2004, an intensive fox control program commenced on Innes NP, prior to the reintroduction of Mainland Tammar Wallabies to the park. 1080 baits are laid at 0.5 km intervals along all roads and service tracks within the park, on a fortnightly basis. Following two years of intensive fox control, the average number of active mounds rose to 9.8 (range = 9 to 11) and has remained stable since. Fox control activities were further enhanced in 2009 with the establishment of a community-based fox control program on southern Yorke Peninsula (28 participants, 60,000 ha). The low density fox environment within Innes NP is providing a haven for a range of other threatened species, including Western Whipbirds, whose presence in the park initiated its proclamation. The success of the fox control program is best highlighted by the recording of a Bush Stone-Curlew in the reserve in early 2009; a species which hasn't been recorded on the Yorke Peninsula for more than 40 years. Subsequent sightings of the birds have also been recorded (J Swales, pers. comm. 10 Oct 2011).

Murraylands Region

Murraylands DENR received $22,000 of funding from PIRSA in 2010 to carry out research into the effects of Locust spraying on Malleefowl. Mallee Eco-Services and Joe Benshemesh were contracted, and worked together with volunteers, Rangers and DENR staff to undertake the project. See Ellen Ryan-Colton's report for further details.

See report from Dave Setchell for an update on monitoring and related activities in the Murraylands.

Eyre Peninsula Region

The Eyre Peninsula (EP) NMR Board has been running a large-scale 1080 baiting program to control fox numbers on EP since 1999, as part of the West Coast Integrated Pest Management Program. The program was established to support reintroductions of Brush-tailed Bettongs and Greater Bilbies to Venus Bay CP. Due to community motivation to protect biodiversity and livestock in the region, the program was expanded significantly in 2002 with additional monitoring measures in place. By June 2004, there were 400 participating landholders, with properties totalling over 15,000km^2. Analysis of the monitoring data from this ongoing project has shown that fox populations in most areas have decreased over the survey period 2002 – 2009; and on average, observations of foxes were 55% lower in 2009 than in 2002 (Coventry 2010), keeping in mind, however, that this was also a period of drought. Anecdotal reports from across EP suggest an increase in sightings of native fauna, including Malleefowl (Coventry 2010). Further research is required to draw any conclusive relationships between the decline in foxes and the increase in native species.

The EP NRM Board continues to fund fencing on private land to exclude stock from native vegetation. This is often Malleefowl habitat and would total over 1000 ha in the last four years.

Aboriginal Lands

See report from Matt Ward on the Status, monitoring and management of Nga̠namara in South Australia's Aboriginal Lands, this volume.

Conclusion

The past four years has seen the consolidation of the national Malleefowl monitoring system across 30 consistently monitored grids in SA, including entry of data into the national database. The challenge now is to utilise and explore the range of information provided by the monitoring data, in conjunction with management and other research results.

Within the scope of regional and National Recovery Plan objectives and the existing staff and volunteer base, there are opportunities to further drive recovery actions for Malleefowl, particularly at the regional level.

Acknowledgements

Sincere thanks to all those who contribute to Malleefowl conservation in South Australia. Many thanks to Oisin Sweeney, Threatened Species and Habitat Recovery Ecologist, DENR South East Region; Andy Sharp, Manager Conservation Programs, DENR Northern & Yorke Region; and Andrew Freeman, Biodiversity Program Manager, Eyre Peninsula NRM Board, for their regional updates.

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6. Malleefowl monitoring in the SA Murray Darling Basin: 2011 update

David and Heidi Setchell, Mallee Eco Services, Department of Environment and Natural Resources (Murraylands Region) Malleefowl monitoring program coordinators

Abstract

The 2010/2011 Malleefowl breeding season in the SA Murray Darling Basin has seen the best conditions for many years due to widespread above average rainfall beginning in September 2009. There has been a significant rainfall deficit in the area since the mid 1990's. During this extended dry spell, Malleefowl breeding activity has been comparatively low and has only responded positively to localised heavy rainfall events in specific areas.

Twenty grids in the region are included in the regular annual monitoring program, which cover an area from Danggali Conservation Park in the north to Peebinga Conservation Park in the east to Ferries MacDonald Conservation Park in the south west. Ten of these grids are in heritage agreements on private land (including Gluepot Reserve), nine are in conservation reserves and one is on Department of Defence (Commonwealth) land.

Unfortunately breeding activity has not responded to the improved conditions in all areas, particularly north of the Murray River. Other areas within the region where recent rainfall deficits have been particularly pronounced have also not seen an increase in breeding activity. Elsewhere, breeding activity was higher than in previous years, with a record number of active mounds recorded at Peebinga Conservation Park.

Possible reasons for the lack of positive response include a lag effect from the extended dry spell and reduced Malleefowl populations. Follow up rains during 2011 may be critical for vegetation recovery to continue and to encourage increased breeding activity across the entire region.

Introduction

Malleefowl monitoring grids have been established in the SA Murray Darling Basin since the late 1980's. A variety of groups have been involved, including the Department of Environment and Natural Resources (DENR), the Murray Mallee Local Action Planning Group, Greencorps and the Department of Defence, with the extensive assistance of volunteers. During this time, monitoring grids have been established on public, private and Commonwealth land.

In 2004, DENR initiated a project in the region to adopt the monitoring method pioneered by the Victorian Malleefowl Recovery Group (VMRG), which has since been formalised as the national monitoring standard. The project also involved revitalizing Malleefowl monitoring in the region and engaging with all groups involved in monitoring to create a consistent and sustainable volunteer based annual monitoring program which could feed data into the national database, where it could be constructively utilized.

Twenty grids in the region are now included in the regular annual monitoring program, which covers an area from Danggali Conservation Park in the north, to Peebinga Conservation Park in the east, to Ferries MacDonald Conservation Park in the south west (see Figure 1). Ten of these grids are in heritage agreements on private land (including Gluepot Reserve), nine are in conservation reserves and one is on Department of Defence (Commonwealth) land.

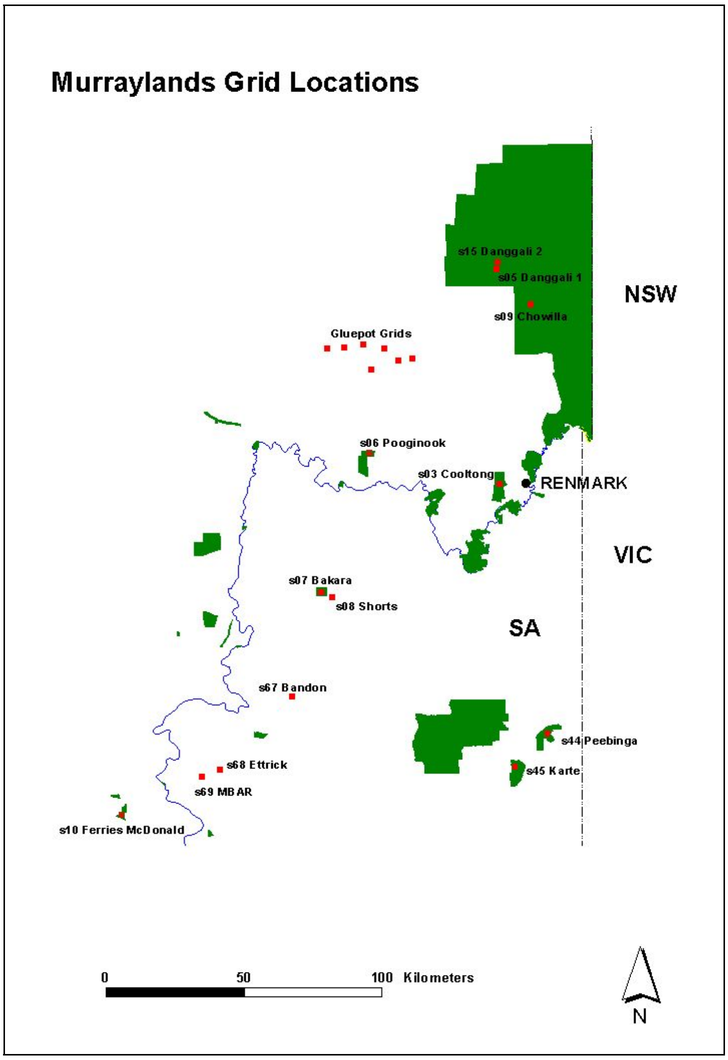


Figure 1: Murraylands (SA) grid locations.

Unfortunately breeding activity has not responded to the improved conditions in all areas, particularly north of the Murray River. Other areas within the region where recent rainfall deficits have been particularly pronounced have also not seen an increase in breeding activity. Elsewhere, breeding activity was higher than in previous years, with a record number of active mounds recorded at Peebinga Conservation Park (see Table 1).

In recent years, the project has also focused on the collection of rainfall figures and correlating them with breeding activity on individual grids (see Figure 2). This has involved the collation of monthly rainfall totals and comparing the total annual rainfall figures against the long term average. The cumulative rainfall totals for the May to September period have also been compared to the long term average for this period, as rainfall during this period has been shown to have a pronounced effect on breeding activity (Benshemesh, Barker & MacFarlane, 2006). Rainfall figures have been taken from the nearest Bureau of Meteorology rain gauge or from landholders' gauges if they are closer to the grid. This year will also see the first installation of an automatic weather station on a grid in the region.

Table 1: 2010/2011 Monitoring results.

Grid	Mounds Visited	Active Mounds 10/11	Active Mounds 09/10	Comment
Bakara CP s07	56	1	1	
Bandon (Burdett's HA) s67	59	6	2	
Chowilla RR s09	18	0	1	
Cooltong CP s03	40	1	0	
Danggali CP 1 s05	10	1	1	
Danggali CP 2 s15	7	0	0	
Ettrick (Fullston's HA) s68	24	2	2	
Ferries McDonald CP s10	61	6	4	
Gluepot 11 s59	15	0	0	
Gluepot 12 s60	15	0	0	
Gluepot 15 s63	13	0	0	
Gluepot 3 s52	23	0	0	Burnt 2006
Gluepot 5 s54	16	0	0	Burnt 2006
Gluepot 7 s56	15	0	0	
Gluepot 8 s57	10	1	0	
Karte CP s45	24	0	0	
Murray Bridge AR s69	49	6	5	
Peebinga CP s44	54	10	4	
Pooginook CP s06	33	0	0	Burnt 2006
Shorts HA s08	41	1	1	

NB: Grid names in red show a negative response or no change in breeding activity in 2010/2011; grid names in green show a positive response

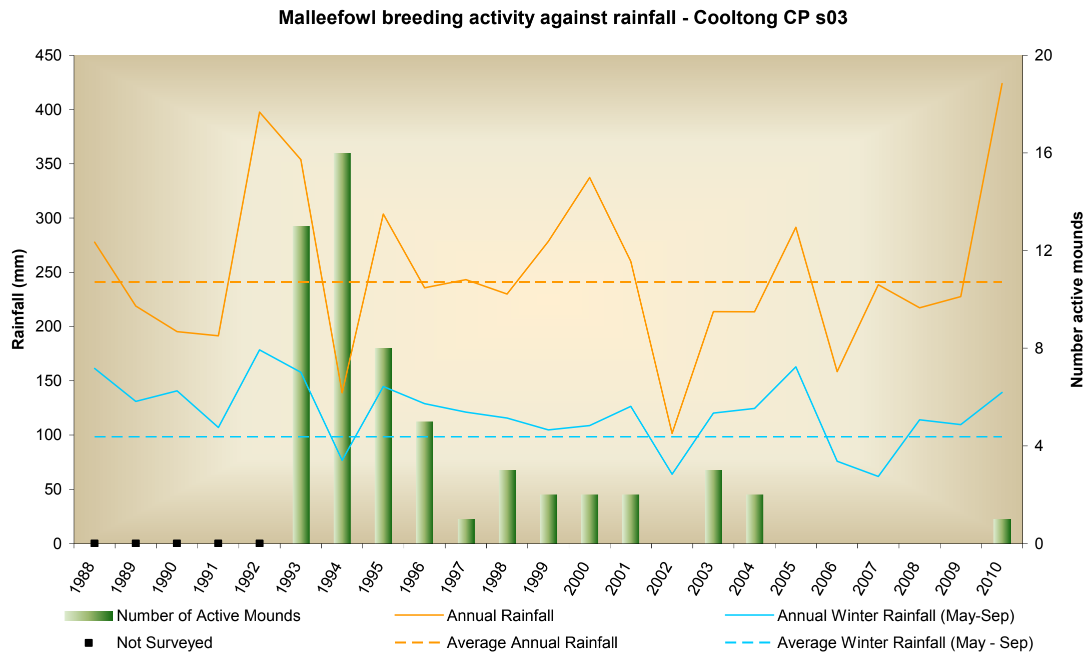
Discussion

Possible reasons for the lack of positive response in some areas include a lag effect from the extended dry spell and reduced Malleefowl populations. It is possible that in certain areas, Malleefowl populations have become so reduced by the extended dry conditions that they are not able to positively respond to improved conditions for breeding. Follow up rains during 2011 may be critical for vegetation recovery to continue and to encourage increased breeding activity across the entire region. If low levels of breeding activity are repeated in the 2011/2012 season on specific grids it will suggest that the Malleefowl populations in those areas may no longer be self sustaining.

Three grids north of the Murray River were burnt in the Bookmark fire at the end of 2006. The monitoring of these grids in the intervening years has been conducted to take advantage of the opportunity to monitor the regeneration of vegetation on the grids. Breeding activity is not expected on these grids for some time yet.

Recommendation

The lack of a general positive trend in breeding activity across the region in response to the much improved conditions over the last 18 months highlights the need to move on from solely monitoring Malleefowl breeding activity in the SA Murray Darling Basin. I would like to see the monitoring program continue in the region but I think it should be rationalized. The priority should now be to monitor grids in conjunction with adaptive management trials. The volunteer time saved from reducing the number of grids monitored annually could be reinvested in assisting with the adaptive management trials. This would also help renew enthusiasm and interest in the volunteer network.



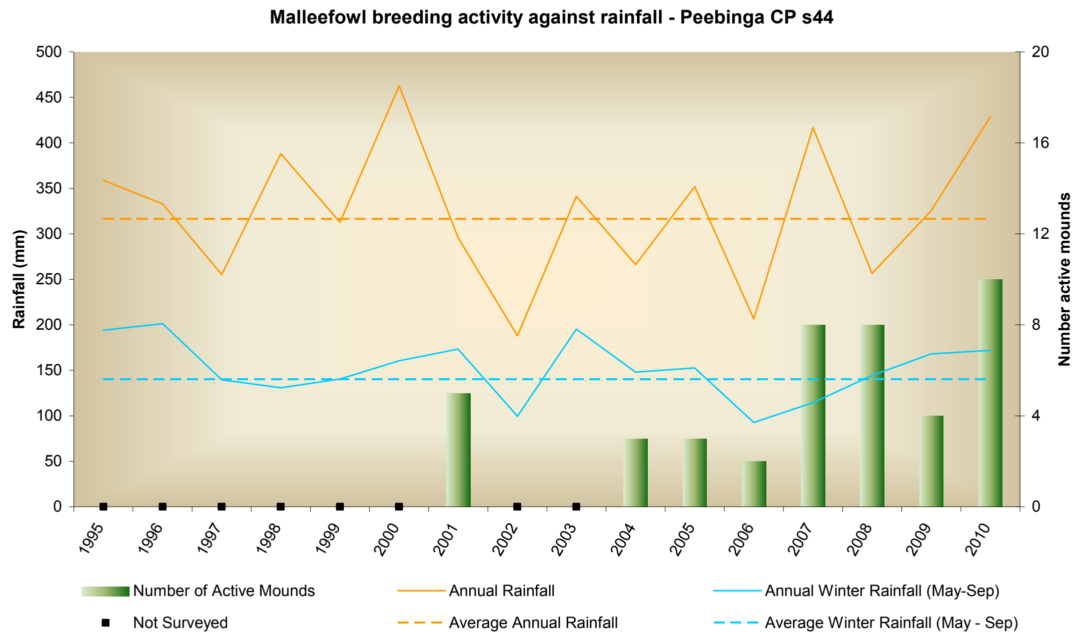


Figure 2: Examples of breeding & rainfall graphs.

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7. Status, monitoring and management of Nganamara in South Australia's Aboriginal Lands. A brief follow-up from 2008.

Dr Matthew Ward, Ecologist, Dept of Environment & Natural Resources, Alinytjara Wilurara Region

Abstract

Determining the distribution and status of Malleefowl (Nganamara) in South Australia's remote Aboriginal Lands is essential for conserving this threatened species, but provides a difficult and ongoing challenge for communities, ecologists and Nganamara enthusiasts. Low detectability of birds, vast tracts of inaccessible land and variable capacity of communities means that comprehensive monitoring is expensive in time and money, and accurate reporting is difficult to achieve. Successful surveys in 2007 in the southern Alinytjara Wilurara NRM region and Maralinga Tjarutja Lands, however, provided an excellent basis for developing some regional monitoring guidelines and targets for 2008 - 2012. Here, I report on progress towards achieving the objectives and provide recommendations and goals for future monitoring frameworks.

Background

The Alinytjara Wilurara (AW) NRM region in South Australia covers 26% of South Australia. The region is contiguous with the Western Australia border and stretches from the Northern Territory south to the Great Australian Bight. It encompasses the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, the Maralinga Tjarutja (MT) Lands, and Yalata Indigenous Protected Area (IPA), all of which are lands managed by Aboriginal people. The region is one of the most intact and pristine wilderness areas in Australia and most of the area has been untouched by the ravages of pastoralism and agriculture. As such, many important species of conservation significance still persist in the region, such as the Marsupial Mole *Notoryctes typhlops*, Tjakura (Great Desert Skink) *Egernia kintorei*, Princess Parrot *Polytelis alexandrae*, Sandhill Dunnart *Sminthopsis psammophila* and, of course, the iconic Nganamara (Malleefowl) *Leipoa ocellata* (Fig. 1).

Despite the vast tracts of contiguous and potentially suitable habitat across the arid zone, Nganamara numbers are thought to have declined markedly in central Australia since the onset of pastoralism and the spread of foxes. In the 1990s, however, surveys revealed that the species still occurred in the APY Lands (Robinson *et al.* 2003), and subsequent surveys have recorded numerous sites in the APY Lands (Benshemesh 2007b; 2007a; Partridge 2008). South of the APY Lands, recent surveys have demonstrated that Nganamara are distributed throughout the Great Victoria Desert (albeit at very sparse densities), in the Maralinga Tjarutja Lands, Yellabinna Regional Reserve, Yellabinna Wilderness Area and Yumburra Conservation Park (Ward and Bellchambers 2008).

Many questions still surround the status of Nganamara in the region, not the least of which is: what is the trend of the Nganamara population in the AW region? In a region so vast, only comprehensive and regular monitoring, with reporting tools specific to the region, can answer this critical but challenging question.

Monitoring of Nganamara in the Alinytjara Wilurara region, 2008-2012

In 2008, I reported of a number of objectives for Nganamara / Malleefowl monitoring in the southern Alinytjara Wilurara region for 2008 - 2012 (Ward and Bellchambers 2008). Here I report on progress towards each of these objectives, with relevance to the entire Alinytjara Wilurara region.

Figure 1: Records showing Malleefowl distribution across the Alinytjara Wilurara NRM region in South Australia.

1) Establish monitoring guidelines for Nganamara.

Monitoring of Nganamara in the AW region provide unique challenges, because of the vast areas of potentially suitable habitat and the low density of birds. In turn, this leads to a very sparse distribution of mounds and difficulty in finding animals. The most efficient method of detecting Nganamara in these landscapes is the tracks they leave behind in suitably soft sand.

Monitoring guidelines have been established, therefore, which reflect these difficulties (Ward 2008). These guidelines reinforce the notion that the most meaningful method of monitoring Nganamara abundance in the region is to measure the occurrence (presence / absence) and persistence over time of the birds at specific sites, rather than attempt to measure the number of breeding attempts (Victorian Malleefowl Recovery Group 2007), a method that is more suitable where population densities are higher..

In order to measure persistence over time across this vast landscape, the area in question needs to be divided into reportable units. For southern areas of the AW region, Ward (2008) nominated 10 km x 10 km grid cell units.

Given an appropriate and sufficient monitoring effort, persistence of Nganamara, therefore, could be reported as the percentage of 10 km x 10 km grid cells in which MF were recorded in, as a proportion of the number of grid cells which had been searched during that monitoring period. Using this method also provides the benefit of allowing determination of ‘Area of Occupancy’ and ‘Extent of Occurrence’, as used by the IUCN for reporting of the status of threatened species (IUCN 2001) and more recently for regional threatened species prioritisation in South Australia (Gillam 2008; 2009).

Recommendations

- Continue to develop reporting system around monitoring guidelines with relevant staff in the region, in particular regional staff and GIS / Knowledge and Information Officer.
- Assess the size of reporting units / grid cells by conducting reporting.
- Continue to encourage the need for objective Nganamara monitoring at a landscape scale.

2) Communicate monitoring guidelines with relevant staff (DENR project staff, land management staff, DENR rangers).

Monitoring guidelines for Nganamara have been distributed amongst relevant staff and agencies in the region and variations of this monitoring method have generally been adopted in the region. Also, training was conducted for the volunteer group Friends of Great Victoria Desert, so that this group could potentially conduct Nganamara site-based searches (Ward 2008) and record opportunistic Nganamara records.

The benefit of this monitoring and reporting method is that simple records, such as opportunistic records of Nganamara tracks in any area of the region, can contribute significantly to both the number of records, and in the “area” that had been searched for the region (given that each reporting unit is 10 km x 10 km).

Recommendations

- Continue to foster communication between different government agencies and relevant staff, in particular the support that can be provided for reporting of Nganamara monitoring across the region.
- Continue to encourage Nganamara monitoring amongst volunteer groups, in particular Friends of Great Victoria Desert.
- Promote appropriate recording, including photographs and measurement that would enable validation of data, of opportunistic Nganamara records for all people travelling and working in the region.
- Continue to communicate the need for objective Nganamara monitoring at a landscape scale.

3) *Establish a database for Nganamara monitoring in the region.*

A "Nganamara Monitoring in the Alinytjara Wilurara Region" project has been established in the Department of Environment and Natural Resources Biological Database of South Australia (BDBSA), in which approximately 70 individual monitoring "sites" have been established. These sites include areas where searches have taken place and Nganamara activity has been both present and absent. This data has been adopted by the Alinytjara Wilurara DENR region, and it is hoped this more regional adoption will lead to better reporting in the future.

However, there is still a need for an internet based style method of submitting Nganamara records specific for the region, to minimise data handling and standardise data input and subsequent reporting.

Recommendations

- Consolidate all Nganamara monitoring data in the region.
- Develop Nganamara database through AW DENR Knowledge and Information Officer to allow ease of data submission and extraction by all staff in region.
- Investigate internet data submission and extraction.

4) *Establish capacity of land management authorities to conduct monitoring, including equipment, resources and work plans.*

In the APY Lands, monitoring of known Nganamara sites has generally been a component of the workplans of both Walalkara and Watarru IPAs. There are numerous scattered known Nganamara mounds near both communities, and there is capacity and detailed plans (Benshemesh 2009) for Anangu to conduct monitoring of these at least twice per year. In order to report on Nganamara persistence in each IPA as per Ward (2008), however, there also needs to be a dedicated effort to conduct site searches for Nganamara in both historic and new locations to record both presences and absences, rather than a focus primarily on known mounds.

In the southern Alinytjara Wilurara region, and in particular the Maralinga Tjarutja Lands, the capacity to conduct surveys and monitoring is a little more challenging. This is because there is only one small community (Oak Valley) central to the entire MT Lands, which in itself has a very transient population making continuity in participation difficult. Furthermore, regional field staff have many threatened species priorities over such a vast area, and these priorities are subject to variation in funding at a local, regional, State and National level.

At the same time, however, a vast array of mining access tracks have recently been made, providing the capacity for Anangu and scientists to survey a greater proportion of the area for Nganamara (thereby increasing scope and precision of reporting). Because of the vast distances involved, systematic monitoring and survey for Nganamara across the majority of the MT Lands by Anangu and scientists will best be done across multiple survey trips in one year.

Opportunistic monitoring of Nganamara in the region can also be assisted through volunteer groups such as FOGVD, Desert Discovery or West Mallee Protection Group. Furthermore, it is possible to encourage the reporting of Nganamara sightings along Goog's track through provision of a fact sheet and reporting material for anyone who is issued a Desert Park's Pass by DENR.

Recommendations

- Encourage regular systematic and regular survey and monitoring across the landscapes of southern APY Lands and Great Victoria Desert, incorporating employment and training of Anangu.
- Due to capacity challenges, consider whether dedicated bi-annual comprehensive monitoring and reporting is more appropriate, possibly in alternate years to general biannual 2-ha sandplot surveys.
- Encourage systematic and regular site searches in historic Nganamara locations and new locations.

- Develop Nganamara reporting fact sheet which is accessible to members of the public, mining companies and other stakeholders to encourage the submission of opportunistic Nganamara sightings in desert parks regions.

5) *Conduct consistent annual monitoring of known Nganamara sites, and*
6) *Conduct surveys for Nganamara in new areas of the region.*

By the nature of the monitoring guidelines for the Alinytjara Wilurara NRM region, survey is often conducted by default when larger 'site searches' are encouraged in areas where Nganamara have not previously been recorded. Following the establishment of monitoring guidelines for the region (Ward 2008), monitoring in the region has included:

- Monitoring / survey of 39 sites in the southern Alinytjara Wilurara region in 2008 by DENR staff and Oak Valley community members (Ward, Read and Keen, unpublished data), including sites in Yumburra, Yellabinna Regional Reserve, Goog's Track, Maralinga Section 400 and Maralinga Tjarutja Lands.
- Monitoring / survey of Biological Survey site Patch ID 248 (P. Schmucker and R. Matthews), and video monitoring of the mound close to airstrip in Maralinga Section 400 by AW DENR staff and Maralinga caretaker (P. Schmucker, H. Ehman, T. Gurney and R. Matthews).
- Monitoring of eight sites by the FOGVD in 2009, including two opportunistic records along Goog's Track.
- Ad-hoc monitoring of Nganamara mound sites and sand-plot surveys in the APY lands, including Walalkara and Watarru IPAs.

In addition, landscape-scale 2-ha general sandplot surveys in at least 120 sites have been conducted across the Maralinga Tjarutja Lands in each of 2007 (Southgate *et al.* 2007), 2009 (Southgate *et al.* 2009) and currently in 2011. Although these surveys were not designed specifically for Nganamara, they do cover areas in which Nganamara are likely to occur, and the results of these surveys could be incorporated into the persistence reporting when combined with broader Nganamara searches.

In the southern Alinytjara Wilurara region, at least 4 new active mounds have been located since the surveys conducted in 2008 (Ward and Bellchambers 2008). This includes one close to Mt Christie siding in Yellabinna Regional Reserve (Ward and Read unpublished data), one in north-western Yellabinna near Sandhill Dunnart monitoring sites (Ward 2009), one along the dog fence near in Yumburra Conservation Park (A. Yendall, Dog Fence Patrol Officer), and at least one active mound near airstrip in Maralinga Section 400 (probably a mound of the birds whose tracks had been recorded in 2008 and 2009).

Recommendations

- In the APY Lands where the majority of known Nganamara sites are known, begin dedicated persistence monitoring in combination with on-going searches in areas where Nganamara have and have not previously been recorded.
- Conduct dedicated Nganamara monitoring and surveys across southern AW region in 2011-2012.
- Due to capacity challenges, consider whether dedicated bi-annual comprehensive monitoring is more appropriate, possibly in alternate years to biannual 2-ha general sandplot surveys.
- Develop Nganamara reporting fact sheet which is accessible to members of the public to submit possible opportunistic Nganamara sightings in desert parks regions.

7) *Review monitoring data.*

Data from this monitoring currently sits in the BDBSA, and with Alinytjara Wilurara DENR region's Knowledge and Information Officer. It is assumed by the author that data from the APY monitoring resides both with Alinytjara Wilurara DENR region and Anangu Pitjantjatjara Yankunytjatjara Land Management, and requires further consolidation (as per Benshemesh 2007a).

This data has not been consolidated or reported on since Benshemesh (2007a), Partridge (2008), and Ward and Bellchambers (2008).

Recommendations

- Conduct data consolidation and reporting for all monitoring and surveys conducted for 2008-2012, including dedicated Nganamara work and 2-ha sandplot surveys, prior to June 30th 2012.

Summary

There has been definite progress towards achieving the aims of Nganamara monitoring for 2008-2012 (Ward 2008). Although we are not quite yet at a point where we can objectively describe the distribution or determine a trend for Nganamara populations in the region, the renewed focus, extra resources and greater survey effort in the region has seen the number of known Nganamara sites increase.

At this point in time, successful monitoring and reporting of the status of Nganamara in the Alinytjara Wilurara region is primarily dependent on:

a) A willingness and capacity to conduct systematic, regular and widespread monitoring and survey of known, historic and new Nganamara locations across a landscape scale by both Anangu and scientists, and
b) Commitment to consolidating all possible Nganamara data in the region in a format which makes reporting possible.

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8. Activities of WA Malleefowl Network 2009 – 2011

Professor Stephen Davies, Curtin & Murdoch Universities WA; Member National Malleefowl Recovery Team

Abstract

The WA Malleefowl Network was established by WWF under its Threatened Species Program in 2003, to provide contact between the various groups and individuals monitoring Malleefowl in WA. In 2009 support for the Threatened Species Program was greatly reduced and WWF could no longer support the Network. The Network approached the WA Department Of Environment and Conservation with three options to maintain the coordination of mound monitoring and transmission of data to the National Database: (i) the Department provide an officer one day a week to coordinate these activities, (ii) the Department provide $10,000 to enable the Network to employ someone part-time to do this, or (iii) coordination be left to volunteer groups. The Department refused to provide any support; the Malleefowl Preservation Group then undertook to maintain the coordination and transmission. That is the present situation.

The WA Malleefowl Network 2003 - 2011

The WA Malleefowl Network was established at a meeting of interested people at Panda Cottage, WWF's office in Perth, on March 18, 2003. It was established by WWF within its Threatened Species Program and was chaired by Raquel Carter, then the WWF Threatened Species coordinator.

It had clearly defined aims:

- To take a state wide coordinated approach to the conservation and recovery of Malleefowl through the implementation of actions within the national Malleefowl Recovery Plan.
- To strengthen partnerships and working relationships between groups working towards Malleefowl conservation in WA
- To increase communication between groups and increase state-wide awareness of Malleefowl activities and projects.
- To take a collaborative approach to applying for funding in relation to Malleefowl conservation.
- To establish a state-wide data base for Malleefowl sightings to evaluate the success and progress of the implementation of the Malleefowl Recovery Plan and Recovery Program.

The Network has made some progress with the first three objectives, one successful approach to the fourth aim, but no progress with the fifth.

The WA Malleefowl Network has met 18 times since its establishment. It has also taken part in or organised several workshops to help people understand the methods of monitoring mounds.

In 2005, working with the Avon Catchment council, WWF was able to obtain funding for the position of Malleefowl Coordinator within its Threatened Species Program. The first coordinator was Alice Rawlinson and she was succeeded by Carl Danzi. The availability of a coordinator, with a permanent office and phone gave a considerable boost to monitoring activities. The network became incorporated in 2009, but has not so far attracted funding to support Malleefowl conservation. In 2009 funding to WWF's Threatened Species Program was severely cut and the position of Malleefowl Coordinator had to be terminated.

The WA Malleefowl Network then wrote to the WA Department of Environment and Conservation seeking support for the coordination of volunteers to monitor mounds and for the transmission of data to the national data base. The Malleefowl is not considered to be a threatened species in Western Australia, and is classified as vulnerable. This means work on it has a lower priority than work of many threatened species, and the WA Department of Environment and Conservation was unable either to provide time of a staff member or provide funds to employ a part time person to coordinate volunteers and transmit the monitoring data. When this decision was made the Malleefowl Preservation Group offered to undertake these roles. I understand that it is in the process of transmitting data to the national data base, doing some monitoring and undertaking some surveys with support from mining companies.

The WA Malleefowl Network did take a major role in the organization of the Katanning National Malleefowl Forum in 2008, and did manage to get Peter Mawson of the Department of Environment and Conservation to the Forum, but participants were not able to persuade him of the need for support for Malleefowl monitoring. The classification of the Malleefowl as vulnerable rather than endangered in Western Australia depends, not only on many other competing species, but on its widespread occurrence in the vast areas of uncleared woodland and its survival for many years in small remnants in the wheatbelt, despite the presence of foxes and cats. Nevertheless, support from the National Malleefowl Recovery Team in a further approach to the WA Department of Environment and Conservation for support for monitoring work would be very helpful.

9. North Central Malleefowl Preservation Group – update

Sally Cail, Secretary, North Central Malleefowl Preservation Group, WA; Member National Malleefowl Recovery Team
sallycail@westnet.com.au

Abstract

The National Malleefowl Network is encouraging groups such as ours to work to an overall plan for the conservation of Malleefowl. We aim to follow these guidelines to monitor the different sites and to record the changes from year to year. We do this by monitoring all 158 mounds in five grids between December and March each year. This is done by volunteers following the National Monitoring plan.

The results averaged over the last four years show that there has been a marked decline in the number of active mounds over all sites. Possible factors that may have contributed to this decline are that these years have been particularly dry in late Autumn, Winter and early Spring, and have coincided with the cessation of our major fox baiting drive at this time.

Farmers dropped out of the fox baiting programme due to a number of reasons - mainly drought, cost of baits and destocking their land. It is hard to convince them that there is more to be considered than sheep! The cost of getting someone to mix the 1080 with oats has also become a problem with the Agricultural Department no longer doing this, and we have to get the dogger (person who baits for dingoes) from Merredin, adding quite a lot to the overall cost (400km+ round trip).

The implication of this is quite disturbing as reports indicate that Malleefowl are still being seen in most areas, although in reduced numbers.

We need to be vigilant and bait our grids and hope that weather conditions improve and we get the nesting activity back to a reasonable number. Farmers will be made aware of declining numbers and encouraged to once again participate in the conservation of Malleefowl by fencing known areas on their properties where Malleefowl are seen and baiting for rabbits and foxes.

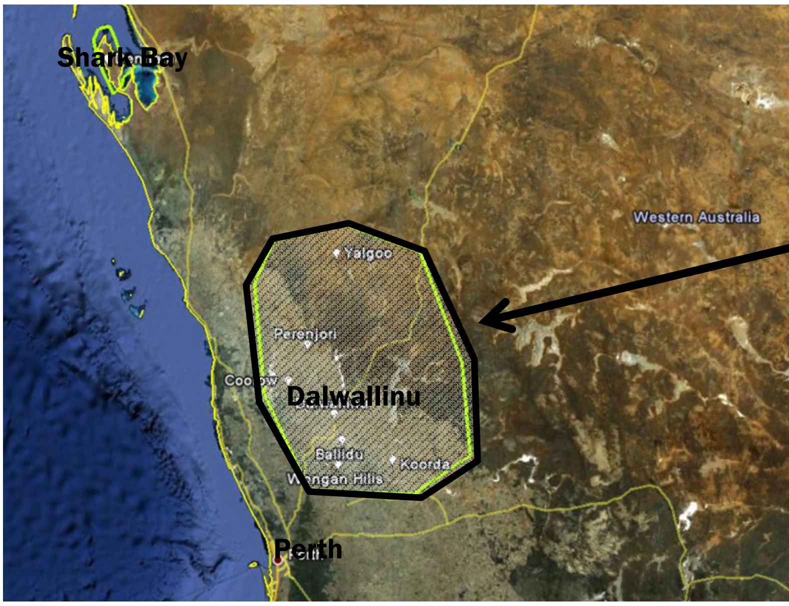
Background

The North Central Malleefowl Preservation Group (NCMPG) is a group of volunteers working together towards protecting Malleefowl and its habitat in the northern wheatbelt and adjacent pastoral areas of WA. The NCMPG formed in 1993. We are one of the few organisations who operate on privately owned bushland.

Our group currently monitors five grids located in an area around Dalwallinu, north-east of Perth (Figure 1) according to the National Monitoring Guidelines. We monitor all 158 mounds in our grids between December and March each year. Another site is also checked by two NCMPG members, in conjunction with the Environmental Officer from Mount Gibson Iron.

Since 2007 the overall average shows a decline in active Malleefowl mounds within our grids. We feel this is largely due to seasonal conditions (but is it coincidence that this was also the last year of our major fox baiting programme?).

This paper outlines the monitoring results from 2007/08 to 2010/11 and other NCMPG activities during this time.



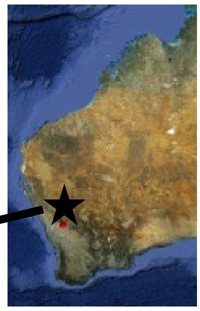


Figure 1. NCMPG area of operation, covering agricultural, pastoral and mining areas north-east of Perth.

Monitoring results from 2007/08 to 2010/11

Milton McNeill Reserve:
The Milton McNeill Reserve site covers an area of approximately 400 ha located 22 km's north east of Dalwallinu, and is comprised of open red mallee, wodjil and thickets of sugar brother and tea tree. Mounds are found throughout the reserve, but mostly in dense sugar brother, wodjil and tea tree. Figure 2 shows the history on the Milton McNeill site from 1996 to end 2010, of May-Sept rainfall, total rainfall for the Dalwallinu area, and percentage of active mounds.

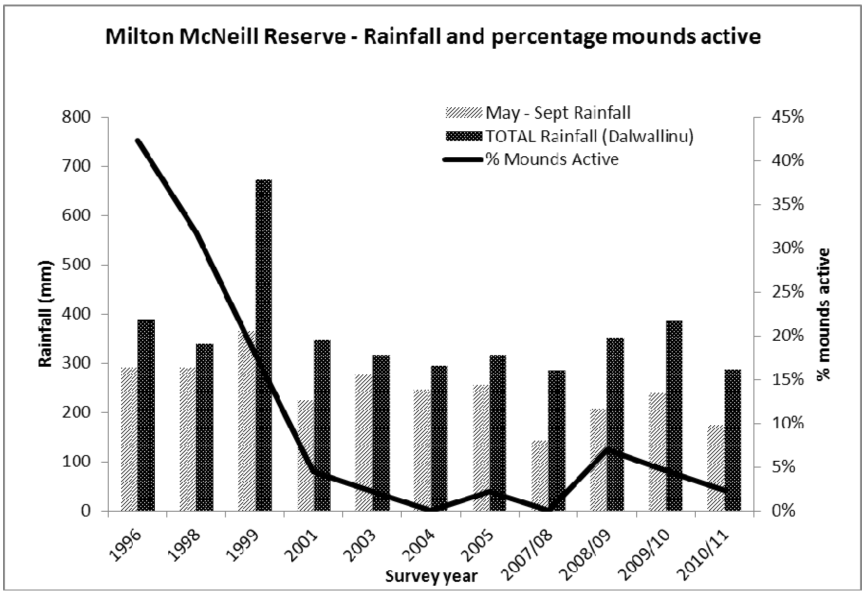


Figure 2. Graph of the Milton McNeill Reserve site showing May to September rainfall, total rainfall for the Dalwallinu area and the percentage of active mounds, from 1996 to 2010/11.

The site has a total of 42 mounds. In 07/08 there were no active mounds; 08/09 we had three; 09/10 there were two, one less active mound than the previous season - there was very recent activity on at least four mounds. Both mounds that were active were different to those active in 08/09. 2010/11 season saw only one active mound with six others showing recent signs of Malleefowl scratching to some extent. In all, twelve mounds had Malleefowl tracks on them.

Old Well Reserve:
This reserve is approximately 100 ha, consisting of open mallee and also dense thickets containing a lot of prickly 1080 bush. It is located east of Latham, 80 km's north east of Dalwallinu. Figure 3 shows the rainfall and percentage of active mounds history for the Old Well Reserve site, from 1999 to end 2010.

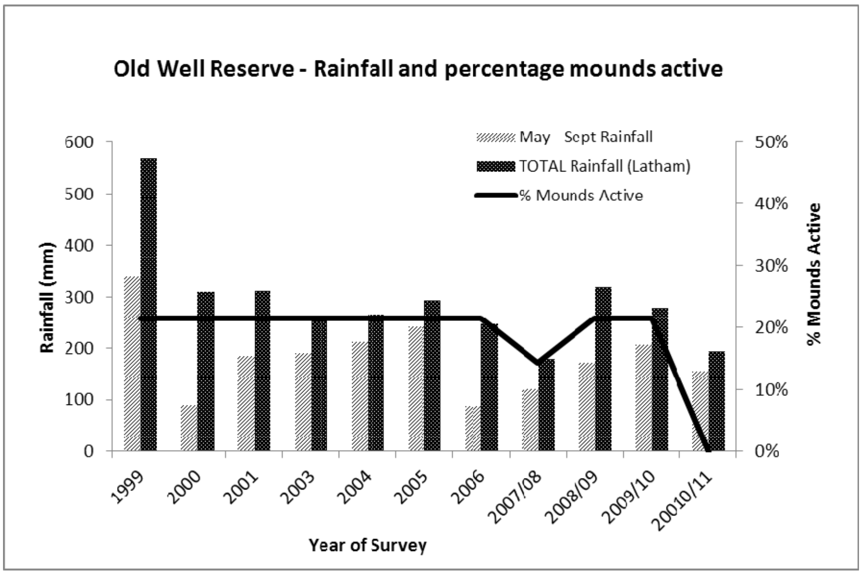


Figure 3. Graph of the Old Well Reserve site showing May to September rainfall, total rainfall for the Dalwallinu area and the percentage of active mounds, from 1999 to 2010/11.

The Old Well Reserve site has a total of 43 mounds. There were three active mounds in 07/08, 08/09 and again in 09/10. Of the three active mounds in 09/10, only one of those mounds was active in 08/09. Also in the 09/10 season, there were two other mounds with very recent activity on them. The 2010/11 season saw no active mounds. Three mounds had recent Malleefowl scratching, with two of those completely coned out. In all, five mounds had Malleefowl tracks on them.

Carter's:
This patch of remnant vegetation is on private property east of Wubin (50 km's north east of Dalwallinu). Being on private property, this bush has been previously grazed by sheep, particularly on the north and east sides. In 2004 funding from Threatened Species Network enabled the landholder to fence the whole 175 ha of bushland. This bush is around 50% wodjil, with the remaining made up of sugar brother, tea tree, mallee and banksia. Figure 4 shows the history of rainfall and percentage of active mounds for the Carter's Bush site, from 2004 to end 2010.

A total of 32 mounds are located on the Carter's Bush site. This site has had the least activity of the five sites monitored with only one active mound in 09/10 compared to two active in 08/09; along with that there was not much other sign of Malleefowl activity. The active mound in 09/10 was a different one to the previous season. The 2010/11 season saw no active mounds but bird sightings have been reported on several sections of the site, along the roads, and six mounds had recent Malleefowl scratching (one being completely dug out).

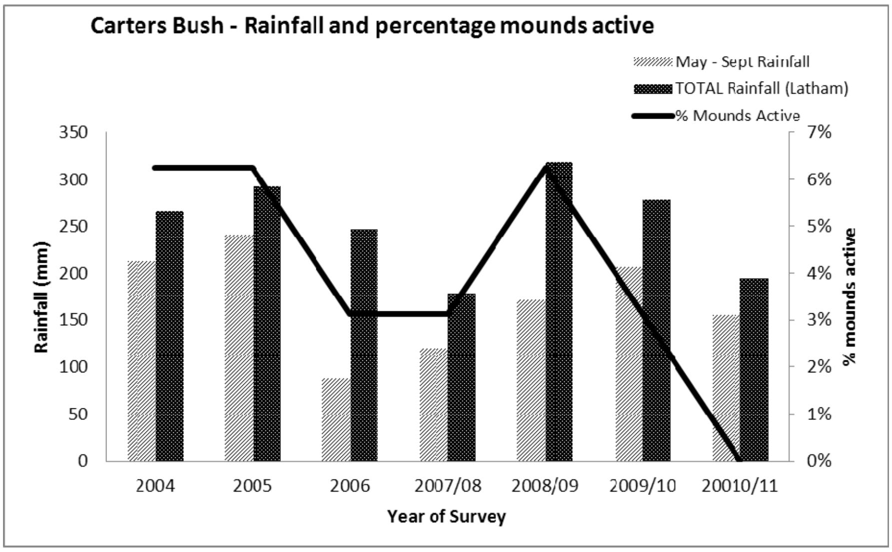


Figure 4. Graph of the Carter's Bush site showing May to September rainfall, total rainfall for the Dalwallinu area and the percentage of active mounds, from 2004 to 2010/11.

Reudavey's:
This 185 hectares of bush is on private property east of Wubin (45 km north east of Dalwallinu). This is 75% wodjil and tea tree country, with occasional mallee, banksia and acacia. Figure 5 shows the rainfall and percentage of active mounds history for the Reudavey's Bush site, from 2005 to end 2010.

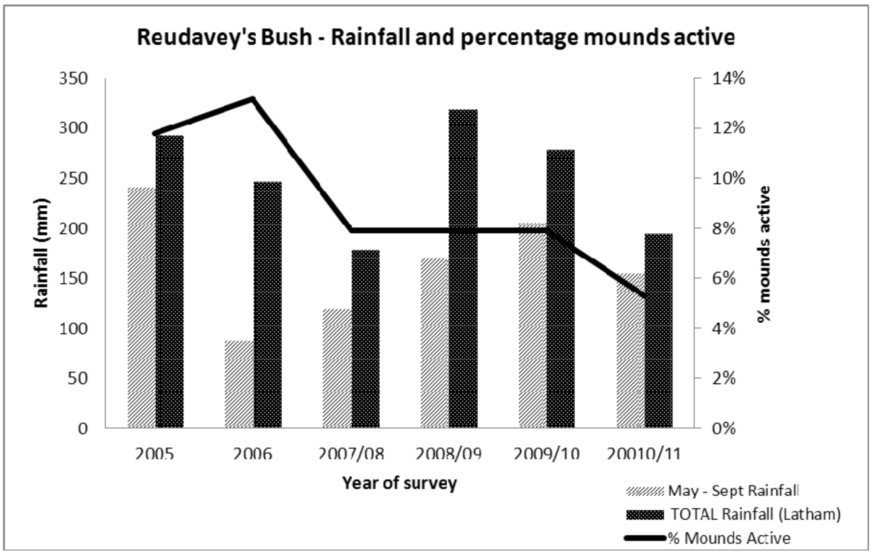


Figure 5. Graph of the Reudavey's Bush site showing May to September rainfall, total rainfall for the Dalwallinu area and the percentage of active mounds, from 2005 to 2010/11.

The Reudavey's site has a total of 38 mounds. This site had good signs of activity with three active mounds in 09/10, the same number as the previous season. All the active mounds were different ones in 09/10 to 08/09. In 09/10 there were signs of tracks on some other mounds and some scratching on two or more inactive mounds. 2010/11 saw two active mounds with recent activity on two other mounds. In all, six mounds had Malleefowl tracks on them. Three pairs of Malleefowl have been seen in the paddock adjacent to the bush since April 2011. All three pairs were seen within minutes of each other so were not the same pair in different places.

Charles Darwin Reserve (White Wells Station):
This area was previously a sheep station until it was purchased by Bush Heritage and renamed Charles Darwin Reserve. This is pastoral country 100 km north east of Dalwallinu on the Great Northern Highway. In 2005 the NCMPG assisted Bush Heritage to search 220 ha of the station in sugar brother, wodjil and acacia bush. In 2007 the mounds were monitored and tagged. Figure 4 shows the history of rainfall and percentage of active mounds for the Charles Darwin Reserve site, from 2005 to end 2010.

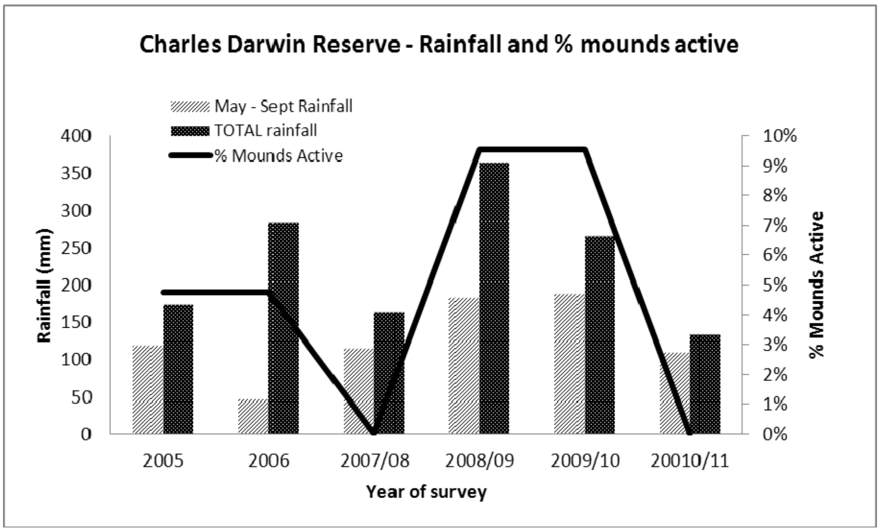


Figure 6. Graph of the Charles Darwin Reserve site showing May to September rainfall, total rainfall for the Dalwallinu area and the percentage of active mounds, from 2005 to 2010/11.

The Charles Darwin Reserve site has a total of 18 mounds. The same two mounds were active in 08/09 as in 09/10. There was not very much other sign of Malleefowl activity other than at the active mounds, but two active mounds out of the eighteen mounds at the site is quite a good percentage due to extremely low rainfall over the last few years and forage very hard to find.

Other North Central Malleefowl Preservation Group activities

Mount Gibson Iron:
Mount Gibson Iron operate an iron ore mine near White Wells station (Charles Darwin Reserve), approximately 100 km north east of Dalwallinu on the Great Northern Highway. The area has a total of 122 mounds, with 12 being so-called 'active' in 2010/11. Although these numbers seem quite high, the way they assess active mounds are different to ours. Because quite a few of these mounds are in the mine impact area, they are described as active if the mound shows any sign of being worked from the previous year, even if it is only hollowed out. They have a reasonable feral animal management plan in operation and they monitor the impact of grazers and predators. By comparing grazers (rabbits, goats, sheep) against predators (foxes, cats), the grazers are shown to have a larger impact on the Malleefowl monitored area.

During the mine's development, the NCMPG was contacted to comment on the environmental assessment review. Following this, two members (Gordon McNeill and Peter Waterhouse) assisted Jessica Sackmann, the Environmental Officer for Mt Gibson Iron, to survey the mining lease area and assess the status of mounds in the proposed mine footprint area. Gordon and

Peter have also assisted Jessica to search areas for Malleefowl mounds along Wanarra Road where there are planned earthworks. The group has ongoing commitments with Mt Gibson Iron for future surveys and monitoring.

Later this year (2011) we will be searching and monitoring the area to National Guidelines as they are very keen to see how the mine impacts on the Malleefowl. They are also interested in seeing how the two sets of data compare.

Koorda Shire:
Many Malleefowl were seen in a particular area during harvest and after contacting the Koorda Shire, we received permission to erect "Caution Malleefowl" signs. The Shire is very keen to protect this area and with the help of local people, we will endeavour to search this very large area of approximately 1000 hectares, and again, monitor it annually to National Guidelines.

Conclusion

It is unfortunate that our annual fox baiting drive has ceased owing to a run of poor seasons, cost of baits, and lack of government support for grants to assist with baiting (as well as farmers thinking it was a waste of time due to the fact that a lot of them had destocked their land). Unfortunately, it takes some convincing that they are helping all native species, not just the Malleefowl, by baiting. The cost of getting someone to mix the 1080 with oats also has become a problem with the Agricultural Department no longer doing this and we have to get the dogger (person who baits for dingoes) from Merredin, adding quite a lot to the overall cost (400km+ round trip). We need to be vigilant and bait our grids and hope that weather conditions improve and we get the nesting activity back to a reasonable number. Farmers need to be made aware of declining numbers, encouraged and supported to once again participate in the conservation of Malleefowl by fencing known areas on their properties where Malleefowl are seen, and baiting for rabbits and foxes.

The NCMPG is only a small group of volunteers who concentrate on monitoring our grids and working with the local community for the sustainability of Malleefowl. Being a small group with limited funds, it is becoming very difficult to garner help by community volunteers without the assistance of funding for fuel and travel expenses. No one wants to help these days without monetary assistance. The days of the true volunteer are rapidly vanishing and without some sort of funding our group will find it very difficult to continue as it currently is.

The NCMPG recommends that for the continuing management and conservation of Malleefowl that the National Recovery Plan is followed as closely as possible and that the National Recovery Team urges Federal and State Governments to make funds available for baiting programmes to encourage the conservation of all native species, particularly the Malleefowl.

10. To Be or Not to Be – The Future of Malleefowl Conservation

Susanne Dennings, Coordinator, Malleefowl Preservation Group, WA

Abstract

In 2010 the Malleefowl Preservation Group (MPG) was faced with the serious option of winding up the organisation after nearly 20 years of operation. The sharing of knowledge gained during this process serves to provide the broader community with a greater understanding of the challenges facing rural community groups today.

The appointment of a new executive committee to oversee a series of meetings and a 'Where to From Here' workshop assessed future MPG alternatives.

In accepting its 2010-11 action plan, a new structural business model was adopted to move away from a 95% volunteer basis to a system that appoints a full time executive officer to manage the day-to day operations of the group. Within that process the following MPG strengths were acknowledged:

- landholder linked membership
- extensive partnerships
- rural networks
- on-ground project implementation focus
- increased community based and community owned projects
- national Malleefowl conservation advocacy & support
- information exchange
- reporting and administration processes
- volunteer involvement and support
- awareness and education

Figure 1: WA: The land of the 'sandgroper'
Artwork by Stephanie Nield, Albany, WA.

Without the support of a dedicated fully employed officer, the group will cease to operate. The loss of their membership services to local and state Government, Natural Resource Management/Local Action Planning groups, corporate sector, research students and the national adaptive management/data base project will impact heavily on Malleefowl conservation projects in rural Australia.

New options and new partnership opportunities are unfolding for the Malleefowl Preservation Group however they will require time to develop and a dedicated executive committee to manage those processes.

Challenges and Opportunities

The MPG established a 2010-11 strategic action plan where it examined the issues it is facing and determined that if it is to both continue as a functioning entity and be able to provide the same corporate, Natural Resource Management/Local Action Planning groups (NRMs and LAPs), local and state Government and community services, then it needs to change its structure and the business model under which it operates. A key objective is to move away from a volunteer basis to a system that has a full-time dedicated professional staff guiding its day-to-day operations.

The current funding opportunities through either the State Natural Resource Management process or the Commonwealth *Caring for Our Country* program either do not provide sufficient funds, or a funding stream beyond a 12-month cycle, or do not currently support threatened species as a core objective.

Consideration has been given to establishing a funding stream primarily through the services that it currently provides. While this could be achieved by charging a fee-for-service on a case by case basis, such an approach provides no guarantee of a steady funding base and provides little opportunity to maintain or expand services for all of the MPG activities in a co-ordinated manner. A new structure based around a paid Executive Officer position is now proposed, with that position responsible for co-ordinating the day-to-day operations of the MPG.

The volunteer overloads referred to above are primarily due to forces beyond the group's control such as social and economic downturns that have been occurring over the last 10-15 years in the Gnowangerup Shire, Western Australia, culminating in a rapid decline particularly over the last 3 years when the population of the MPG administration centre town in Ongerup has reduced from 120 to 80 residents (34.6%). Reasons for this decline are attributed to many factors including a) low incomes and diversification opportunities i.e. relying solely on agricultural income b) the development of the mining industry offering better paid jobs elsewhere c) loss of government support infrastructure in smaller communities and d) smaller family properties gradually being leased or sold to larger landholders who often live outside the local community.

Projects and Focus

In October 2009 the MPG met with members of the National Malleefowl Recovery Team and Victorian Malleefowl Recovery Group with the aim of providing each group with an opportunity to understand the culture and driving forces behind rural community conservation organisations in Australia. In assessing past and future options, the Malleefowl Preservation Group's unique strengths remain:

1. landholder linked membership
2. extensive partnerships
3. rural networks
4. on-ground project implementation focus
5. increased community based and community owned projects
6. national malleefowl conservation advocacy & support
7. information exchange
8. reporting and administration processes
9. volunteer involvement and support
10. awareness and education

1. Landholder Membership

As a membership based organisation, the MPG's part time administration officer has maintained the group's membership data base of 500 (approximately 1200 individuals). This is primarily made up of landholders, past and present and associated environmental groups in rural areas.

Figure 2: Farmers and Malleefowl – looking over the fence.

2. Partnership Values

The strong on-ground landholder membership and practical approaches to 'getting their hands dirty' and 'getting things done' has led to support and project partnerships from the following:

Local Government:

- Gnowangerup Shire
- Yilgarn Shire
- Shire of Westonia
- Shire of Mt Marshall
- Jerramungup Shire
- Shire of Trayning
- Shire of Nungarin
- Shire of Mukinbudin
- Shire of Lake Grace
- Shire of Merredin

State Government:

- Dept of Education
- Dept of Environment and
- Conservation
- Land for Wildlife Program
- West Australian Museum
- Perth Zoo
- Dept Agriculture

Federal Government:

- Landcare Funding Programs
- Caring for Country Funding Program
- Commonwealth Scientific Industrial Research Organisation (CSIRO)

Community Groups:

- WA Landcare groups (6)
- Bush Heritage, Australia
- Gondwana Link
- Birds Australia WA
- World Wildlife Fund
- Threatened Species Network
- Maleo Working Group – Indonesia
- WA Malleefowl Network Group (WAMN)
- Merredin Malleefowlers
- Monarto Malleefowlers –SA
- Volunteering Western Australia
- Yongergnow Australian Malleefowl Centre
- Sporting Shooters Association
- Naturalist Clubs (3)
- South Coast Natural Resource Management (SCNRM)
- Great Southern Development Commission
- Australian Wildlife Conservancy

Education Sector:

- 139 Schools (includes 20 high schools)
- University of Western Australia
- Tertiary Student support (10 projects)

These partnerships have been instrumental in providing the Malleefowl Preservation Group with the opportunity to offer free guidance and support towards the establishment and expansion of community engagement for the following organisations:

- Gilbert's Potoroo Conservation Group
- Carnaby's Cockatoo Project
- Project Numbat Group (in partnership with Perth Zoo)
- South Coast Natural Resource Management (NRM) group
- Gondwana Link Inc
- Maleo Working Group – Indonesia

3. Rural Networks

Through working with communities across Australia, the MPG has expanded its rural networks beyond its landholder members to incorporate and assist the following local government Shires Fig. 3):

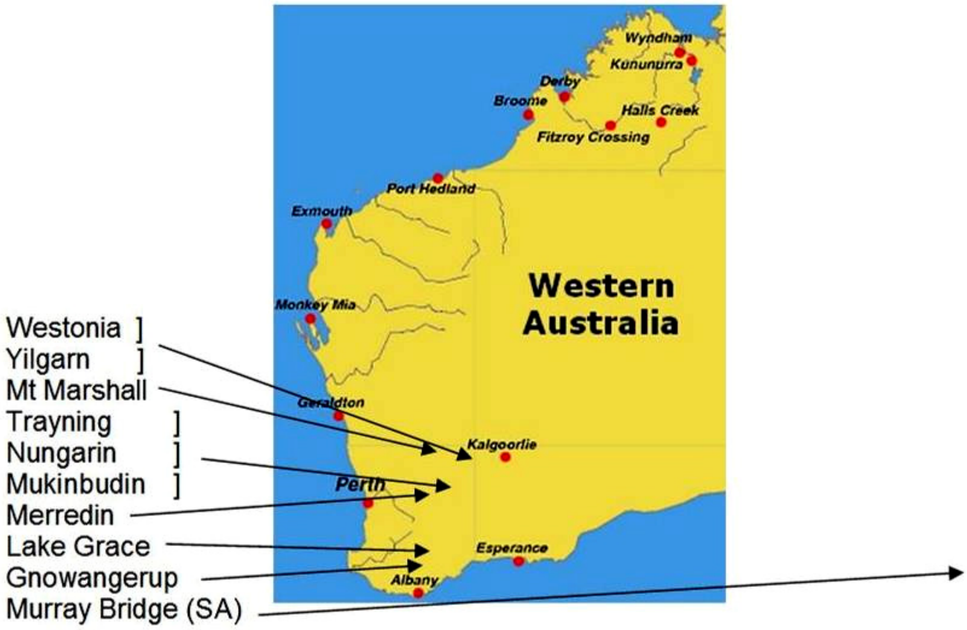


Figure 3: MPG Regional Shire Partnership areas.

4. On-Ground Projects

The 2009-2011 operational challenges impacted heavily on the group's capacity to develop landholder based conservation projects. Given the organisation's plan to raise full time Executive Officer funding, the group aims to:

1. Expand on the first planning stages of a 'landscape scale' Malleefowl corridor biodiversity project that proposes to:
   - Maintain the value of the Malleefowl as the keystone species
   - Incorporate broader biodiversity ecological restoration
   - Increase climate change awareness
   - Involve private and corporate sectors through providing carbon funded restoration opportunities
   - Contribute to farming sustainability practices
2. Address the loss of coordinated broad scale baiting programs in WA and address current challenges for landholders participating in the WA 'red card for red fox' campaign.

5. Increased Community Based and Community Owned Projects

It is widely recognised that the key strength for Malleefowl conservation projects across Australia is the level of community support, particularly in Western Australia.

The serious decline in small town populations across the country has therefore increased the need for groups, agencies and NGO's to communicate clearly, share resources and work more closely and effectively together to achieve common goals. The decline in rural communities has therefore provided an opportunity for the MPG to extend its support network.

6. National Malleefowl Conservation Advocacy & Support

Through encouraging and supporting the group's national membership by becoming a nationally incorporated body, the MPG aims to develop stronger on-ground landholder links and support networks across Australia. Their history in providing support to the following interstate groups has led to the organisation appointing an Executive Committee member based in Adelaide.

- Wedderburn Conservation Management Network Group, Victoria
- 'Malleefowl Monarto' in South Australia.
- Murray Mallee Local Action Planning Association (MMLAP), South Australia - hosting 3 day visit event to Ongerup
- Eremophila Festival, Vic
- Hopetoun Historical Society (support to MPG members in the region)
- Australian National Botanical Gardens Education Centre, Canberra

6.1 National Database/Adaptive Management Project

With support from the Merredin Shire/NRM Officer, local community groups (Merredin Wildflower Society and Merredin Pistol Club) and the Victorian Malleefowl Recovery Group, the MPG coordinated its first state based monitoring workshop in September 2010 with the aim of improving and upgrading WA's contribution to the National Database.

The event was attended by 43 participants representing WA groups, communities and corporate organisations and was held over a 3-day long weekend. Outcomes from the workshop included:

a) Prioritising WA monitoring sites
b) Appointing/confirming volunteers to monitor those sites
c) Developing recommendations for the National Recovery Team
d) Identifying operational challenges for national feedback:
   i) Mobile Mapper operations
   ii) State funding support for national projects
e) Involving/training corporate sector employees

Given the size of Western Australia and the travel distances required to hold a workshop weekend (approximately 400 km from any direction), the success of the training workshop resulted in support and planning for annual events to be held at the central location of Merredin each year.

6.2 WA Monitoring – Challenges and Successes

Before discussing WA's contribution to the national monitoring database, a well used and common expression from members, I believe, is worthy of consideration here:

> '*Monitoring – we are not just monitoring for the sake of monitoring –we want to know the results. Being involved in 'human chain' searches develops relationships with other volunteers and the corporate sector, provides us with a sense of achievement and strengthens the group to expand it conservation and research projects into other areas. The last thing we want to do however is monitor the Malleefowl until they are all gone so lets see the results, lets have some feedback and lets do more on-ground work towards their survival'*.

In partnership with community, local shires and the corporate sector, the MPG has established 17 monitoring sites in WA (Table 1). The total 'human chain' searched area of 10,548 ha includes one site at Mt Jackson of over 3,000 ha and does not include monitoring grids established at Yeelirrie station, a 250,000 ha property approximately 360 km north, north west of Kalgoorlie (Figure 4 and Table 1).

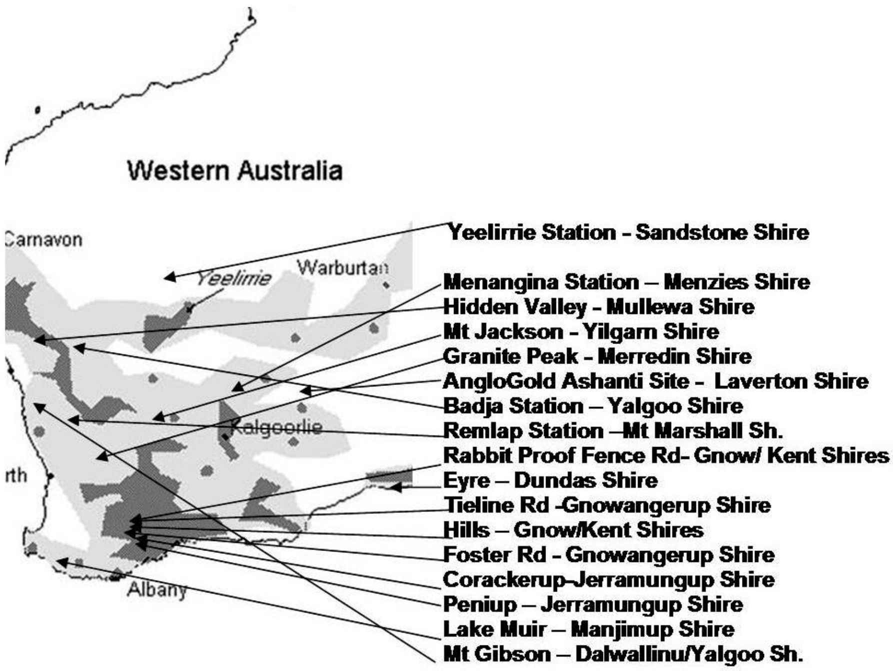


Figure 4: MPG Community and Corporate Survey Sites
Map provided by Dr. J Benshemesh, National Recovery for Malleefowl, 2000.

Table 1: Monitoring Summary (provided by Carl Danzi from National Data base)

2010/11 WA Malleefowl mound monitoring summary
Revision: 21 Jun 2011 – compiled by Carl Danzi

Site code	Site name	Nests monitored	Active	Comment
w01	Nugadong	44	1	
w02	Old Well	34	0	
w04	Carters	33	0	
w07	Reudaveys	37	2	
W09	Charles Darwin	13	0	
w11	Corrackerup	45	0	
w12	Foster Rd	25	5	
w13	Peniup	18	0	1 x profile 3 marked as active
w14	Hills	17	0	
w15	Tieline			
w16	Yeelirie	25	5	
w17	Mt Jackson	55	0	1 x profile 1 & 5 x profile 3 marked as active
w18	Eyre	1	0	Done by Stephen Davies, Nest 33 or 65? 6-7km NE of Observatory
w19	Hidden Valley			
w20	Kalgoorlie			
w21	Merredin	19	1	
w22	Eurardy			
w23	Cowcher Rd	29	0	
w24	Bodallin	11	2	
w25	Narkal	17	1	No photos yet, not done on mobile mapper, needs to be transferred to correct format
w26	Menangina	30	5	N32 & 51 each shown twice
w27	Mt Gibson A	24	1	3 extra profile 3's marked as active
w28	Mt Gibson B	49	4	3 extra profile 3's marked as active
	Total	**525**	**27**	5.1% of all mounds monitored were active

6.3 Case Studies:

6.3.1 Mt Jackson (Cliffs Natural Resources Ltd) site has been expanded annually since 2004 so that it now totals 3,060 ha incorporating approximately 340 mounds (Figure 5).

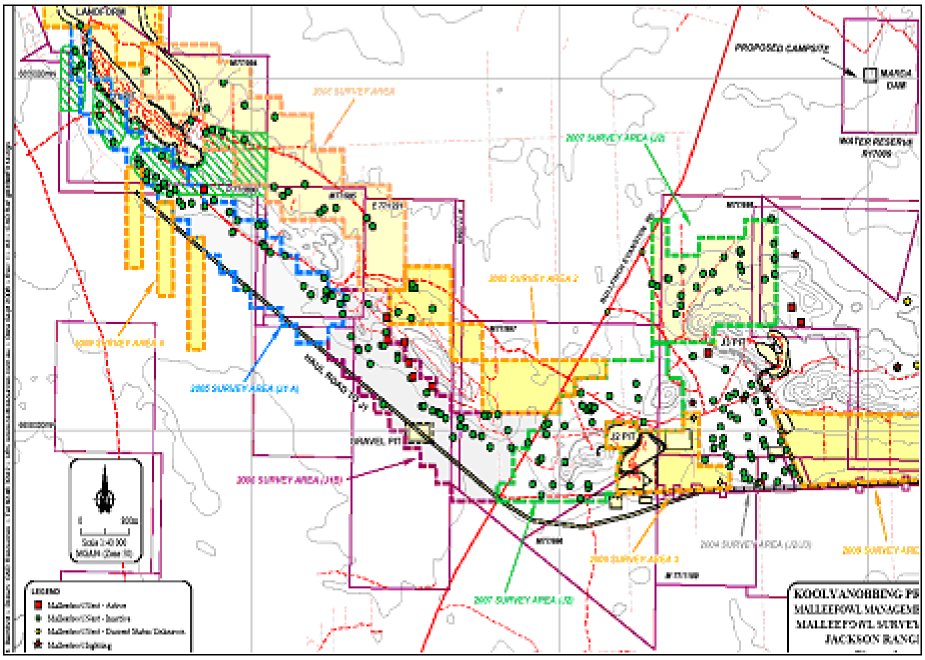


Figure 5: Mt Jackson Malleefowl survey sites showing mound locations.

6.3.2 Mt Gibson Station in partnership with the **Australian Wildlife Conservancy -** Mt Gibson station is situated approximately 70 km north east of Wubin on the Great Northern Highway in a 'mulga-eucalypt' habitat transitional line (refer Figure 4 - last site listed). It covers an area of 137,000 ha and has been purchased by the Australian Wildlife Conservancy (AWC) with the aim of establishing long term conservation projects for the area.

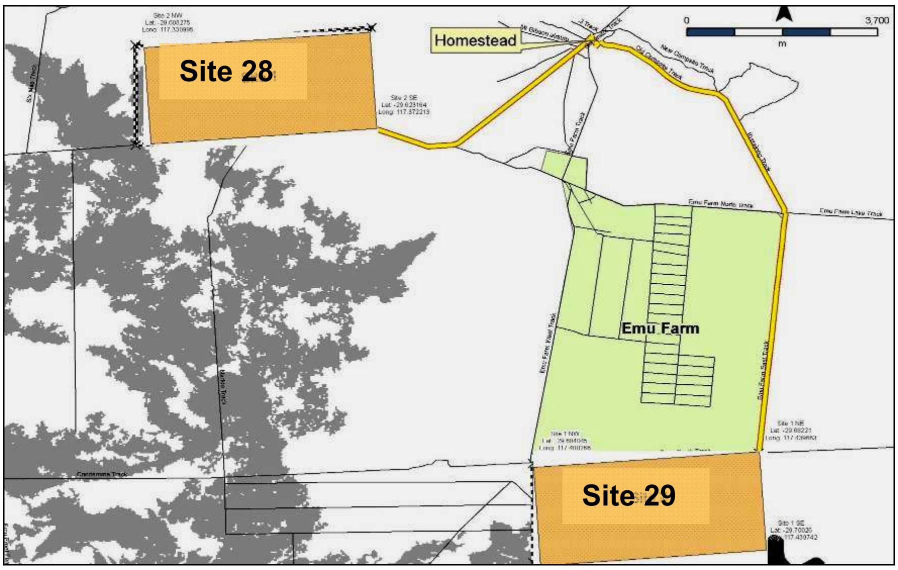


Figure 6: Mt Gibson Station survey sites and general area (map provided by Australian Wildlife Conservancy).

Two sites, 28 and 29, met with the MPG site selection criteria (Figure 6). Malleefowl mounds in site 28 appeared to be in the sandier Acacia/Casuarina habitat and not on the shallow soils over granite outcrops where as mounds in site 29 were evenly distributed throughout this area. Site 29 also supported extensive Malleefowl activity (recorded as GPS waypoint track locations in the report). As an example, a 100 metre walk along the northern Emu Farm fence boundary fence identified 34 Malleefowl tracks.

The final result from the survey (both sites) was:

- Total Area Surveyed 1330 ha
- Kilometres walked approximately 996 (sum of individual contributions)
- Total Mounds located 88
- Mound Activity 21 mounds supported recent activity
- 'Megamounds' 4
- Malleefowl tracks in excess of 400 GPS locations. Two birds were observed at site 29.

7. Information exchange

Given the long-term commitment of communities and volunteers towards the conservation of the Malleefowl, the need for volunteer acknowledgement and support through the MPG's *Malleefowl Matter* newsletter (Figure 7) has been identified as a key editorial objective. Produced tri-annually, this community based newsletter published its 52nd edition in March 2011 and has recently expanded to a 12 page full colour publication to incorporate more research and broader biodiversity editorials. With the loss of the Threatened Species Network (TSN) newsletter, 'Around the Mounds', an MPG recommendation has been made that consideration be given for the *Malleefowl Matter* publication to be formally adopted as the national newsletter inviting and encouraging input from all states.

MALLEEFOWL Preservation Group Inc.

Malleefowl Matter

Edition 49, March 2010

In this edition...

- The future direction for the MPG
- Monjebup corridor
- Active mound found in burnt bush
- Chingarrup fauna surveys
- Malleefowl Believers: the book coming soon

Malleefowl Preservation Group Inc.

'It's Gnow or Never'

Formed in 1992 to preserve malleefowl in their natural habitat in WA, the group conducts surveys, monitors nesting sites, sources funds for research, conducts awareness raising programs and provides support to its membership base of over 500.

Originating from the Shire of Gnowangerup (the Aboriginal name for the malleefowl) the group's philosophy is that malleefowl preservation is not just about saving malleefowl, it is about contributing to overall biodiversity conservation.

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Malleefowl Matter

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MPG documentary rates well

It started at a meeting in 2003, progressed to a road trip throughout country WA and culminated in the making of the documentary, 'Gnow or Never'.

The 30 minute film about the plight of the malleefowl and the formation of the Malleefowl Preservation Group aired on ABC1, Thursday 4th February this year, to great acclaim.

According to official ratings, 442,000 people watched the program nationally and it ranked 26th from a massive 393 programs rated between 2pm and 2am that day. It rated fourth out of 42 ABC1 programs during that period, coming in behind the news, the Seven Thirty report and 'Seven Ages of Rock' – the latter being only marginally ahead of 'Gnow or Never'.

Malleefowl with attitude! This photo was taken in the Little Desert, Victoria, by bird photographer Keith Hindley who watched the documentary and was one of many people who contacted the MPG expressing encouragement and support.

The chair of the MPG, Alan Dennings, described the documentary as a wonderful achievement for the group.

Claudine Deering, office manager for the MPG, said the response has been incredible. She has received about 150 emails and letters, since the program aired, resulting in tax-deductible donations, new memberships and about 30 DVDs being ordered.

The documentary was made over five years, on a shoe string budget. The patron of the MPG, John Williamson introduced and narrated the film.

To be published soon: The untold film interviews: Malleefowl Believers, Stories of the Malleefowl and its Champions. Read author and film maker, Frank Rijavec's account of the book's making on page 6.

The future direction for MPG

By MPG chairperson, Alan Dennings

A new direction and a new location are the outcomes from members' feedback to a questionnaire seeking preferred options for the future of the Malleefowl Preservation Group.

You will no doubt remember the process of reviewing the organisation's viability, its priorities and its operations presented to the 2009 AGM, which was followed by a questionnaire forwarded to all members inviting input. The 2009

continued on page 2

Malleefowl Preservation Group Inc

Figure 7: *Malleefowl Matter* Front Page, Issue 49, March 2010.

8. Reporting and Administration Processes:

The MPG currently employs the part time services of an office manager and newsletter editor to ensure that proper reporting and administration operations have been maintained. In addition, project reports and monthly reports are provided to the Executive Committee for guidance and recommendations.

9. Volunteer Involvement and Support

An estimated 100 volunteers support the Malleefowl Preservation Group each year and it is those individuals who provide the MPG workforce and motivation. Given that the group has unsuccessfully applied for volunteer support funding in the past, a proposal has recently been made for the group to establish a specific 'volunteer funds' account for this purpose.

10. Awareness and Education

10.1 Primary School Education – *Malleefowl Magic* Designed as a curriculum/outcome based education pack, *Malleefowl Magic* was developed in response to teachers' requests for Australian species education programs. It contains a 'big book', teachers' junior, middle and upper primary curriculum package and a DVD including ABC TV film documentary, Malleefowl calls and 'Ol Man Malleefowl' song. In 2000 *Malleefowl Magic* received the West Australian Dept of Education's recommended 'Sustainable Schools Project' approval status.

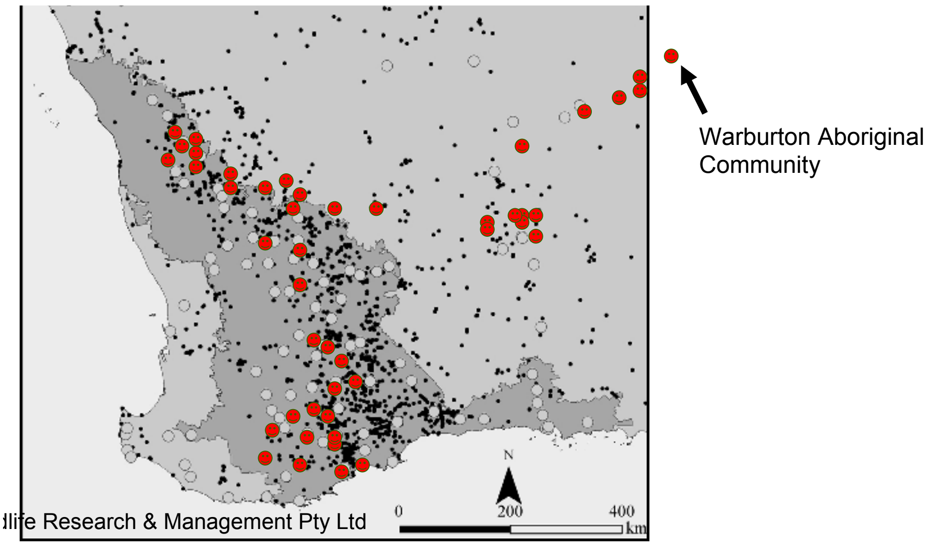

Figure 8: Malleefowl Sighting records (black dots) linked to the 2007-08 *Malleefowl Magic* education program school visits (red dots). *Map provided by B Parsons, Malleefowl Conservation – informed and integrated community action, 2008.*

To date 139 schools have received the *Malleefowl Magic* program. The road show was delivered to 6,212 students/ teachers across 4,600 kms to 51 schools in 2007/8 which included the Warburton, Mount Margaret and Cosmo Newbury Aboriginal communities in Central Australia (Figures 8 & 9).

Figure 9: Mt Margaret Community School students greeting 'Merve the Malleefowl'.

With the advent of a national education curriculum, it is important that *Malleefowl Magic* continues to meet the increasing demands of nature based education projects to ensure that new students and teachers coming up through the system are given an equal opportunity to have access to this education service.

10.2 The Making of a Film Documentary:

The MPG's story has recently been told in a half hour documentary, *'Gnow or Never'* introduced and narrated by the group's patron, John Williamson and broadcast by national ABC TV on three occasions, another four times in WA and also once Internationally.

In 2010, the group launched its first general reading publication, *Malleefowl Believers – Stories of the Malleefowl and its Champions'* based on the film research interviews that could not be incorporated in the half hour documentary. Both productions have served to raise the profile of the species, advertise the commitment of ordinary every day people and increase general public awareness.

The MPG has kept a record of feedback, particularly emails, as an acknowledgement to the volunteers and their patron, John Williamson's support.

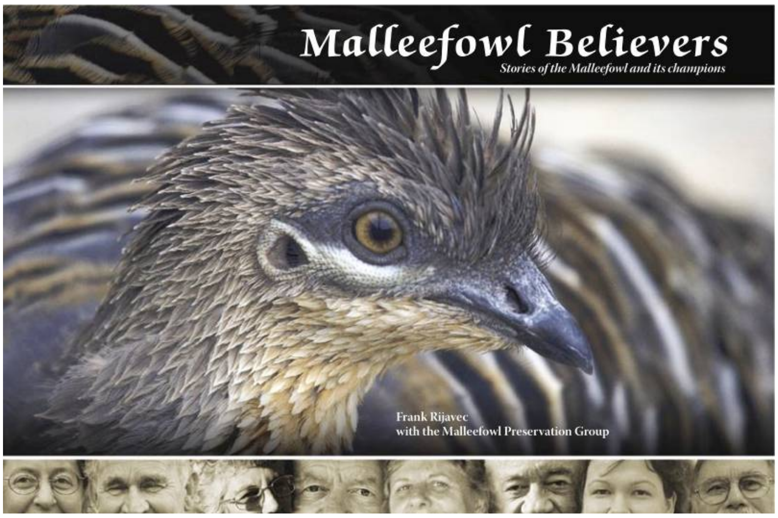

Figure 10: *Malleefowl Believers* publication front cover.

10.3 United Nations World Environmental Day Awards:

In June this year the Malleefowl Preservation Group was selected as one of three national finalists in the United Nations World Environment Day Community Group category award. Congratulations to all involved and justly deserved.

Figure11: United Nations World Environment finalist Award Certificate.

Conclusion

Community-owned Malleefowl conservation groups continue to lead by example and drive conservation programs, particularly in Western Australia. The cultural changes to 'sense of community' are, in many rural regions cause for concern for remaining residents resulting in a real sense of loss. In assessing those changes, we need to pursue new options for rural based Malleefowl conservation groups and understand the value and roles at various levels individual groups, government, corporate and national bodies have to play.

Community groups that have survived the rural decline in Australia ironically now have increased potential to 'fill the widening gap' through developing further partnerships. This will however, only be possible by organisations such as the MPG implementing their 2010-11 action plan to appoint a fully paid executive officer.

New options and new partnership opportunities are unfolding for the Malleefowl Preservation Group however they will require time to develop and a dedicated executive committee to manage those processes.

In presenting this paper to the 2011 National Malleefowl Forum to increase understanding of what drives community conservation, the Malleefowl Preservation Group looks forward to sharing its challenges, encouraging national support and assisting others to ensure a bright future for the Malleefowl and the uniquely Australian biodiversity it represents.

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11. New South Wales update

Peter Ewin, Regional Biodiversity Conservation Officer, NSW Office of Environment and Heritage, Department of Premier and Cabinet; Member National Malleefowl Recovery Team

Abstract

There have been a number of changes in the management of Malleefowl in NSW since the 2007 Forum in Katanning. As in the past, there continues to be relatively little volunteer effort in the monitoring and management of the species, though there has been an increase in 'off-park' management coordinated through Catchment Management Authorities (CMAs). Some programs have continued (fox-baiting, fire management, habitat management) although some, such as monitoring, are in a modified form. Other programs, however, have not continued (Fox TAP, Captive Breeding). The increased habitat management on freehold and leasehold land outside the National Park estate is a major change since the previous Forum, as has been the increase in the use of remote cameras in monitoring of mounds. Future recovery actions are currently being reviewed, a modified monitoring methodology is being considered and it is hoped that the increased involvement of CMAs in Malleefowl management will continue.

Past and Current Programs

At the previous Malleefowl Forum in Katanning Western Australia, I presented a paper on Malleefowl management in New South Wales. At the time it was noted that there was little coordinated volunteer work and that most of the management actions were being implemented by NSW government agencies, chiefly the then Department of Environment and Climate Change (now the Office of Environment and Heritage (OEH)). Many of the programs were undertaken on OEH estate (National Parks and Nature Reserves), with the main programs summarised as:

- Fox-baiting and monitoring
- Aerial survey
- Captive breeding/release of chicks
- Habitat (including Fire) Management

Over the period since the last Forum there have been a number of changes in the management of the species in NSW. Some programs have continued (fox baiting, fire management, habitat management) although some, such as monitoring, are in a modified form. Other programs, however, have not continued (Fox Threat Abatement Plan, captive breeding). There has also been an increase in management for the species outside the reserve system ('off-park'), chiefly coordinated through various Catchment Management Authorities (CMAs). Figure 1 shows the boundaries of the CMAs that have been involved in Malleefowl management, as well as showing the location of OEH reserves where Malleefowl have been recorded. Other locations discussed in this paper are also shown on the map.

<u>Fox Baiting and Monitoring</u>
Fox baiting has been ongoing in many reserves since the 1980s and data collation on baiting effort has been collated since the 1990s. In 2001 the Fox Threat Abatement Plan (Fox TAP) was developed with the objectives of ensuring fox control programs were targeted at the threatened species that were most likely impacted by foxes (including Malleefowl) and putting in place a program where the effectiveness was maximised but could also be measured. Funding was available through Fox TAP for intensive baiting, monitoring of fox numbers and monitoring for selected threatened species. Six priority sites for Malleefowl were selected in NSW with all of these except one having programs undertaken between 2005 and 2009.

Most baiting is ground-based and occurs up to four times per year, though aerial baiting is also undertaken at Yathong Nature Reserve (NR). Baiting programs have been hampered in the last year, chiefly due to poor access as a result of high rainfall. There has also been an increase in baiting effort on private (both freehold and leasehold) lands, coordinated by both CMAs and OEH. A baiting program within Goonoo National Park (NP) and adjoining private land has been cooperatively organised by the Dubbo Area of OEH and Central West CMA. Trained OEH staff also undertake aerial control of feral animals, particularly goats and pigs, and if time permits, foxes and cats are also targeted during these operations.

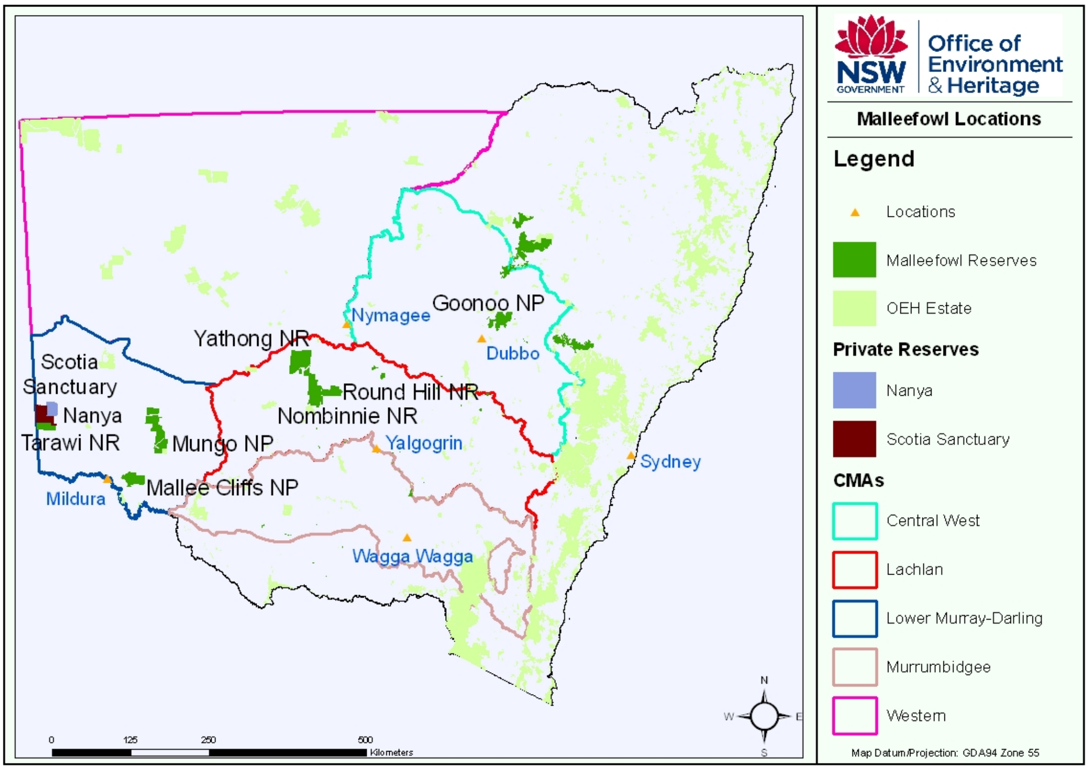

Figure 1: Map showing locations and reserves listed in this paper and highlighting OEH reserves where Malleefowl have been recorded and Catchment Management Authorities where management has been undertaken.

There are a number of ways that fox numbers are monitored, including bait take (most areas where baiting is undertaken); sand pads (Tarawi NR and Nanya – a property owned by the University of Ballarat and managed for conservation and research); spotlighting (Mallee Cliffs and Mungo NPs) and, more recently, with remote cameras (Nanya). Some of the interesting results of this monitoring include:

- an apparent increase in movements of foxes from areas that haven't been baited into areas where they have been poisoned, leading to sand pads showing an increase in fox activity; and
- remote cameras on Nanya showing that the use of sand pads alone may underestimate the number of predators present, particularly cats.

There are currently trials on Tarawi NR and the Australian Wildlife Conservancy's (AWC) Scotia Sanctuary using M44 Ejectors to poison foxes. This system requires sufficient upward force to trigger the ejector, which then injects the dose of poison directly into the mouth of the fox. This trial is attempting to minimise the chance of non-target species, such as ravens and goannas, being poisoned during baiting programs and also to reduce the habit of some foxes caching baits without being poisoned. The ejectors are being trialled around active mounds and in some cases remote cameras are being used to monitor the mound to observe the interactions of animals around the bait station.

Monitoring

Unlike the other states, NSW has only a small number of Malleefowl grids and none of these have been fully resurveyed since they were established. Where grids have been monitored, they have usually been part of aerial surveys, such as in Mallee Cliffs NP. The Fox TAP program funded these surveys and both transect and mound-to-mound methods were used. Although a final report for Fox TAP has not been prepared, the preliminary analysis of the data collected from Mallee Cliffs NP showed a general increase in the number of active mounds over the survey period. The final aerial transect surveys were undertaken in 2008, though some mound-to-mound survey has occurred since, particularly in Yathong NR.

As a central source of funding is no longer available to cover the large costs of aerial survey, it is unclear how long this method of monitoring will be continued. For example, in 2009 Lachlan CMA provided half the funds for Cobar Area of OEH to undertake surveys and this CMA has also undertaken extensive aerial and ground surveys on private lands which has greatly increased the knowledge of Malleefowl breeding activity within central NSW. There continues to be some resistance from landholders to this data being made available to the National Database, but it is hoped in the future that the importance and benefits of the monitoring will be understood and the results will be transferred.

Due to the lack of funding for aerial surveys, the Lower Darling Area of OEH has implemented an abbreviated form of monitoring for the 2010 season. The activity status of the 25 historically most active mounds of the 149 previously monitored within Mallee Cliffs NP was inspected, in an attempt to identify breeding trends from a substantially smaller dataset. Mounds were widely scattered across the reserve and visited by OEH staff on foot in mid October. The 2010 monitoring found ten of the 25 mounds to be active which the long term data (20+ years) shows to be an above average year although not an exceptional year, such as in 2005 (fifteen of these 25 active) or 2006 (fourteen active). It is anticipated that this method will form the basis of the Malleefowl monitoring in Mallee Cliffs NP for the foreseeable future. All known mounds within Goonoo NP were also revisited during the last breeding season and this will continue in the future.

More recently there has been an increase in the monitoring of Malleefowl mounds at both Scotia Sanctuary and Nanya. AWC has used volunteers from the Victorian Malleefowl Recovery Group (VMRG), Bendigo TAFE and Mildura High School to survey for mounds. Once a mound is detected, AWC monitors the activity in spring. There was a large increase in known mounds on Scotia Sanctuary due to the efforts of the VMRG in 2010 (an increase from four to 22 known mounds) and more mounds are likely to be discovered because large areas of the reserve remain inadequately surveyed. Similarly, the University of Ballarat has surveyed approximately 1200 hectares of the high quality habitat on Nanya and have located 35 mounds. These mounds have been monitored for activity in spring. The University of Ballarat has also been in contact with the VMRG regarding monitoring. The low density of mounds on both properties means that it is unlikely that a traditional Malleefowl grid would be used to monitor breeding activity, with staff aiming to visit the currently known and any additional mounds discovered, but it is hoped that the data collected could still be incorporated into the National Database.

As noted above, there has been an increase in the use of remote motion-detecting cameras as part of Malleefowl management in NSW. For example, Western CMA have deployed eighteen cameras (increasing to 28 in the future) across a property, resulting in images of foxes, goats, kangaroos, pigs, pigeons, and one Malleefowl which was 4.5km from the nearest known mound. Table 1 details the 6250 images captured at an active mound over a six week period in February and March 2011 on the same property. Photographs of courtship behaviour between a pair of birds and interactions between Malleefowl and foxes have been taken. Figure 2 shows a picture of a fox patiently waiting while the bird works the mound and then, 20 minutes later once the bird has departed, digging up the mound, though it is unclear whether it is after eggs or hatchlings. The University of Ballarat has obtained similar images showing interactions between foxes and Malleefowl on a mound with a remote camera on Nanya. More encouragingly, OEH has remote cameras on three mounds in Goonoo NP and these have taken over 60000 photographs and although these have yet to be fully analysed, no photographs of foxes have been taken at any of these sites. A Masters student, Annette Brown, also undertook a project to determine the best camera monitoring setup on the mounds.

Table 1: Number and percentage of photographs taken using remote cameras located at mounds at Western CMA Incentive PVP Reserve in six weeks. *2313 (39.5%) of these photographs included two birds. (Data courtesy of Western CMA).

Species	No. of Images	Percentage
Malleefowl*	5853	93.6
Fox	216	3.5
Goat	48	0.8
Pig	9	0.1
Kangaroo	3	0.0
Nil	119	1.9
Unidentified	2	0.0
Total	**6250**	**100**

Captive Breeding

A population of Malleefowl has been maintained at Taronga Western Plain Zoo (TWPZ) at Dubbo since 1988, with the progeny of these birds used for release programs. This population was sourced from Yalgogrin and has numbered up to sixteen pairs of birds. The current population is seven males and five females, with another two birds located at Taronga Zoo in Sydney. Over 500 semi-adult birds have been released at Yathong, Nombinnie and Round Hill NRs. However, the release program is currently suspended with no releases since the 2007 Forum. Due to the unlikelihood of the release program continuing, the maintenance of a captive population for release is not currently a priority for the Taronga Conservation Society Australia and they are planning to distribute the Malleefowl held at TWPZ to other zoos and associated stakeholders who would benefit from acquiring birds.

There continues to be interest, particularly from landholders, for the release of captive-bred birds. While this remains in the National Recovery Plan, OEH would support the resumption of this program if funding was sourced independently. OEH has reviewed its Translocation Policy and has developed draft Procedures to be used in translocation programs. Any release program for Malleefowl would require the appropriate licences and the preparation of a Translocation Proposal detailing such issues as translocation procedure, ecological impacts, research requirements and monitoring of the released population. Although this policy is yet to be finalised it has been implemented as part of the release of captive-bred Bridled Nailtail Wallabies at Scotia Sanctuary. The dispersal of the captive population from TWPZ may make the sourcing of birds for release as part of a translocation more difficult in the future. The release of the progeny of these NSW birds to other states may also be dependant on the outcomes of the studies of the genetics of the Malleefowl population presented elsewhere at this Forum.

Fire Management

Fire management within OEH reserves is ongoing and has the duel aims of preventing large wildfires burning entire reserves and creating different age classes to ensure at least some suitable habitat is available at any one time. The Mallee Fire and Biodiversity Project and other research projects are providing information that is being incorporated into fire planning. Fire management on private land remains difficult and is chiefly aimed at suppression, though planning is coordinated by the Rural Fire Service. Landholders hold concerns for this year being a significant fire season following the above average rainfall of the last twelve to eighteen months. The increased number of observations of birds in some locations (such the Pooncarie-Ivanhoe Road, Nanya and Round Hill NR) and evidence of increased breeding activity, including second clutches, that has been noted by landholders may be due to this rainfall.

Figure 2: Photographs taken using remote camera showing fox waiting while Malleefowl on mound and then digging mound 20 minutes later after bird has departed. (Photographs courtesy of Western CMA).

Habitat Management

The introduction of the *Native Vegetation Act 2003* and associated *Native Vegetation Regulation 2005* has meant that broad scale vegetation clearance, including Malleefowl habitat, has significantly decreased in NSW with clearing only permitted if it improves or maintains environmental outcomes. This legislation allows the development of Property Vegetation Plans (PVPs) which are legally binding agreements negotiated between landholders and the local CMA. There are a number of different reasons to develop a PVP including:

- Clearing – for clearing of native vegetation other than invasive native scrub there is a requirement for another area to be set aside as an offset and managed so that environmental outcomes are improved or maintained.

- Incentive – if a landholder wants to manage their land in a more sustainable manner, they can obtain incentive payments from the CMA to undertake such actions as sustainable grazing or goat control. An incentive PVP or agreement is required to obtain this funding. This can extend as far as the landholder managing his land for conservation, rather than primary production, with such actions as stock exclusion, management of introduced predators and herbivores and water point closure. This latter incentive program is called a Conservation PVP.

Within the Lower Murray Darling CMA area in south western NSW there is currently 4750 hectares of Malleefowl habitat protected in offsets for Clearing PVPs and 36000 hectares within incentive agreements and PVPs. At least 16000 hectares of the latter area is managed purely for conservation purposes. This is in addition to the 51000 hectares of Malleefowl habitat that was already managed for conservation including OEH reserves and existing clearing offsets in the same area in 1997.

Feral goat management, through the use of goat traps, mustering and shooting, on both reserves (by OEH) and private lands (coordinated by CMAs and Livestock Health and Pest Authorities) also contributes to Malleefowl habitat quality by reducing total grazing pressure and is one of the main habitat management actions within the Lachlan CMA area.

Future Activities

It is hoped that many of the management actions currently being undertaken for Malleefowl in NSW will continue to be implemented into the future. The following paragraphs discuss a number of the activities that are changing the way the species may be managed in the future.

In 2007 OEH developed the NSW Threatened Species Priorities Action Statement (PAS) which provided an integrated approach to species recovery and threat abatement. One of the outcomes of the PAS was that the development of a Recovery Plan for each threatened species was no longer mandatory, though the PAS actions for Malleefowl were closely tied to the National Recovery Plan. Given the large number of species listed as threatened in NSW, there is currently a review underway (PAS2) to categorise each of these (mainly between site-based or landscape-scale management actions) and to then develop and fully cost recovery actions to be undertaken. The Malleefowl has been classified in a relatively small group of Iconic Species which are ‘flagship’ species that the community has higher expectations for recovery to be achieved. As part of the review, actions linked to those in the National Recovery Plan are likely be costed and there is an increased likelihood that these will be funded in the future. This review is currently underway in a phased process and the first PAS2 document is due for public exhibition in mid 2012.

The abbreviated mound survey discussed above may be less statistically robust than the aerial survey previously used but is still useful in determining long term trends in mound activity. It is possible that this form of monitoring could be used in other areas where volunteer numbers are low and where a reasonable number of accessible mounds is known or can be located. This method will be continued at Mallee Cliffs NP where there is a long history on the activity of its mounds, but could be the standard method used at a number of other locations including Scotia Sanctuary, Nanya, Goonoo NP and private land around Nymagee. There are also a number of leasehold properties in south western NSW that have known Malleefowl mounds and there is potential to involve the landholders, possibly through the CMA, in the collection of data on breeding activity on these mounds annually. Some initial survey may be required to add to the number of mounds for annual survey (particularly on Scotia Sanctuary and on private land) but if this is not possible, then current known mounds would be a start. The other crucial element is ensuring the data is suitable and can be entered into the National Database. For example, the mounds surveyed this year at Goonoo NP have been assessed using the Monitoring Guidelines, but it may be necessary to modify the type of data collected at other sites. If this data cannot be entered into the National Database then a centralised repository in NSW should be considered to ensure this data is not lost in the future.

The initial results from the use of remote cameras are encouraging but the role of this technology in ongoing management may need clarification. While the photographs of birds obtained from the cameras located on mounds may provide interesting information on behaviour, it is the potential to capture data on the management of the species, particularly information on foxes and goats that may prove the most beneficial in the long term. Information on bait take, and prey and herbivore abundance before and after management actions (particularly if individual animals such as cats can be identified) could be collected through the use of cameras. Information obtained could also guide the location of targeted management in the future. If, for example, the Goonoo results of no foxes in 60000 photos on three mounds are correct, then this is evidence that fox control in this reserve (and surrounding properties) is successful. Trials varying baiting rates could be undertaken with cameras used to assist in the assessment of the impacts or parts of the reserve could be targeted for additional baiting if foxes are found to have re-entered these areas.

One of the major changes in management of Malleefowl in NSW since the Forum in 2007 is the increased CMA role. This has included funding of programs, habitat management, research, monitoring and community liaison. It is hoped that this interaction will continue, and there is potential for some CMAs to increase their activities targeted at threatened species in general and Malleefowl in particular. There is potential for greater interaction with the National Recovery Team, and it may be through this process that a community representative for NSW can be added to the team. There is also scope, through such projects as the Lachlan CMA monitoring program, to increase the role of landholders in the ongoing management and monitoring of Malleefowl outside the reserve system. This would assist to fill an area which is probably the largest gap in knowledge of the species in NSW.

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Additional thanks are given to Western CMA for the use of camera images and data within this paper.

12. Malleefowl Conservation Action in Victoria 2007 – 2011

Peter Stokie, A/President, Victorian Malleefowl Recovery Group; Member National Malleefowl Recovery Team

Abstract

In Victoria, Malleefowl almost exclusively live in large public National Parks and Reserves and are managed by Parks Victoria and The Department of Sustainability and Environment (DSE) through policy development and on ground actions including fire regimes and predator/ competitor control.

Since 2000 the Victorian Malleefowl Recovery Group manage and carry out all monitoring of Malleefowl in 35 sites in all places where Malleefowl exist, and since 2004 have also re-searched or established the majority of these sites. Community groups and individuals have been actively involved in these searches. There are a few unrepresented areas in the monitoring program especially in the Little Desert and the Western Big Desert that the VMRG are addressing.

The Wedderburn Conservation Management Network has organised extensive rehabilitation programs to protect Malleefowl in Victoria's most isolated remnant in the Wychitella NCR.

The VMRG organise annual training of monitors to carry out the monitoring and re-searching activities. The group has supported the PhD Genetics Research Project through participation in field activities. The VMRG produced and distributed the National Malleefowl Monitoring Manual and a Malleefowl Education Kit for grades 5/6 with great success. Actions to protect Malleefowl habitat from inappropriate development have been pursued.

Planning and cooperative activities between Victoria/SA have developed significantly since 2004, and with the establishment of Habitat 141 this will be enhanced.

There are challenges for this forum and for Victoria to devise ways to maintain volunteer effort, address inappropriate fire regimes, to refine and improve the National Monitoring Manual, and to effectively use the National Malleefowl Database.

1 *Introduction*

In the four years since the last forum, activities in Victoria have concentrated on annual data collection of Malleefowl breeding density and maintenance of existing sites by systematic on ground searches in several locations. I will report on these activities in detail throughout the paper.

The Victorian Report at Katanning (2007) raised several goals for the management and conservation of Malleefowl in our state, namely that:

- The Little Desert will be a priority to establish monitoring sites
- Adaptive Management strategies will be encouraged
- Education will be an increasing priority for the VMRG
- Support for the National system and monitoring will continue
- Interaction with the National Database will be a priority

In this paper I will report on the recent Victorian activities and also outline the progress that has been made on some of the challenging goals since Katanning.

2 *Location of Malleefowl Monitoring Sites in Victoria*

The Victorian Malleefowl Recovery Group is responsible for collecting all data from monitoring sites in Victoria. Malleefowl are found almost exclusively in the National Parks of northwest and central west Victoria and in smaller Conservation Reserves close to these National Parks. The majority of the monitoring sites (30 sites in total) are situated in these parks and reserves, with an additional four sites in a small isolated remnant patch of habitat in the Wychitella Nature Conservation Reserve in central Victoria near Wedderburn.

A satellite image of Victoria showing the location of monitoring sites is presented in Figure 1. The map shows that the major national parks of Murray Sunset, Hattah Kulkyne and eastern Wyperfeld are well represented with monitoring sites, but there are gaps in areas of the Western Big Desert and the Little Desert where suitable habitat is less common. Since 2007, two additional monitoring sites have been added to the existing sites, one in the Little Desert and one in the Southern Western Big Desert. However there are still some additional gaps where we would like to install new sites to ensure adequate geographical coverage is achieved.

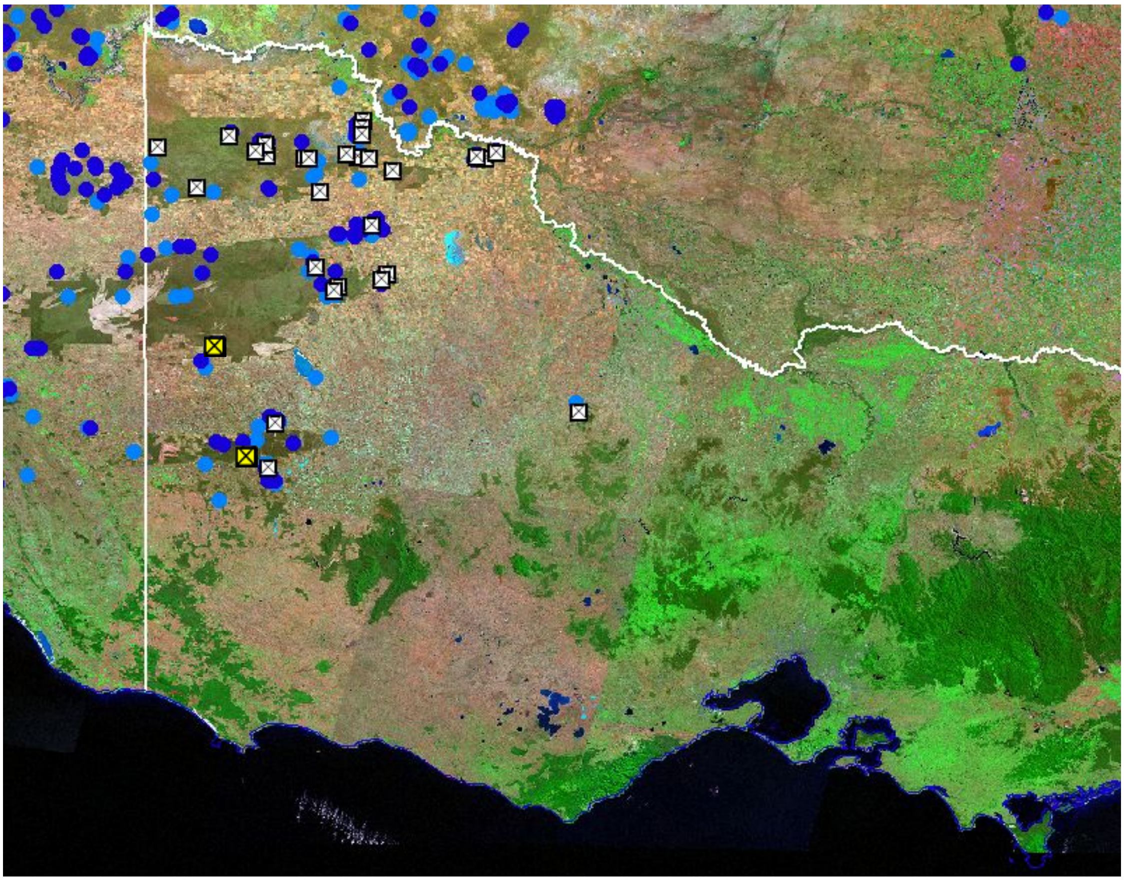

Figure 1: Satellite image of western Victoria showing the location of Malleefowl monitoring sites (crossed squares: white= established before 2007; yellow= established since 2007). Historical sightings of Malleefowl are also shown for the periods 1992-99 (light blue circles), and 2005-05 (dark blue circles).

3 *Monitoring results from Victorian sites since 2007*

Members of the VMRG conduct systematic and thorough data collection at all 34 monitoring sites to assess breeding density of Malleefowl in each of the sites. Monitoring of sites to determine breeding numbers remains the major role of the VMRG, and national standards are rigorously maintained by the group.

Following attendance at an annual Training Weekend and AGM held in Wyperfeld National Park, teams of two to four people visit all mounds in each site over a few days between mid October and late December. Data are collected on data loggers (Magellan/Ashtech Mobilemappers), mounds are photographed, and then data and photos are downloaded onto the National Malleefowl database.

The following data is extracted from the National Database and the annual Malleefowl Monitoring in Victoria reports from 2007 to 2011. *(The full reports can be accessed from the VMRG website at www.malleefowlvictoria.org.au).*

Table 1: Data from 2006/07 to 2010/11 showing the number of sites, mounds inspected; the increase or decrease in mounds found/monitored; the percentage of mounds visited and the number of active mounds in total across all sites, per year.

Year	Number of sites	Mounds inspected	Increase/ Decrease mounds	% of mounds visited	Active total all sites
2006/07	29	1043		99.0%	90
2007/08	32	1170	+127	99.7%	75
2008/09	34	1169	-1	99.6%	131
2009/10	34	1164	-5	99.4%	110
2010/11	34	1213	+49	99.3%	136

Notes on Breeding Density Numbers 2007 – 2011
Five new sites have been added to the annual monitoring effort:

- *1 site in the locality of southern Wyperfeld National Park (five to six active mounds annually)*
- *1 site in the southern Big Desert Wilderness Park (one active mound annually)*
- *1 site in the Little Desert National Park (one active mound annually)*
- *2 sites in Wychitella Nature Conservation Reserve (one to two active mounds annually)*

The last three years (2008/09 to 2010/11) indicate a significant increase in Malleefowl breeding numbers coinciding with improved annual and winter rainfall, and the end of a ten year period of drought conditions (Benshemesh 2009). The additional 5 monitoring sites added only a few extra active mounds to the total count as shown in Figures 2 and 3 that indicate a marginal impact on the total number of active mounds (Benshemesh 2010). Other explanations for the increase need to be explored through further research as part of an adaptive management project.

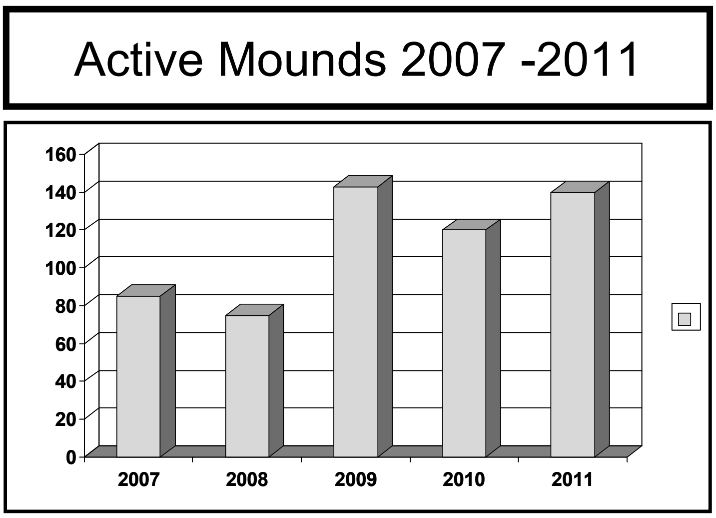

Figure 2: Active mounds at all sites including new sites 2007- 2011.

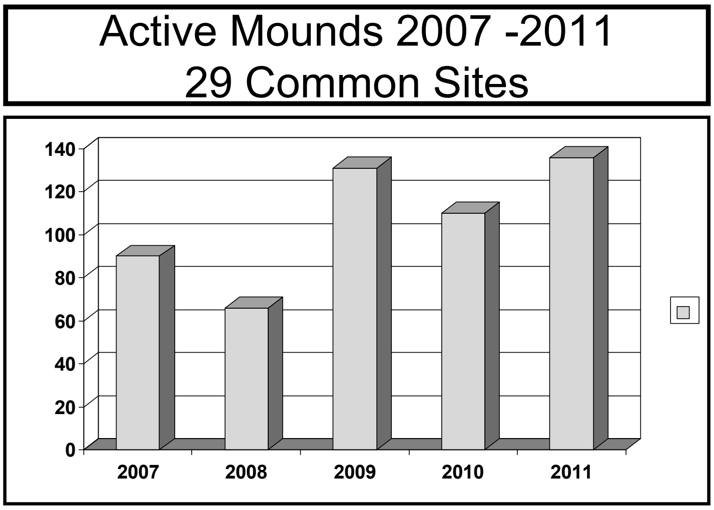

Figure 3: Active mounds at 29 common sites for all years, excludes new sites 2007 – 2011.

Despite the improved breeding numbers over the last three years, numbers have not returned to the pre drought years of 1994/95.

Data has been collected from 22 set sites (Figure 4) since long-term monitoring commenced. In this period all mounds within each site have been visited annually during the breeding

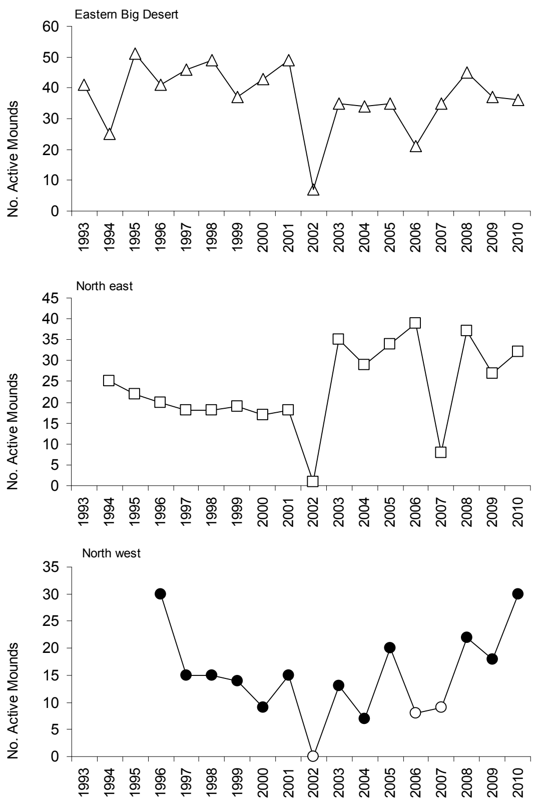

Figure 4: Trends in Malleefowl breeding numbers at 22 set sites over the past 15-19 years: Eastern Big Desert comprise 6 sites over 18 years (triangles);North East comprise 4 sites over 17 years (shaded squares): North West comprise 12 sites over 15 years (solid circles). White shapes indicate major drought years (1994/5, 2002/3, and 2006/7). Data from the annual Malleefowl Monitoring in Victoria report (Benshemesh 2011).

season. The sites have been grouped into convenient regional clusters to assist in assessing breeding trends. The sites in the Eastern Big Desert have 18 years of continuous data. Sites in the North East have 17 years of continuous data. Sites in the North West have 15 years of continuous data.

Data for the past four years show a general increase in breeding numbers in each of these three regions, but there are considerable variations between regions. The 2010/11 breeding numbers are encouraging as Malleefowl appear to have returned to historic numbers in Murray Sunset National Park in the north west, and stabilized in other Parks and Reserves (Benshemesh 2011). It is intriguing to speculate why birds in the Murray Sunset NP have almost doubled in breeding this season whereas a similar increase has not occurred in other places despite similar climatic conditions. It is a classic case of "the more you know about Malleefowl, the less you know at the same time". The active mounds in each of the regions are presented in Figure 4.

4. *Search/Survey results from Victorian sites since 2007*

Following recommendations arising out of the 2004 National Forum in Mildura that all sites needed to be re-searched/re-surveyed every five to ten years, the VMRG initiated a series of site searches between 2004 and 2007. A total of thirteen existing sites *(v01, v02, v04, v05, v09, v11, v12, v13, v16, v19, v20, v21 and v23*) and seven new sites *(v26, v27, v28, v29, v30 v31 and v32)* were targeted for complete searches to find all existing and new mounds within these sites, representing 80 square kilometres and a large investment of volunteer hours.

Between 2007 and 2011 an additional four established sites *(v03, v07, v08 and v14)* have been searched and five new sites *(v33, v34, v35, v36 and v37)* established, representing 25 square kilometres.

There are now only six sites *(v10, v15, v17, v18, v22 and v24)* still to be searched, according to the 2004 plan. If these can be managed within the next three years then all Victorian sites will have either been re-searched or recently established in the ten year cycle from 2004 to 2013.

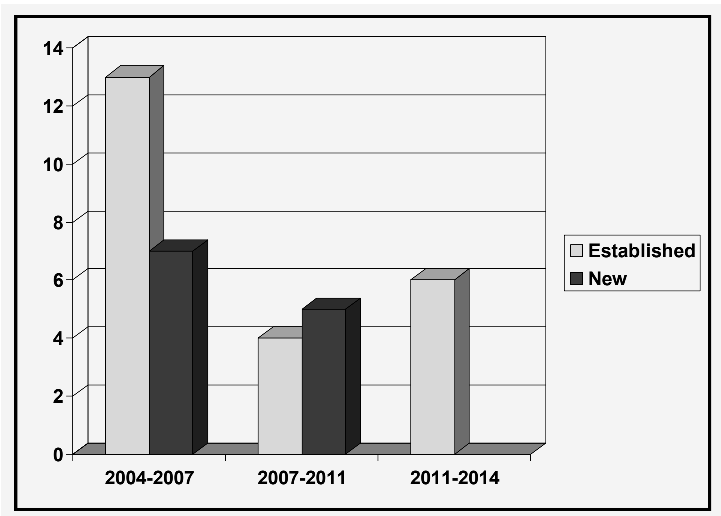

Figure 5: Numbers of sites searched and established 2004 – 2011, and six sites planned to be searched between 2011 – 2014.

As the Little Desert was a priority area in the previous four years, the VMRG has identified five or six previously unsearched areas where it is likely that Malleefowl may be present. We have established a new site in the vicinity of Broughton's Track, and have searched an area in the Cooack locality in the southern section of the Little Desert. Several mounds, both old and active, were recorded at the long unburnt Broughton's site in the heart of the Little Desert. However, at the Cooack site, we were unable to locate any mounds of any type in approximately 150 hectares of apparently suitable habitat, suggesting that Malleefowl have not bred at the site for many decades, if indeed ever. There have been several extensive wildfires in this general locality in the past fifteen years, some of which have burnt known Malleefowl habitats, but it would seem the area we searched was not suitable as a refuge for birds following these fires. The work in the Little Desert will still be a priority in the next four years as the group move to search other appropriate areas.

Since 2007 many community groups, most that had little or no experience of Malleefowl conservation, have participated in the site searches organised by the VMRG. These include Kindergarten parents groups, Landcare groups including the Victorian Mobile Landcare Group, an SES group, a local Lions Club, conservation groups including the Mid Murray Field Naturalists, Friends of the Simpson Desert and Wedderburn Conservation Management Network and the Bendigo TAFE College. We estimate that during the past four years (2007 – 2011) at least three hundred and twenty people were involved.

Re-searching the monitoring sites has been an important achievement of the VMRG, and has provided us with updated mound lists that will ensure that our monitoring of breeding numbers remains accurate. But it has been a big effort and it needs to be assessed whether the VMRG will be in a position to maintain the level of coordination and effort required to sustain the next ten year cycle of revisiting all of the 34 Victorian monitoring sites without the continued support of other community groups and more support from government departments. To that end, I submit the following recommendation for consideration:

- **Recommendation: A meeting of Parks Victoria, DSE, relevant CMA's and VMRG needs to be convened to determine a sustainable strategy for site re-searches. Once established, the group should meet annually to discuss continuing strategies and other matters relevant to Malleefowl Conservation in Victoria**

5. *National Malleefowl monitoring, population assessment (breeding density) Project*

At the 2007 National Forum, the National Manual for the Malleefowl Monitoring System was launched, and since then has been widely distributed to existing groups in Western Australia, South Australia, and Victoria. The manual was a collective effort by Malleefowl monitoring volunteers across Australia, and was produced by the VMRG. It is used as the standard for Malleefowl monitoring and is extensively referred to at various training sessions across the range of the species. It has been gratifying to have been contacted by biodiversity officers who are interested in monitoring Malleefowl throughout the Malleefowl's range, such as most recently from those working in reserves such as Goonoo National Park and Tollingo State Reserve in NSW.

As with all manuals, systems and processes are constantly developing and the inaugural manual is desperately in need of review and republishing. I submit a recommendation to address the requirements for a new edition of the manual:

- **Recommendation: funding and resources be made available for a review of the National Malleefowl Monitoring Manual to create Version 2, and to devise a mechanism to update the manual on a regular basis.**

The final aspect of the National Malleefowl project was to produce an education package for schools. The Malleefowl Education Kit for Upper Primary School Students was launched on Threatened Species Day in September 2007, and distributed to more than 80 primary schools in the Mallee and Wimmera regions of Victoria. The designer, Mr. Tim Byrne, used the Victorian Curriculum Frameworks and Essential Learning Standards to ensure the educational value of the content of the kit. The kit provides detailed teachers' notes and twenty-four Student Activity sheets as well as detailed suggestions for teachers to develop additional units of work. As education was one of the priorities of the VMRG, the success of the Educational Kit uptake was pleasing. Another initiative is the revamp of the VMRG web page at www.malleefowlvictoria.org.au , as well as actively seeking opportunities to be guest speakers at various conservation and service club groups.

6. *Other initiatives*

Several other initiatives by the VMRG have been featured over the past four years - I will only briefly refer to them here, as many of them are represented as papers and/or poster presentations in other parts of this forum:

- **Little Desert Track Search** – the VMRG organised and conducted systematic searches of the more than 800 kilometres of public and maintenance tracks in the Little Desert. Sandy tracks were driven and walked to locate suitable Malleefowl habitat over two weekends in 2009 and2011
- **Wedderburn Conservation Management Network** has carried out extensive revegetation and pest eradication to improve the conditions for Malleefowl in Victoria's most isolated remnant of habitat for Malleefowl at the Wychitella Nature Conservation Reserve.
- **Genetics PhD Project** – the VMRG has routinely collected feathers and Malleefowl scats during monitoring over a number of years, and these collections have been used by Taneal Cope in her genetics project. The VMRG volunteers have also supported Taneal in the field, most recently at a three day excursion to Wandown Flora and Fauna Reserve in February 2011, where all active mounds were visited daily to collect feathers.
- **Fox Scat Analysis** – The VMRG routinely collect all fox scats that occur on mounds in the monitoring program. These scats are used by Peter Sandell (Parks Victoria) and analysed to provide information on the diet of foxes in mallee parks. The scats from 2006 to 2011 are currently being analysed and a report will be available early next year
- **Trust for Nature Covenants** – A 650 hectare farm block, Mali Dunes, on the edge of the southern Big Desert is in the process of being extensively re-vegetated with appropriate mallee habitat to encourage Malleefowl onto the property and to become part of an extensive corridor linking the Big Desert and the Little Desert
- **Iluka** – The VMRG attended the Environment Effects Statement panel hearings for the Murray Basin Stage 2 Sand Mine proposals in 2008 to argue that significant offsets for Malleefowl needed to be provided if the mine was to proceed. Following the hearing the Victorian and Commonwealth governments made determinations that, in addition to routine offsets required for habitat and threatened species disturbance, a fund of $700,000 should be established for Malleefowl conservation to be managed by a committee made up of representatives from Iluka, Victorian Malleefowl Recovery Group (VMRG) , National Malleefowl Recovery Team (MNRT), Parks Victoria (PV), Department of Sustainability and Environment (DSE) and Department of Sustainability, Environment, Water, Population and Communities (DSEWPC).
- **National Malleefowl Monitoring Database** – VMRG are actively involved in shaping and testing the new online database for Malleefowl monitoring, especially in regard to volunteer needs and in advising how the database might help groups coordinate and manage activities and volunteers.

7. *Concluding Remarks*

Many positive conservation and management initiatives have been achieved in the past four years

- The monitoring, establishing and re-searching Malleefowl sites has comprised the 'core businesses' of the VMRG and has been very successfully accomplished due to a high level of volunteer involvement;
- Long term scientific data analysis continues to be a feature of Annual Victorian Monitoring Reports;

- Public lands continue to be a stronghold for Malleefowl with stable numbers during this period;
- Links between Victorian and South Australian organisations working on Malleefowl conservation are developing where common actions are possible.

There are areas for improvement which will need to be addressed in the next three years

- There are obvious gaps in knowledge of Malleefowl in remote places in the Little Desert and in the Western Big Desert;
- Little is known about Malleefowl in areas of private land and management strategies need to be developed for these areas;
- Co-operation between stakeholders is positive but needs to be strengthened.

In the next three to four years the VMRG will work towards achieving the following goals:

- Maintaining the existing level of monitoring to the current high standard, and extending the monitoring effort into under-represented areas;
- Investigating the population distribution of Malleefowl in the Little Desert through targeted track searches;
- Extending track searches into the Big Desert and monitoring suitable Malleefowl habitat by targeted track searches and the establishment of at least one additional monitoring site;
- Extending the integration of government bodies and the VMRG and other volunteer groups working on Malleefowl policy and management actions;
- Expand the cross-border activities in Malleefowl conservation between South Australian and Victorian groups;
- Contributing to the development of Habitat 141 and participating in activities to retain, improve and expand suitable habitat for Malleefowl;
- Contributing to the Adaptive Management project by providing volunteer resources and working closely with the project coordinators and PhD and post graduate students;
- Expanding the involvement of the group in education programs and initiatives.

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13. Contemporary fire regimes in a fragmented and an unfragmented landscape: implications for persistence of the fire-sensitive Malleefowl

Keynote: Dr Blair Parsons, Outback Ecology; University of WA; Member National Malleefowl Recovery Team

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Abstract

Malleefowl are listed in Australia as a vulnerable species, with fire considered a significant threat to their persistence. There are no contemporary data documenting fire regimes and their effects on Malleefowl habitat within the Western Australian wheatbelt. Therefore it is not clear what the consequences are for habitat that is burnt or whether fire is occurring at a frequency that may threaten the species. We addressed this by:

(1) determining if fire regimes differed between vegetation remnants of differing sizes and uncleared vegetation, using analysis of satellite imagery;
(2) determining vegetation structural responses to time since fire in three habitats: mallee-shrub, *Acacia* shrublands and mallee-heath; and
(3) exploring the consequences of these differences with reference to the fire sensitive Malleefowl (*Leipoa ocellata*).

Fire was infrequent in small remnants, more frequent in large remnants, and most frequent in uncleared areas adjacent to the wheatbelt. Key vegetation structural attributes for Malleefowl, such as canopy and litter cover, increased beyond 45 years post-fire in mallee-shrub, reached a plateau in mallee-heath after 30–40 years, and declined in *Acacia* shrublands after 25–40 years. Senescence in long-unburnt vegetation, combined with rare contemporary fires, suggest progressive decline in habitat quality of *Acacia* shrublands for Malleefowl in the wheatbelt. In the adjacent, continuously vegetated landscapes, more frequent (and extensive) fires in structurally developing mallee-shrub communities are of concern for Malleefowl conservation.

This study illustrates how fire management must be tailored to the specific habitat occupied by the species and must acknowledge the landscape context (e.g. remnant size and surrounding land use) of the site. In small remnants, active management of fire may be required to maintain suitable Malleefowl habitat. In larger remnants and reserves, management actions should aim to prevent wildfires or reduce their scale.

Introduction

Fragmentation and degradation of vegetation in agricultural landscapes has led to significant declines in vertebrate populations worldwide (Andrén, 1994; Fahrig 2003). Typically, faunal decline has been related to loss of connectivity and viability of populations (Fahrig, 2003). However, fragmentation also leads to secondary effects on ecological processes such as fire regime (Baker, 1992; Ford et al., 2001). The implications of such secondary changes for populations of fauna have rarely been investigated.

Fragmentation can have diverging effects on fire regimes in remnant vegetation depending on the social and environmental context in which the remnants are located (Gill and Williams 1996). Increases in fire frequency – one component of a fire regime – occur in some remnants as they are exposed to more intensive use by humans and greater sources and frequency of ignition (Kemper *et al*. 1999; Tabarelli and Gascon 2005). In other cases, the displacement of traditional human societies and their active fire management practices, discontinuous vegetation cover and advances in fire suppression may lead to declines in fire frequency in remnants (Hobbs and Yates 2003; McCaw and Hanstrum 2003). Changes in fire regime have the potential to lead to a decline in health of remnants in agricultural landscapes and the organisms that persist within them (Ford *et al*., 2001; Seager *et al*., 2004).

Structural parameters are fundamental in determining the suitability of vegetation as habitat for many animals (MacArthur and MacArthur 1961; Clarke 2008). The Malleefowl (Leipoa ocellata) is a large (~2kg); sedentary, ground-dwelling bird that uses fermentation and solar radiation to incubate its eggs in mounds (Frith, 1956). The species occurs primarily in mallee and semi-arid shrublands across southern Australia (Storr, 1991; Benshemesh, 2000), habitats that are considered highly prone to fire (Noble et al., 1980; Hodgkinson, 2002). Consequently, Malleefowl persistence is inextricably linked to fire, with inappropriate fire regimes among the primary threats to its existence (Garnett and Crowley 2000; Benshemesh 2007). Fire incidence in agricultural landscapes in southern Australia is thought to have decreased compared with that in unfragmented landscapes (Gill and Williams 1996), although no studies have demonstrated this empirically. Large-scale wildfires, however, have a severe and long-lasting effect on Malleefowl populations (Priddel 1989; Benshemesh 1990).

Malleefowl prefer long-unburnt habitat (at least 40 to 60 years), as it possesses key vegetation structural attributes. A near-continuous canopy provides shelter from predators and weather, while plentiful leaf litter is important for nest mound construction and harbouring food (Benshemesh 1992). In addition, a diverse and abundant shrub understorey provides an important food resource (Harlen and Priddel 1996). How might these habitat elements be affected by time since fire? In the absence of fire for periods well in excess of that typical for a community (e.g. >46 and >66 years for shrublands and mallee-shrub respectively; O'Donnell *et al*. 2011), communities that are limited by climate but modified by fire could be predicted to have increased woody cover (Bond *et al*. 2005), including increasing canopy cover and height and increased leaf litter, suggesting increasing habitat suitability for Malleefowl with time. Alternatively, if communities are regulated by climate, woody vegetation parameters could be expected to plateau within a typical fire cycle, indicating a maximum and stable suitability for Malleefowl beyond a specific age post-fire. In fire-maintained communities, a decrease in woody vegetation parameters would be expected in the oldest vegetation, indicating a peak period of Malleefowl habitat suitability at an intermediate age post-fire.

In this study, we aimed to determine the effect of fragmentation on the fire regime, the ecological implications of differences in the fire regime on vegetation structural development in three major habitats in this region (mallee-shrub, Acacia shrublands and mallee-heath), and, the conservation consequences of any fire regime differences on the Malleefowl.

Methods

ANALYSIS OF RECENT FIRE REGIMES IN THE WESTERN AUSTRALIAN WHEATBELT

Study area

We analysed contemporary fire regimes in the WA wheatbelt (31.5°S, 117.5°E) and uncleared areas up to 100 km to the east (Fig. 1). Since European colonisation, over 93% of the native vegetation in the WA wheatbelt has been removed, largely for cereal cropping and sheep grazing (Saunders *et al*. 1993). The intensity of land use has led to its ranking as one of the most stressed landscapes in Australia (National Land and Water Resources Audit 2001).

The uncleared lands on the eastern edge of the wheatbelt are relatively undisturbed, containing vast tracts of intact vegetation communities similar to those of the wheatbelt (e.g. shrublands, heaths, woodlands and mallee-shrub; National Land and Water Resources Audit 2001). Land uses are primarily extensive pastoralism, mining, nature conservation and vacant crown land. This provides an opportunity to compare fire regimes of these ecologically similar landscapes that now differ in social and environmental context.

Analysis of satellite imagery
To quantify the spatial extent and frequency of fire, we made use of a temporal sequence of satellite images (Landsat Thematic Mapper, calibrated as part of the LandMonitor project; Caccetta et al. 2000) consisting of summer images for every 2 years between 1988 and 2004 (for technical details, see Caccetta et al. 2000). For each time step within the sequence, we identified fire events by determining areas showing clear increases in reflectance between successive images. A 100-m cell resolution was used in a supervised classification in a geographic information system (Spatial Analyst, Arcview 9.1, ESRI 2004). Burns in the 5 years preceding 1988 were identified by a conspicuous decrease in reflectance (i.e. vegetation recovery) between satellite images for the first time step in the sequence, 1988 to 1990. Some visual interpretation was required to distinguish between burnt cells and other types of change such as vegetation clearing or intermittent waterbodies.

We compared the frequency and spatial extent of fire events between 1988 and 2004, and for the 5 years preceding 1988, for three groups of samples within the study area: small remnants (100 to 500 ha); large remnants (>500 ha); and continuous vegetation adjacent to the wheatbelt in the extensive land-use zone (Fig. 1). Samples for the small and large remnant groups were selected based on the following rules: (1) Malleefowl had been sighted within 1 km of the remnant after 1988 (see Parsons *et al*. 2009 for a detailed description of this dataset); and (2) remnant was not contiguous with the extensive land-use zone. Although this sampling regime was designed for another study, we believe it is representative of remaining vegetation in the wheatbelt (as woodlands, which were not specifically sampled, were disproportionally cleared; Burvill 1979). If woodlands were under-represented in the wheatbelt sample compared with the uncleared landscape, it would likely lead to the underestimation of wheatbelt fire incidence, as woodlands burn less frequently than shrublands or mallee-shrub (O'Donnell *et al*. 2011). All samples excluded non-flammable saltland vegetation.

For small remnants, the entire remnant was examined for evidence of fire. For large remnants, we examined one randomly placed, circular 500-ha sample in remnants 500 to 10 000 ha, and five randomly placed 500-ha circular samples in remnants >10 000 ha. For remnants where the circular sample did not fit completely within the remnant (e.g. linear remnants), the 500 ha nearest the sample centroid was used. For continuous vegetation adjacent to the wheatbelt, 500-ha circular samples were placed at random within 100 km of the boundary with the wheatbelt and within the bounds of the imagery. The following measures were summarised for each of three landscape context groups (small and large remnants and continuous vegetation):

- Evidence of recent fire before 1988;
- Number of fire events that occurred between 1988 and 2004;
- The cumulative proportion of the sample burnt between 1988 and 2004.

VEGETATION STRUCTURAL DEVELOPMENT AFTER FIRE
Study areas
We examined how vegetation recovered from fire by conducting a space-for-time study within two areas in south-west WA. The two areas were selected because they contained a range of fire-age classes within three fire-prone broad vegetation structural classifications: mallee-shrub, mallee-heath and *Acacia* shrublands. One area based around Lake Magenta and Dunn Rock Nature Reserves in the south-eastern wheatbelt (Fig. 1) supported closed mallee-shrub (e.g. *Eucalyptus phaenophylla* Brooker and Hopper and *E. scyphocalyx* (Benth.) Maiden & Blakely) communities with understoreys of various *Melaleuca* shrubs interspersed with proteaceous mallee-heath. Mallees are multistemmed *Eucalyptus* spp. that sprout from underground lignotubers after disturbances. They form the dominant tall vegetation stratum in mallee-shrub communities, and occur as scattered emergents in mallee-heath. The second area was situated at Charles Darwin Reserve and Mount Gibson Sanctuary, adjacent to the northern wheatbelt (Fig. 1). The vegetation consisted largely of mixed shrublands (*Acacia coolgardiensis* Maiden, *A. stereophylla* Meisn., *Allocasuarina acutivalvis* (F.Muell.) L. A. S. Johnson, *A. campestris* (Diels) L. A. S. Johnson, *Melaleuca* spp.) interspersed with open woodlands (Beard 1990).

Site selection

We used fire history mapping (Department of Environment and Conservation, ICS Group, unpubl. data 2006) to summarise fire regimes and delineate various fire ages within each study area. Five transects were placed in each fire age within each vegetation community except where noted. In mallee-shrub and mallee-heath, we sampled the following fire-age classes: 3–4, 6, 18–20, 25, 30, 35, 39 and >45 years (mallee-heath >45 years contained eight transects). In *Acacia* shrubland we sampled 5, 7, 12, 15, 22 (three transects), 27 (three transects), 30 (three transects), 38 and >45 (six transects) years. The exact year of fire for areas burnt before 1968–69 was not known and so was set at the minimum possible year, 1962 (i.e. 45 years or more post-fire), for the purposes of analysis.

With space-for-time studies, random error and pseudoreplication are important issues as (1) it may be difficult to locate sample sites that are truly comparable with one another (Oksanen 2001); and (2) replicates may fall within one instance of a treatment and so may not be truly independent (e.g. sample sites within the one fire scar) (Hurlbert 1984). To minimise such bias within the present study, transects were located in separate fire scars within the same fire-age class where possible, or if not, at least 150 m apart. In addition, transects were limited to locations with comparable vegetation species composition. In mallee-shrub, 13 individual fire events were sampled across seven vegetation ages (range of one to three fires per age, with an unknown number of fires affecting sites last burnt pre-1968). In *Acacia* shrubland, nine individual fire events were sampled across nine vegetation ages (i.e. one fire per age, with an unknown number pre-1968). In mallee-heath, 13 individual fire events were sampled across seven vegetation ages (range of one to two fires per age, with an unknown number pre-1968). Data on factors such as season of burn, long-term fire history, fire intensity and post-fire conditions were not available and so could not be incorporated into the study.

Field Measurements

Transects 100 m long were placed within each replicate of vegetation × fire-age combination. At each transect, a 4-m pole was placed at 2-m intervals (50 per transect) recording the presence or absence of live vegetation intercepting the pole in each height interval (0–12, 12–25, 25–50 cm, 50 cm–1 m; 1–2, 2–4, >4 m) (Benshemesh 1992). Litter cover was quantified by making point observations 1 m to either side of the 50 pole placements (i.e. total of 100 litter measurements) with observations falling into one of four categories: (1) litter > 1cm depth, (2) litter < 1 cm depth, (3) bare ground, (4) shrub or herb (i.e. obstructed by low shrubs or ground cover). Field measurements were designed to quantify important changes in vegetation structure, and specifically those considered important to Malleefowl (i.e. canopy, understorey shrubs and litter cover), with respect to time since fire. Mallee-shrub and *Acacia* shrubland measurements were taken during winter (June to August) 2007, and mallee-heath in autumn and winter 2008.

Statistical Analyses

We calculated the average fire interval for each of the three landscape context groups by an extrapolation based on the probability of any sample being burnt within the 16-year time period (1988 to 2004). Additionally, the calculation was performed for a 21-year time period (i.e. 1983 to 2004) incorporating fire events detected before 1988 to provide an indication of the sensitivity of the approach to temporal variation. The equation for calculating the average fire interval for each group is:

$$\text{average fire interval (in years)} = \frac{1}{(x/(y \times n))/z}$$

where x is the number of fire events within the time period; y is the number of observations within the time period; z is the number of years covered by each observation (in this study z = 2); and n is the number of samples. A worked example is given below using the 'small remnant' group:

- Eight observations (y) × 127 remnants (n) = 1016 fire opportunities
- We observed six fires (x) in 1016 opportunities = 6/1016 = 5.905×10^{-3} probability of a fire in any remnant in a 2-year period
- $5.905 \times 10^{-3}/2 = 2.9527 \times 10^{-3}$ = probability of a fire in a remnant in any 1-year period
- Interval for which a probability of a remnant burning is 1 = $1/2.9527 \times 10^{-3}$ = 339 years.

The data measured fires at 2-year intervals, so multiple fires that occurred in the same sample within each 2-year period were treated as one. The calculation also assumed that each sample had an equal chance of being burnt. This estimate of fire frequency does not allow for decadal-scale climate variation (Cullen and Grierson 2009) and is estimated from a relatively short time-window.

Differences in the number of fires occurring between the three landscape context groups for both pre-1988–2004 and 1988–2004 were tested using Pearson's chi square test.

For each vegetation height class and litter cover (>1 cm in depth) in each of the three habitats, we tested a set of regression models that represented four ecologically plausible outcomes for vegetation change (the number of intercepts per transect) with time since fire: an increase or decrease over time (linear, exponential); increasing but reaching a stable maximum (asymptotic, logistic); an increase followed by a decrease (i.e. senescence; quadratic), and fluctuation over time (e.g. the growth of successive vegetation layers through the height class over time; cubic). This fourth model was not relevant for the uppermost height class and was therefore not tested. The most parsimonious model for each parameter was selected using Akaike's Information Criterion (AIC), using GENSTAT Tenth Edition (Lawes Agricultural Trust 2007), and is presented here. Where AIC was equal, the model with the greatest deviance explained was selected. All other models are included in the Accessory publication (available from the journal online), so readers can evaluate alternative outcomes.

Results

CONTEMPORARY FIRE REGIMES IN AND ADJOINING THE WA WHEATBELT

Fire events were distributed non-randomly across the three landscape context groups, for both pre-1988 (χ22 = 13.909, P = <0.001) and 1988 to 2004 (χ22 = 24.44, P = <0.001). A higher than expected number of fires occurred in both the 'large remnant' and 'continuous' groups, with a lower than expected number in the 'small remnant' group.

Of the 127 small remnants sampled, only six (4.7%) were burnt in the period 1988 to 2004 (Table 1), and none were burnt more than once during that time. In larger remnants, 25 of 156 samples (16%) were burnt and of those, nine experienced multiple fires (up to four). In continuous vegetation, 10 (33%) samples experienced a fire between 1988 and 2004, with one sample burnt more than once during this time period (three times).

The fire events observed in samples in large remnants and continuous vegetation were often part of much larger fires (mean area = 26,900 ha, range = 7–393,000 ha) and burnt through a higher proportion of the sample area (Table 1). In contrast, fires in small remnants were all minor fires (mean area = 80 ha, range = 10–264 ha) and tended to burn through a lower proportion of the sample area.

Based on the frequency of fire for 1988 to 2004, the average fire interval for small remnants in the WA wheatbelt was ~339 years (Table 1). The average intervals in large remnants and continuous vegetation were 67 and 40 years respectively (Table 1). The trends described above remained when incorporating data from pre-1988 (Table 1); however, estimates of fire intervals decreased.

DEVELOPMENT OF VEGETATION STRUCTURE POST-FIRE

Development and maintenance of vegetation structure after fire differed between mallee-shrub, mallee-heath and Acacia shrublands (Table 2, Figs 2, 3), suggesting contrasting ecological implications of particular fire-return intervals. Mallee-shrub vegetation retained substantial cover in all height categories over time, except for an absence of vegetation in taller height classes (>1 m) shortly after fire (<10 years) (Fig. 3). Vegetation <25 cm tall in mallee-shrub decreased over time from an initial peak within the first 10 years post-fire, but there was little change in vegetation between 25 and 100 cm. Vegetation between 1 and 2 m increased over time (Fig. 2a), indicating that a 1- to 2-m shrub layer established after ~10 years and remained until the 45+ year limit of the dataset. Mallee-shrub vegetation developed a substantial canopy (2- to 4-m height class) after 20–25 years, with this canopy remaining intact up to 45+ years (Fig. 2b). The slight downward trend in mallee-shrub cover at 2 to 4 m beyond 30 years post-fire was due to the movement of cover through to the higher height class (>4 m, Fig. 3). Mallee-shrub deep litter cover (>1 cm) increased until ~25 years post-fire, where it then appeared to asymptote through to the limit of the 45+ year dataset (Fig. 2c).

Acacia shrubland contained one dense vertical band of vegetation that increased in height over time (sometimes overlapping two height categories) with little vegetation cover remaining beneath it. The 1- to 2-m shrub layer in Acacia shrubland had high cover from 15 to 40 years post-fire, but declined considerably thereafter. The 50–100-cm category showed a similar pattern, but peaked ~10 years earlier. Development of upper vegetation layers in Acacia shrubland lagged that of mallee-shrub, with establishment of the 2- to 4-m layer occurring primarily 25–30 years post-fire, and the 4-m+ height class after 45+ years. The accumulation of litter in Acacia shrubland was similar to that of mallee-shrub habitat until ~30 years post-fire, but after this time, litter decreased considerably, a trend not evident in the other two habitats.

Mallee-heath retained dense vegetation in all height categories <1 m over time, but owing to the lower stature and abundance of emergent mallees, there was little vegetation taller than 2 m at any time. Mallee-heath was alone among the habitats in having no decrease in vegetation <25 cm with increasing time post-fire. Cover of shrubs (50–200 cm) increased over time in mallee-heath, although the relationship between time since fire and vegetation cover at 1 to 2 m was weak. Litter cover in mallee-heath showed an asymptotic pattern similar to mallee-shrub, although it reached an asymptote at a lower litter cover.

Discussion

Contemporary Fire Regimes in and Adjoining the WA Wheatbelt

Analysis of satellite imagery indicated that the frequency of fire in and adjacent to the WA wheatbelt declined with increasing fragmentation. Fires were most frequent in continuous vegetation, least frequent in small remnants, with large remnants intermediate. Recent research indicates that in the continuously vegetated landscape adjoining the wheatbelt, long-term fire return intervals in shrublands and mallee-shrub were 46 and 66 years respectively (O'Donnell et al. 2011). Our results closely approximate these fire return interval estimates in the landscape contexts of continuous vegetation and large remnants over the period 1988–2004, albeit at the lower end in continuous vegetation. In contrast, there is strong evidence that the incidence of fire has declined substantially since fragmentation in small remnants, under the reasonable assumption that this region historically experienced an equivalent fire regime to that of adjoining, similar, continuously vegetated landscapes. In the heavily cleared landscape of the wheatbelt, fire appears to no longer operate as a natural and functional disturbance (Baker 1992; McCaw and Hanstrum 2003).

There are several factors that may contribute to the relative infrequency of fires in small remnants. First, the agricultural matrix reduces the carriage of fires between remnants, as it has lower fuel loads over summer and provides opportunities for land managers to access and suppress fires (McCaw and Hanstrum 2003). Second, a lower proportion of native vegetation across the landscape reduces the likelihood of lightning ignitions in remnants. Third, total fire exclusion and fire suppression in native vegetation are widespread practices in farming landscapes because of the potential harm of fire to people and infrastructure. Despite this, the majority of fires that have affected wheatbelt remnants originate in non-natural ignitions in the agricultural matrix (Burrows et al. 1987), suggesting the infrequency of natural ignitions and the important role of vegetation connectivity in facilitating fire spread.

Interestingly, we showed that fires in small remnants tended to burn only a small proportion of the remnant (Table 1). This is in contrast to the view held by several authors (Priddel 1990; Hobbs 2003) that small remnants, although infrequently burnt, were more likely to burn in their entirety. Remnants and therefore fires are more accessible in fragmented landscapes and fires can often be effectively suppressed soon after establishment (McCaw and Hanstrum 2003), although large fires have occurred in agricultural landscapes elsewhere in Australia recently. In large remnants and remote areas adjacent to the wheatbelt, large, widespread fires were typical. These fires can burn unattended for weeks or months and exceed 100,000 ha (McCaw and Hanstrum 2003), owing to difficulties with access, low population densities, and lack of infrastructure necessitating a suppression response.

Fire interval estimates incorporating data from pre-1988 showed the same pattern between landscape contexts, but the intervals were substantially less than those for 1988 to 2004 only, suggesting that the incidence of fire was more common before 1988. Alternatively, the sampling method used to detect fires before 1988 may have sampled fires from a longer period than expected, resulting in an underestimation of fire return intervals.

For both sampling periods, the fire-return estimates were based on data spanning a short time period, which was less than the estimated intervals for all three landscapes. Multidecadal climate fluctuations (Cullen and Grierson 2009) and post-clearing changes in cloud formation process (Lyons 2002; which could lead to altered rainfall patterns) influence vegetation growth and could have a bearing on fire regimes (Prober et al. unpublished data). The two different estimates of fire interval demonstrate the vulnerability of the method to sampling effort and climate fluctuations and should be considered as approximations.

It is plausible that landscape context groups differ in other attributes that affect their probability of burning. These may include climatic gradients and weather patterns (Lyons 2002), the vegetation type present (hence spatial distribution of fuel) relative to the probability of clearing (Burvill 1979), exposure to anthropogenic ignition sources (e.g. population centres, transport routes), human population density (Syphard et al. 2009), adjacent land use, remnant configuration and underlying biophysical properties (e.g. soils, topography). The paucity of fire instances in small and large remnants prevented us from taking a more predictive approach, so we have had to assume our landscape context samples are randomly distributed relative to these attributes. A more detailed analysis incorporating these factors into predictive models might be informative, and may become feasible as fire scar imagery continues to be collected, increasing sample sizes. Further, as the time spanned by these data increases, more accurate estimates of fire interval may be determined.

In addition to interpreting the current gross differences in fire return intervals between landscape contexts with reference to historic precedents, current regimes can also be considered in light of their effects on aspects of ecological condition, such as vegetation structure, and on species conservation, such as for the Malleefowl.

DEVELOPMENT OF VEGETATION STRUCTURE POST-FIRE

The post-fire structural response of three habitats common in the WA wheatbelt differed, suggesting that fire may play a contrasting role in maintaining vegetation structure in each, despite the occurrence of these communities in a mosaic across the landscape.

Acacia shrubland showed evidence of being a fire-maintained community, as litter and some vegetation cover classes decreased 25 to 40 years post-fire, indicating a decrease in productivity and senescence in the long-term absence of fire (Gardner 1957; Yates and Broadhurst 2002). To maximise understorey and litter complexity in Acacia shrublands, and thus habitat suitability for Malleefowl, fire intervals could be in the order of 25 to 40 years. Other intervals, however, might be appropriate for other fauna (Burrows and Abbott 2003; e.g. longer intervals for hollow-dependent species) or other objectives. In the WA wheatbelt, a continuation of contemporary fire frequencies may result in diminishing understorey and litter layer complexity; thus, it may be appropriate to promote fire in small remnants of this habitat to stimulate recruitment and rejuvenation of senescent vegetation and increase habitat suitability for Malleefowl.

Of the habitats and locations sampled, mallee-shrub appeared to exhibit the most sustained productivity, as evidenced by the rate and trajectory of increase in litter and vegetation cover and height over time. Mallee-shrub continues to develop in stature in the long-term absence of fire, although fire may have a role in maintaining the mallee-shrub structural formation at fire-return intervals greater than those able to be examined in this study, as suggested by Hopkins and Robinson (1981). However, a continuation of contemporary fire regimes in small fragments is likely to result in less community degradation than in Acacia shrublands, at least in the short to medium term. In mallee-shrub habitat, fire intervals in excess of 45 years over substantial parts of the landscape would allow for ongoing vertical development while maintaining maximal understorey and ground layer complexity. These habitat elements are of known importance to several species of conservation concern occurring in the wheatbelt and adjoining regions, including Malleefowl (Benshemesh 2007; Priddel et al. 2007).

In contrast to the other habitats (in which vertical extension continued through to the oldest age class), mallee-heath appeared to reach its maximum vertical potential ~30 years post-fire, by which time vegetation cover in all height classes appeared to plateau, suggesting that growth and productivity had peaked. This is a similar pattern to that reported by McCaw (1997) for the higher-rainfall Stirling Range, although the length of time until growth reached a plateau was greater. We are unable to determine from the present study whether this state would be maintained over time or if senescence would commence, but Maher (2007) indicates that community change to Allocasuarina-dominated woodland can occur in some locations in the long-term absence of fire, suggesting that the mallee-heath community is fire-maintained. The absence of change in vegetation structure over the period 30 to 40+ years suggests that fire frequencies in this range may be appropriate to maximise structural complexity.

IMPLICATIONS FOR MALLEEFOWL

The Malleefowl is subject to several threats across its range, including predation by foxes, destruction of habitat, grazing by introduced herbivores and inappropriate fire regimes. Widespread and too frequent fire has been suggested as responsible for the local disappearance of Malleefowl from parts of south-west WA (Milligan 1903, 1904; Carter 1923a, 1923b, 1923c). It is unlikely that too frequent fire represents a current threat to Malleefowl within the WA wheatbelt as intervals for small and large remnants (339 and 67 years respectively) exceed the 60-year minimum suggested by Benshemesh (1992) as appropriate for Malleefowl. These intervals are also likely to be underestimates of interval length for any particular location as they do not account for the patchiness of fires within a sample. It is more likely that threats other than fire (e.g. predation, habitat loss and fragmentation) are more significant in this region (Benshemesh 2007; Parsons et al. 2008).

Conversely, continuous vegetation adjacent to the wheatbelt showed an average fire interval of 40 years, which is less than the recommended interval for Malleefowl. Further, fires were very large. Extensive, homogeneous and too-frequent fires are known to have deleterious and long-lasting effects on Malleefowl (Benshemesh 1992), and similar fire regimes are operating and threatening Malleefowl in large remnants and continuously vegetated landscapes in eastern Australia (Benshemesh 1990). Management aimed at retaining more long-unburnt habitat may be appropriate, although guidance as to how this might be achieved in practice is currently lacking (Clarke 2008).

The differences in habitat response to fire between mallee-shrub and Acacia shrubland (Malleefowl rarely use mallee-heath) suggest that they are most suitable for Malleefowl over different periods of the fire cycle. An important element of Malleefowl habitat is a varied understorey, which can provide food at different times of the year including during drought (Harlen and Priddel 1996), and abundant litter cover for mound construction. Mallee-shrub retains substantial litter cover and understorey structure 45 years post-fire and beyond, suggesting that this habitat is likely to remain suitable for Malleefowl for long periods in the absence of fire. Conversely, understorey and litter cover peak ~25 to 30 years post-fire in Acacia shrublands, then decline. Therefore, it is plausible that as Acacia shrublands age, they may become less suitable for Malleefowl.

A lack of fire may now consequently represent a long-term threat to Malleefowl in small Acacia shrubland remnants. The active reintroduction of fire may be an appropriate management response, although managing the interaction of fire and other processes that degrade native vegetation in small remnants (e.g. weed invasions, salinity; Hobbs and Yates 2003) presents a considerable challenge. Quantitative research examining the effect of senescing vegetation on Malleefowl abundance and density would clarify whether an absence of fire poses a genuine threat to the species.

We found that the three habitats developed structural attributes of importance to Malleefowl over a time period considerably shorter (i.e. between 25 and 45 years) than the recommended fire interval for the species of 60 years (a cautious overestimate based on breeding densities; Benshemesh 1992). This may be due to higher productivity of our study areas compared with those of Benshemesh (1992), as mean annual rainfall was over 90 mm greater in our study area (Bureau of Meteorology 2008). Further, congruence of peak habitat suitability and population density may be unlikely owing to density being influenced by other factors (e.g. predation) and the Malleefowl's reproductive and behavioural ecology. Therefore, for Malleefowl conservation, we suggest that a conservative approach to fire management that considers both direct fire effects on the species and its habitat and other environmental stressors is necessary.

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Table 1. Fire regimes for three landscape contexts within or adjacent to the Western Australian wheatbelt.

Size class	Sample size	% burnt 1988 - 2004 (number)	% burnt pre-1988 (number)	Mean proportion of sample burnt (range)	% of sites burnt more than once (1988 – 2004) (number)	Estimated fire interval 1988 – 2004 in yrs (95% ci)	Estimated fire interval 1983 – 2004 in yrs (95% ci)
100 to 500 ha	127	4.7 (6)	7.1 (9)	0.26 (0.01 – 0.53)	0 (0)	339 (156 to 909)	178 (108 to 317)
> 500 ha	156	16 (25)	23 (36)	0.48 (0.01 – 1.0)	5.8 (9)	67 (49 to 96)	45 (36 to 57)
Unfragmented	30	33 (10)	40 (12)	0.69 (0.04 – 1.0)	3.3 (1)	40 (23 to 77)	26 (17 to 40)

Table 2. Summary of regression models for vegetation and litter cover versus time since fire for mallee-shrub, *Acacia* shrubland and mallee-heath.

Class (cm)	Model form	Model	% deviance explained	Standard error	P
Mallee-shrub					
400+	Logistic	$y = 0.23 + 15.75/(1 + e^{-0.972(x-32.37)})$	65.5	5.27	< 0.001
200 to 400	Quadratic	$y = -7.32 + 1.847x - 0.0262x^2$	78.3	5.21	< 0.001
100 to 200	Cubic	$y = -2.22 + 2.63x - 0.1158x^2 + 0.0015x^3$	31	5.56	< 0.001
50 to 100		No significant relationship			
25 to 50		No significant relationship			
12 to 25	Negative linear	$y = 25.72 - 0.2094x$	18.0	6.03	0.004
0 to 12	Negative linear	$y = 33.83 - 0.4272x$	45.4	6.56	< 0.001
Litter > 1	Logistic	$y = 0.2179 + 36.57/(1 + e^{-0.2252(x-15.27)})$	73.8	8.14	< 0.001
Acacia shrubland					
400+	Exponential	$y = 0.42 + 0.00022(1.28^x)$	41.3	6.02	< 0.001
200 to 400	Logistic	$y = 0.1697 + 31.18/(1 + e^{-0.3471(x-25.54)})$	90.3	4.52	< 0.001
100 to 200	Quadratic	$y = -6.6 + 2.757x - 0.05205x^2$	49.6	8.11	< 0.001
50 to 100	Cubic	$y = 3.68 + 3.39x - 0.1539x^2 + 0.001819x^3$	38.1	7.18	< 0.001
25 to 50	Asymptotic	$2.79 + 21.76(0.965^x)$	51.1	4.77	< 0.001
12 to 25	Negative linear	$y = 17.18 – 0.305x$	38.4	5.43	< 0.001
0 to 12	Negative linear	$y = 12.53 - 0.1931x$	23.6	4.79	< 0.001
Litter > 1	Cubic	$y = 7.32 - 1.49x + 0.1582x^2 - 0.002762x^3$	52.2	9.37	< 0.001
Mallee-heath					
400+		No significant relationship			
200 to 400	Quadratic	$y = -1.792 + 0.355x – 0.00575x^2$	23.4	2.51	0.002
100 to 200	Positive linear	$y = 1.944 + 0.1466x$	21.0	3.96	0.001
50 to 100	Cubic	$y = 8.10 – 0.859x + 0.0881x^2 – 0.001397x^3$	65.4	5.43	<0.001
25 to 50	Cubic	$y = 17.78 – 0.761x + 0.0832x^2 – 0.001392x^3$	60.2	5.13	<0.001
12 to 25		No significant relationship			
0 to 12		No significant relationship			
Litter > 1	Quadratic	$y = 4.91 + 0.96x - 0.009x^2$	35	9.97	< 0.001

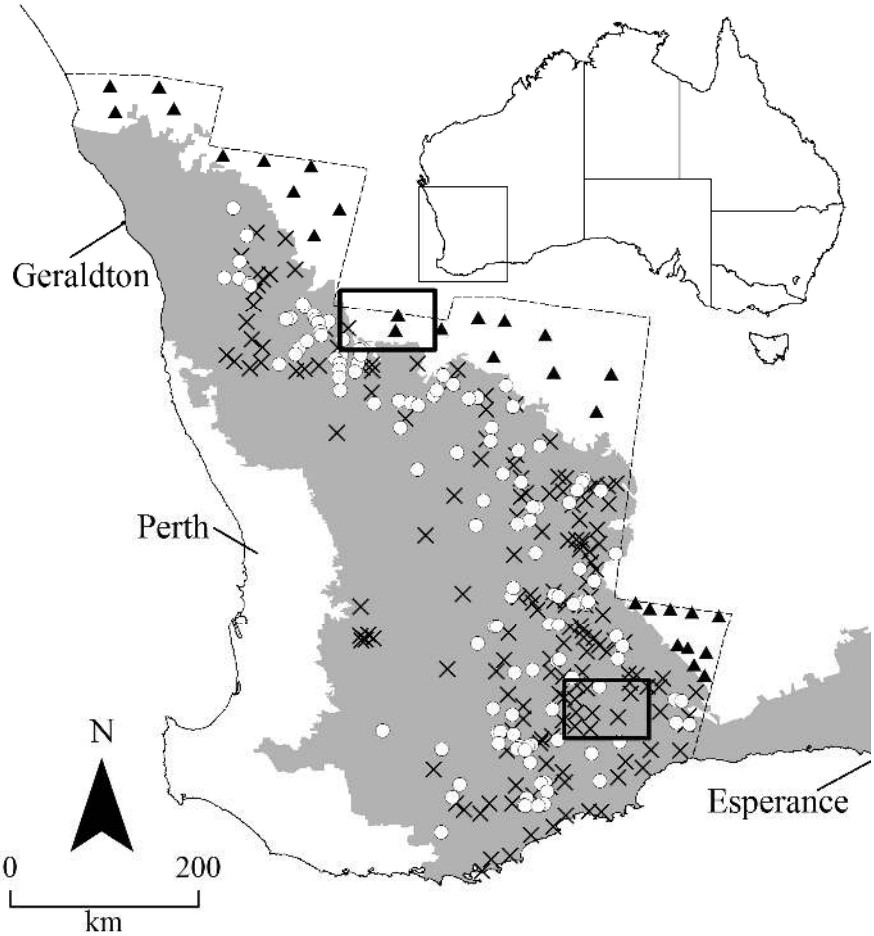

Figure 1. Study area. Shaded area illustrates Western Australian wheatbelt, white circles = small remnant samples, crosses = large remnant samples, triangles = continuous vegetation samples; bold rectangles denote study areas for habitat analysis (*Acacia* shrubland was sampled in the north, and mallee-shrub and mallee-heath in the south); dashed line represents limits of imagery used in analysis.

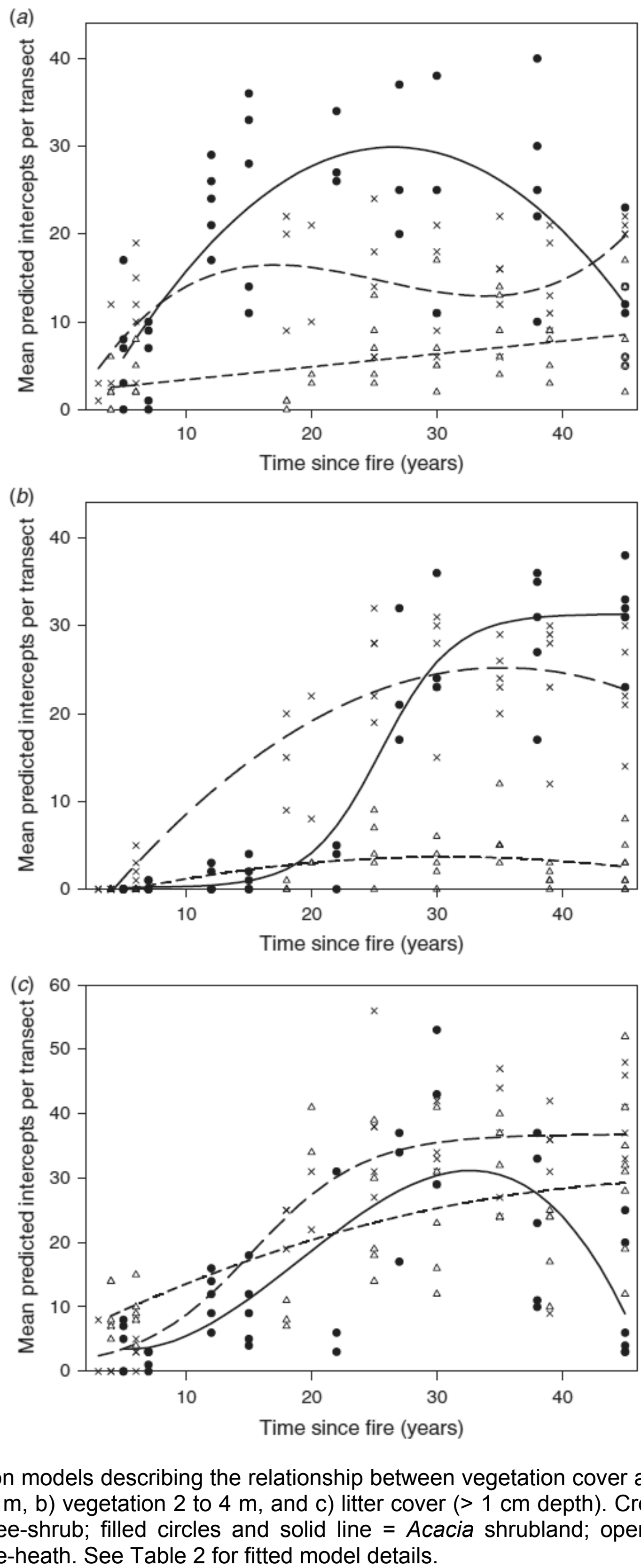

Figure 2. Regression models describing the relationship between vegetation cover and time since fire for a) vegetation 1 to 2 m, b) vegetation 2 to 4 m, and c) litter cover (> 1 cm depth). Cross symbols and thin dashed line = mallee-shrub; filled circles and solid line = *Acacia* shrubland; open triangles and thick dashed line = mallee-heath. See Table 2 for fitted model details.

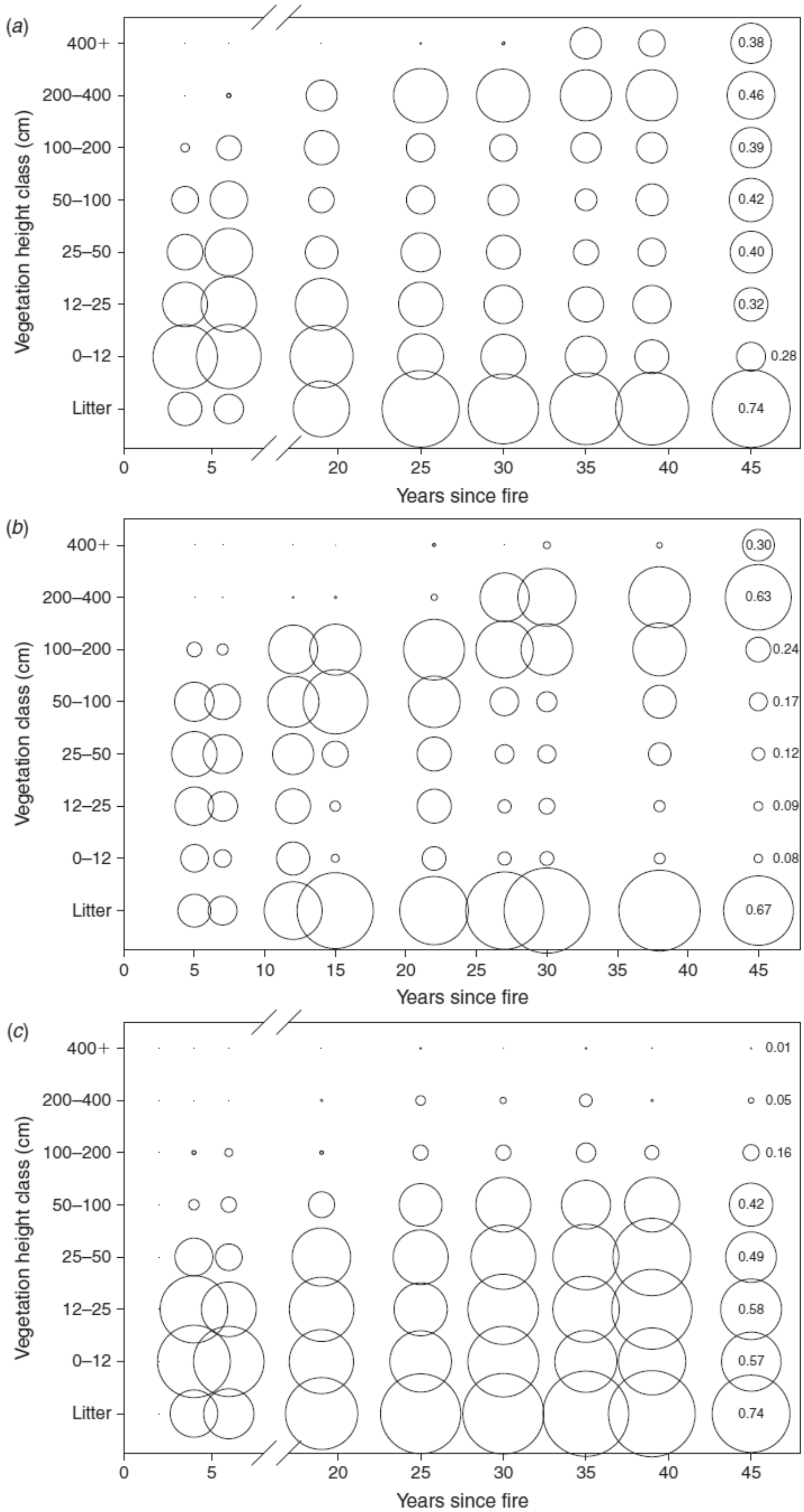

Figure 3. Vertical vegetation profile and litter cover development with increasing time since fire for (a) mallee-shrub (b) *Acacia* shrubland and (c) mallee-heath. Proportional cover is shown for litter and all vegetation height class bubbles for the 'unburnt' (i.e. > 45 years) treatment for scale.

14. An overview of the Mallee Fire and Biodiversity Project

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Abstract

Fire is a widespread natural disturbance and an important ecological process in mallee ecosystems. Understanding the effects of fire on plants and animals presents a key challenge for the conservation and management of biodiversity in the Mallee. Commencing in 2006, the Mallee Fire and Biodiversity Project was developed to investigate the effects of fire on a range of taxa (plants, invertebrates, reptiles, birds and mammals). This project represents one of the largest ecological studies of fire ever undertaken in Australia. The project has had a particular focus on investigating the influence of the properties of 'fire mosaics' on biota. To do this, we employed a novel 'whole of landscape' design, in which we sampled the flora and fauna in 28 landscapes (each 4 km in diameter, 12.5km^2) across a 104,000 km^2 area of the Murray Mallee region of Victoria, SA and NSW. Here, we present a summary of some key results and outputs from this project. These include: detailed maps of a) fire history (from 1972 – 2007), and b) major vegetation types; a method for predicting the age of mallee vegetation beyond that which can be accomplished using satellite images; novel information about the distribution of fire age-classes in the region; and changes to vegetation structure and the occurrence of reptile, bird and mammal species over a century long post-fire time-frame. We also present results on the effects that landscape properties of fire mosaics (extent of particular age classes and the diversity of fire age classes) have on the diversity of fauna in different landscapes. A wealth of knowledge has been developed through the Mallee Fire and Biodiversity Project that will assist in management of mallee ecosystems in southern Australia, and contribute to the conservation of threatened mallee species such as Malleefowl *Leipoa ocellata*.

Introduction

Fire affects the structure and function of ecological communities throughout the world (Bowman *et al.*, 2009) and the management of fire is an important element in conserving biodiversity in many ecosystems (Woinarski & Recher, 1997; Noss *et al.*, 2006; Barlow & Peres, 2004; Keeley *et al.*, 2005; Slik & Van Balen, 2006; Sara *et al.*, 2006). In Australia, fire is an important agent of disturbance in many ecosystems, but inappropriate fire regimes have the potential to threaten many organisms (Gill *et al.*, 1999). In Australia alone, >50 species of birds are threatened by inappropriate fire regimes, including Malleefowl *Leipoa ocellata* (Woinarski, 1999; Bradstock *et al.*, 2005; Garnett & Crowley, 2000).

Management of fire for biodiversity conservation requires a strong understanding of the temporal effects of fire on biota (Driscoll *et al.*, 2010). Species are often found to be more common in particular post-fire successional stages. This pattern is commonly exhibited in many fire-prone plant communities with some species being common in early succession stages and becoming less so with time-since-fire, whereas other species become dominant with time-since-fire (e.g. Keeley *et al.*, 2005; Keith, 1996). Similar patterns also have been observed in faunal communities (e.g. Fox, 1982; Smucker *et al.*, 2005). In mallee ecosystems, Malleefowl and Black-eared Miner *Manorina melanotis* are examples of species which are associated with later succession stages (Benshemesh, 1990; Clarke, 2005). By understanding the temporal effects of fire on biota, fire can be managed to promote key seral stages for species.

In addition to the temporal effects of fire, there has been increasing interest into the effects of spatial properties of fires on biotic communities (Bradstock *et al.*, 2005; Gill & Allan, 2008; Parr & Andersen, 2006). All components of the fire regime, their interactions and their variation in space and time generate heterogeneous landscapes, consisting of patches with different fire histories (Bradstock *et al.*, 2005; Turner *et al.*, 1994). Such landscapes are often referred to as 'fire mosaics' (Bradstock *et al.*, 2005). This heterogeneity is generated through two different processes. First, individual fires generate heterogeneity through variation in the rate of fire spread and fuel consumption, creating patches of burnt and unburnt vegetation and patches of differing fire severity (Turner *et al.*, 1994). Second, multiple fires through time generate heterogeneity of different vegetation ages, and different fire histories where fires overlay each other (the 'invisible' mosaic) (Bradstock *et al.*, 2005).

The landscape properties of fire mosaics (e.g. the extent and composition of different post-fire ages in the landscape) may influence biota in a number of ways. One of the most recognised theories surrounding fire mosaics relates to the effect of fire mosaics on the composition of the biotic community. This theory predicts that fire mosaics which contain a greater diversity of post-fire succession stages will support a higher diversity of biotic communities, or "pyrodiversity begets biodiversity" (Parr & Andersen, 2006). Intuitively, if different species use different succession stages, a diverse fire mosaics should support more species. Consequently, promotion of diverse mosaics consisting of patches of differing fire history has become a dominant paradigm in fire management (Parr & Andersen, 2006). However, the "pyrodiversity begets biodiversity" hypothesis is based almost solely on studies undertaken at the site level, which does not account for landscape scale processes. Furthermore, almost any fire, or sequence of fires will generate a mosaic of different fire ages. The terms "diverse" or "heterogeneous" do not provide any information about the temporal or spatial parameters by which this should be defined. For example, a mosaic which consists of 70% vegetation 1 year-since fire, 15% three years-since fire and 15% five years-since fire, has the same number of fire ages as a landscape which has three evenly distributed patches of five, 25 and 50 years-since fire, but these are obviously not equally divers. Thus, if the goal of fire management is to generate mosaics of patches with different fire history, the spatial and temporal properties of the mosaic must be defined.

The landscape properties of fire mosaics (i.e. extent of seral stages and composition of different seral stages in the landscape) may affect individual faunal species in a number of ways. Species which require resources present in a particular seral stage may be more abundant as the extent of that seral stage increases, or alternatively may require a threshold amount of that resource to exist in a landscape. Contrastingly, species may require resources that are provided by multiple succession stages (Law & Dickman, 1998), for instance if a species obtains food resources from recently burnt vegetation, but required older unburnt vegetation for shelter. In such cases the species would require a heterogeneous mosaic containing multiple post-fire ages. Diverse fire mosaics may also indicate the persistence of refuges for species which are not found in homogenous landscapes (Bradstock *et al.*, 2005).

A major challenge for future management of fire for biodiversity conservation is development of reliable knowledge of species' responses to both temporal and spatial elements of fire. The Mallee Fire and Biodiversity project aimed to provide just such information. Here I present an overview of the project, along with some key results.

The Mallee fire and Biodiversity Project

The Mallee Fire and Biodiversity Project is a large project lead by Deakin University and La Trobe University in collaboration with 12 government and non-government partner agencies. The project aimed to investigate the effects of fire on plants and animals – birds, mammals, reptiles and invertebrates (termites, scorpions, centipedes, and psyllids).

The mallee fire and biodiversity project employed a novel whole of landscape approach, whereby entire landscapes are the unit of study, rather than individual sites. By using a whole of landscape approach, fire induced changes to biota which are related to spatial processes at the landscape-scale (i.e. the total extent of particular post-fire ages and the composition of different post-fire ages in the landscape) can be investigated concurrently with the effects of temporal processes at the site scale (i.e. successional changes in biota with time-since-fire).

Twenty-eight study landscapes were carefully selected throughout the Murray Mallee region of South-Eastern Australia (Fig.1). Each landscape was 4 km in diameter (12.5 km^2), and landscapes represented fire mosaics which differed in their composition of fire age classes. Study landscapes were selected to represent a range of values along gradients of two separate landscape properties: 1) diversity of different post-fire age classes; and 2) the proportion of older vegetation (>35 years since-fire) (Fig. 2). The biota in each landscape was sampled using a number of survey sites (20 point-counts for birds, 10 pitfall lines for reptiles, small mammals, centipedes and scorpions and 20 sites for termites and psyllids). Sites were spread throughout the landscape in proportion to the extent of each different post-fire age-class (e.g. if a post-fire age-class covered 50% of the landscape, 10/20 bird point-counts would be in that post- fire age class, Fig 2. provides an example of the sites used for point-count surveys of birds).

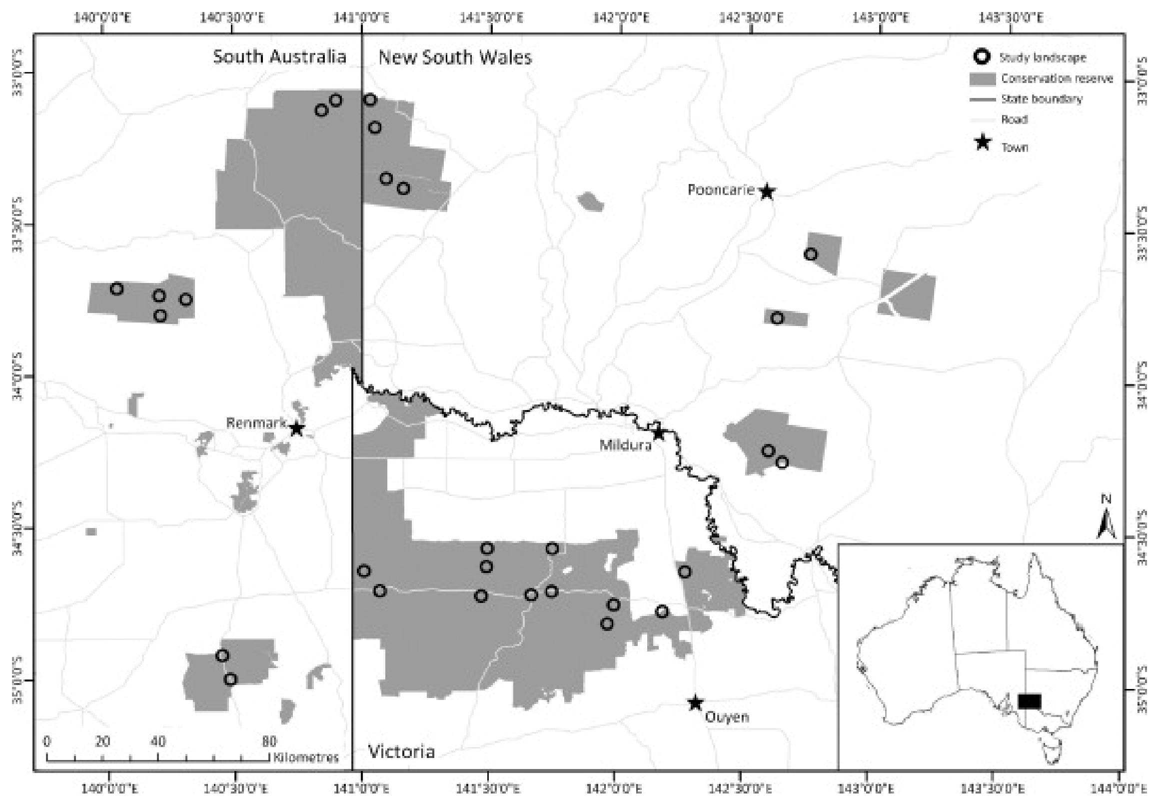

Figure 1. The distribution of study sites in the Murray Mallee region. Inset shows the location of the region in Australia.

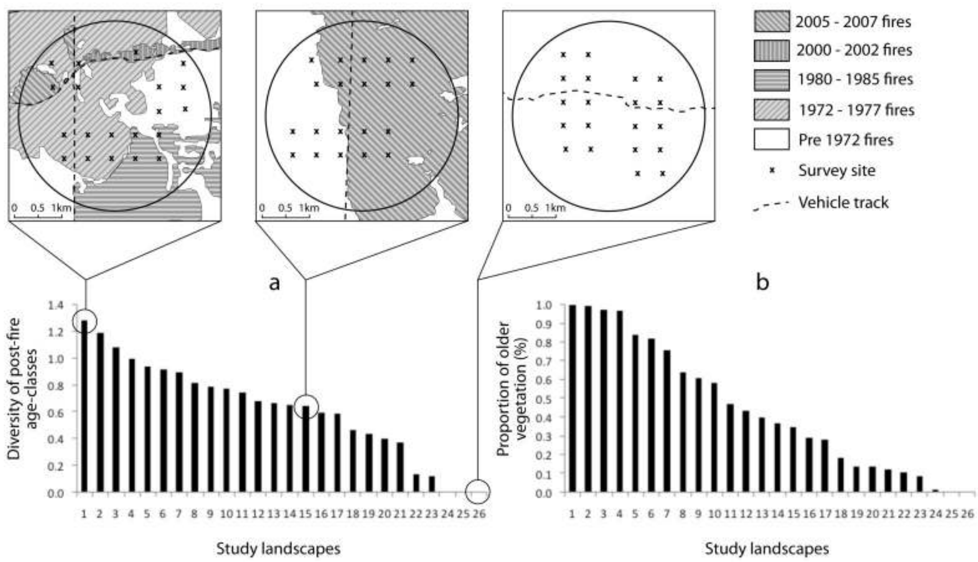

Figure 2. The gradient of (a) the diversity of post-fire age-classes (Shannon's diversity index) and (b) the proportion of older vegetation (i.e. >35 years since fire) across the 26 study landscapes. Examples of three study landscapes with differing diversities of fire age-classes are shown. Surveys sites represent those used for point-count surveys of birds (figure taken from Taylor *et al.*, 2011).

A Framework for mapping vegetation over broad spatial extents

Although fire plays an important role in mallee ecosystems, many species are also associated with particular vegetation associations (Brown *et al.*, 2009). To account for this, we also investigated vegetation associations in the region. Vegetation survey data from 835 sites in tree mallee revealed three major vegetation associations, which varied in relation to the composition of the overstorey Eucalypts and the understorey, herbs, shrubs and grasses: 1) mallee with an understorey dominated by Spinifex grass, *Triodia scariosa* (Triodia Mallee); 2) mallee with an understorey dominated by chenopods / and shrubby vegetation (Chenopod Mallee); and 3) mallee with an understorey dominated by "heathy" plants (Heathy Mallee) (Haslem *et al.*, 2010). Using satellite imagery, maps of mallee and non-mallee vegetation of the three major mallee vegetation associations were developed (Fig. 3). Although more detailed vegetation maps for mallee vegetation exist within individual states and reserves (eg. White, 2006), this map represents a significant advance for region-wide conservation planning, because it was developed using a consistent method across the entire region. For example, this map can help to identify areas of potential habitat for species that are reliant on particular vegetation associations (e.g. the Mallee Ningaui, *Ningaui yvonneae* and Striated Grasswren *Amytornis striatus*, which are more common in Triodia Mallee (Kelly *et al.*, 2011; Watson *et al.*, 2011b).

Spatially and temporally consistent mapping of fire history

Satellite imagery was used also to develop detailed maps of fire history from 1972 – 2007 (Fig. 4). This represents the most comprehensive map of fire history for this region and provided insights into the fire regimes and the distribution of different post-fire aged vegetation. More than1000 fires burnt ~ 40% of tree mallee vegetation between 1972 and 2007. However, 89% of the burnt area can be attributed to 16 large fires (>10,000 ha). Despite the extensive fire activity, recurrent fire at a single location was rare, with <5% of vegetation burnt more than once (Avitabile *et al.*, 2011). This region-wide map highlights the importance of datasets that cross jurisdictions for conservation decision making. If the fire age class distribution in an individual state or reserve were examined in isolation from the fire history of the surrounding region, vastly different conclusions would be drawn about the overrepresentation or underrepresentation of particular post-fire age classes.

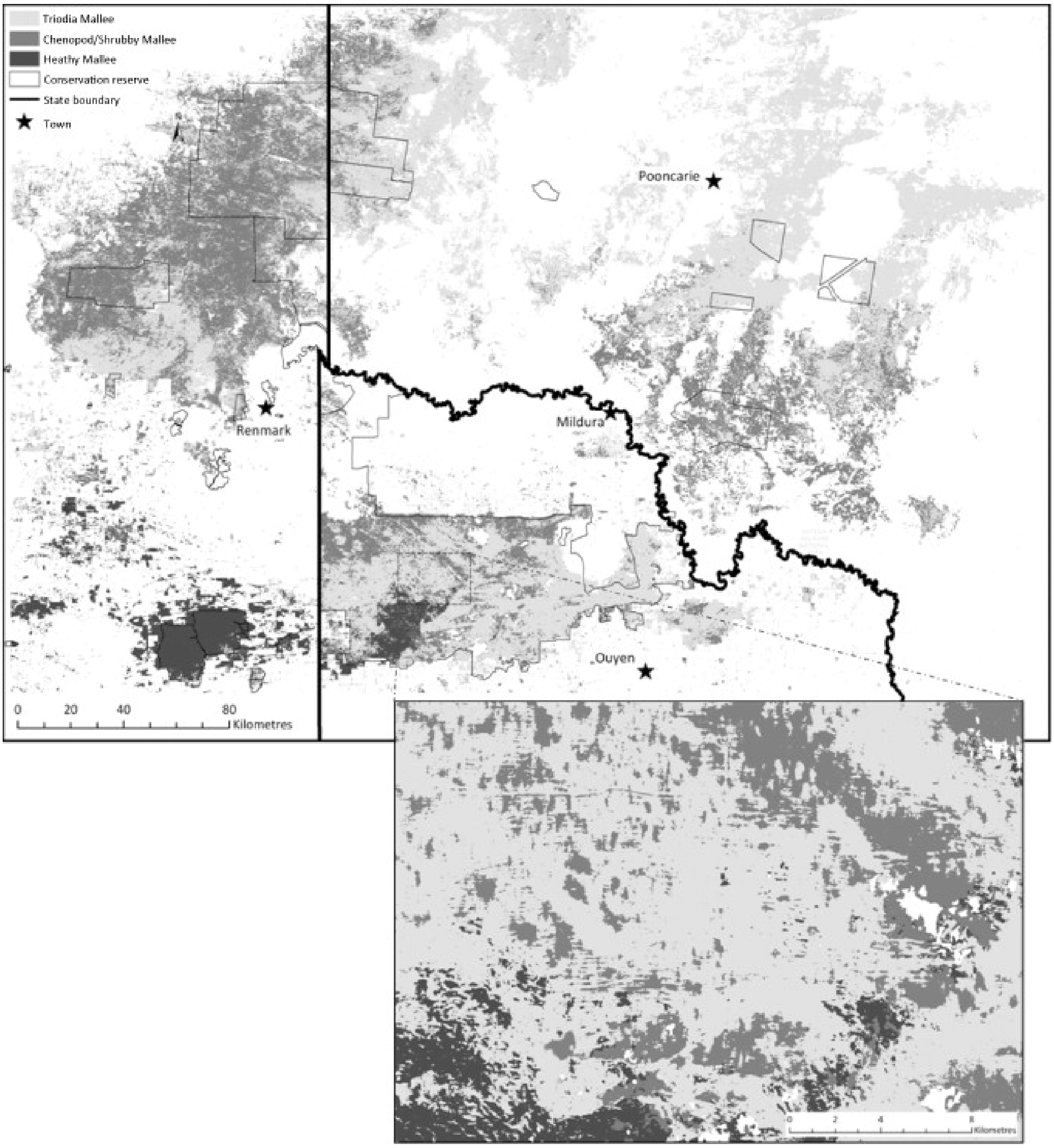

Figure 3. Distribution of three tree mallee vegetation types across the study region, mapped at a 25m resolution. Unshaded (white) areas are non-mallee vegetation (figure taken from Haslem *et al.*, 2010).

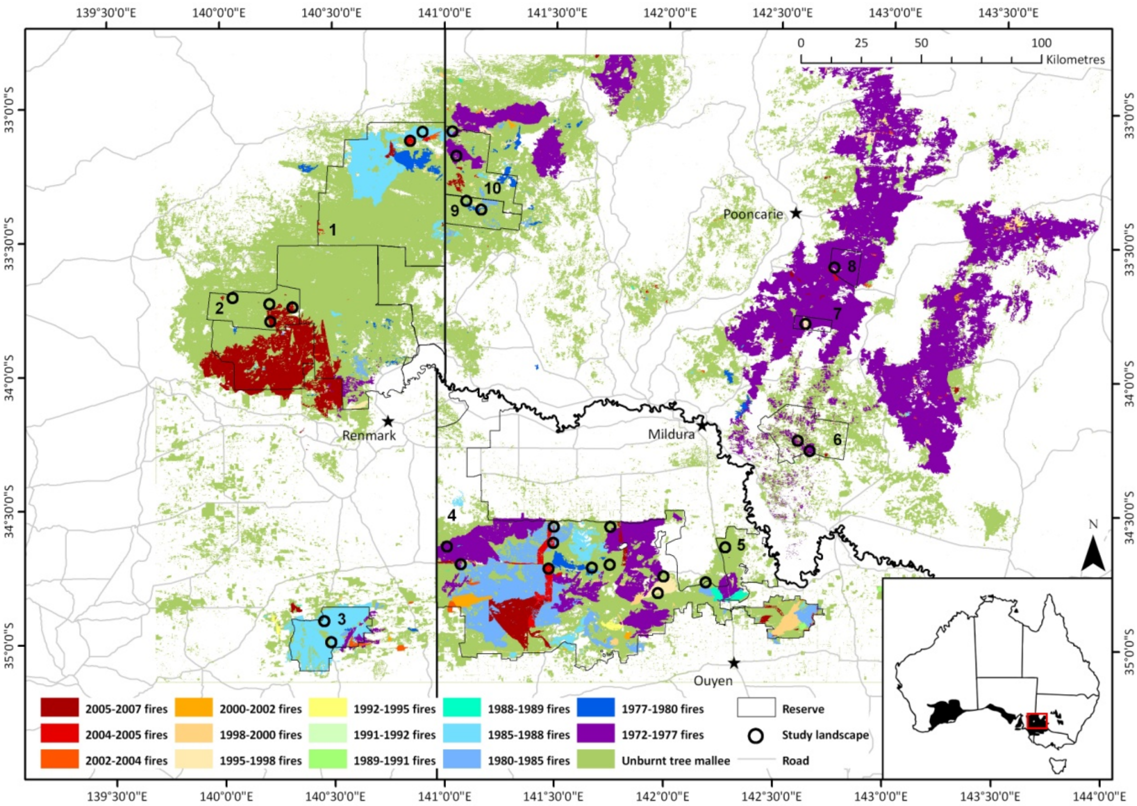

Figure 4. A map of the Murray Mallee study region showing fires from 1972-2007, mapped using satellite imagery. State and reserve boundaries are also shown. Reserves are numbered: 1) Danggali Conservation Park, 2) Gluepot Reserve, 3) Billiatt Conservation Park, 4) Murray-Sunset National Park, 5) Hattah National Park, 6) Mallee-Cliffs National Park, 7) Petro Reserve, 8) Lethero Reserve, 9) Tarawi National Park, 10) Scotia Sanctuary. Circles represent study landscapes. Inset shows the extent of mallee vegetation across southern Australia and the location of the Murray Mallee study region (figure adapted from Avitabile *et al.*, 2011).

Analysing the temporal changes to mallee communities post-fire: extending the chronosequence

Using knowledge of the post-fire age of vegetation, a space-for-time substitution (chronosequence) can be implemented to investigate successional changes in mallee plant and animal communities. This is done by comparing the biota at sites of different post-fire-ages and thus inferring the succession of communities through time. However, satellite derived fire maps only provide the ages of vegetation burnt post-1972, and approximately 60% of mallee vegetation has not been burnt since before 1972 (Avitabile *et al.*, 2011), which indicates that successional patterns continue over longer time-frames. This presents a major challenge because fire management for biodiversity conservation requires knowledge of succession patterns over time-frames commensurate with which the ecosystem functions.

To examine longer term succession processes, models to predict the age of sites were developed on the basis of the diameter of mallee eucalypt stems. Seven thousand and seven stems from 1258 trees at 283 sites of known post-fire age (burnt after 1972) were measured and the data used to generate models of the growth rate for six mallee eucalypt species (Fig. 5). The age of sites burnt before 1972 was then estimated on the basis of the diameter of eucalypt stems at these sites, by following the trajectory of the predicted growth rates. To test the validity of this method, we located 88 ‘validation’ sites in 5 areas, which, on the basis of land management agency records, were known to have burnt in 1917, 1932, 1951, 1957, and 1964 (i.e. 45–92 years since fire). At these sites, a further 1894 stems from 636 trees were measured and the age of the sites estimated using predictive models. There was a strong correlation between the known and predicted age of the sites (Pearson's correlation, $r = 0.71$, $P < 0.001$) (Fig. 6), which indicated that the models performed well for measuring the post-fire age of sites.

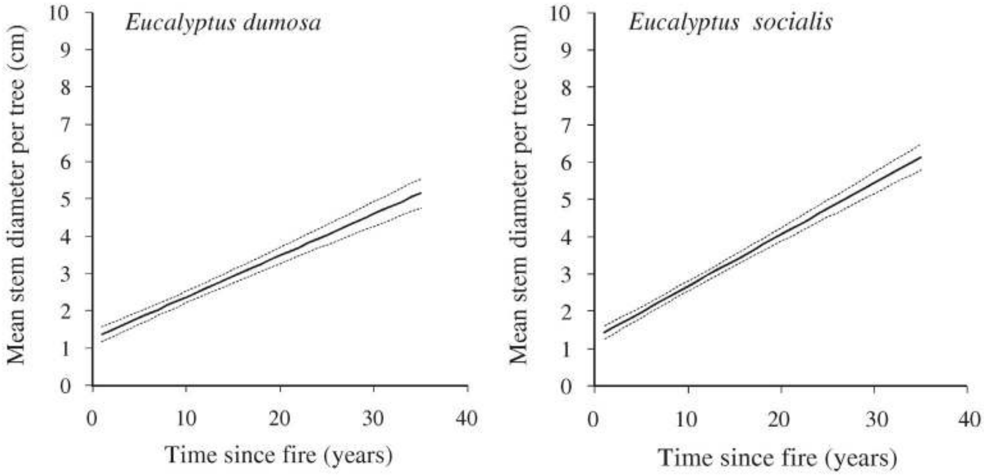

Figure 5. Two examples of the six species-specific models of changes in the mean stem diameter for mallee eucalypts in relation to known time (years) since fire during the first 35 years post-fire (dotted lines indicate 95% confidence intervals) (figure taken from Clarke *et al.*, 2010).

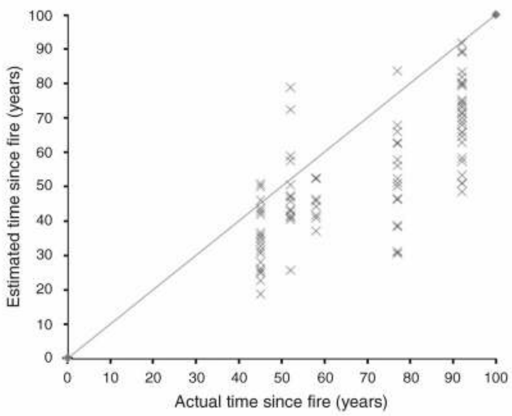

Figure 6. The relationship between the predicted and actual time (years) since fire for validation sites (n = 88). The predicted time was based on averages from species-specific models for eucalypt species at each site. The solid line depicts where a 1:1 correspondence between the predicted and actual ages of sites would fall (figure taken from Clarke *et al.*, 2010).

Advancing our understanding post-fire age distributions of vegetation

Knowledge of the distribution of post-fire vegetation ages is an important element for management of fire. This allows managers to determine if particular fire ages are overrepresented or underrepresented in the landscape. However, inadequate knowledge of the time-frames at which the ecosystem operates may result in inaccurate representation of the post-fire age-class distribution. Using the predictive models described above, the post-fire age of 346 sites burnt prior to 1972 was estimated. These sites had been selected with no knowledge of their likely age, other than that they had not been burnt since 1972.

Consequently, if we assume that these sites are a representative sample of the pre-1972 post-fire age-class distribution, then an understanding of the likely fire age class distribution may be developed.

Comparing the post-fire age-class distribution generated using the predictive models with that generated using only satellite imagery (1972-2007) (Fig. 7) demonstrates the significant truncation of the distribution derived from satellite imagery. The satellite imagery distribution indicates an overabundance of vegetation >35 years since fire. By using the extended data derived from the predictive models to estimate the likely distribution age-classes reveals that this 35+ age class represents a large a range of different post-fire ages up to 160 years-since-fire. In contrast to being overabundant, these older post-fire age-classes are exceedingly rare and may provide important resources for fauna (e.g. large hollows).

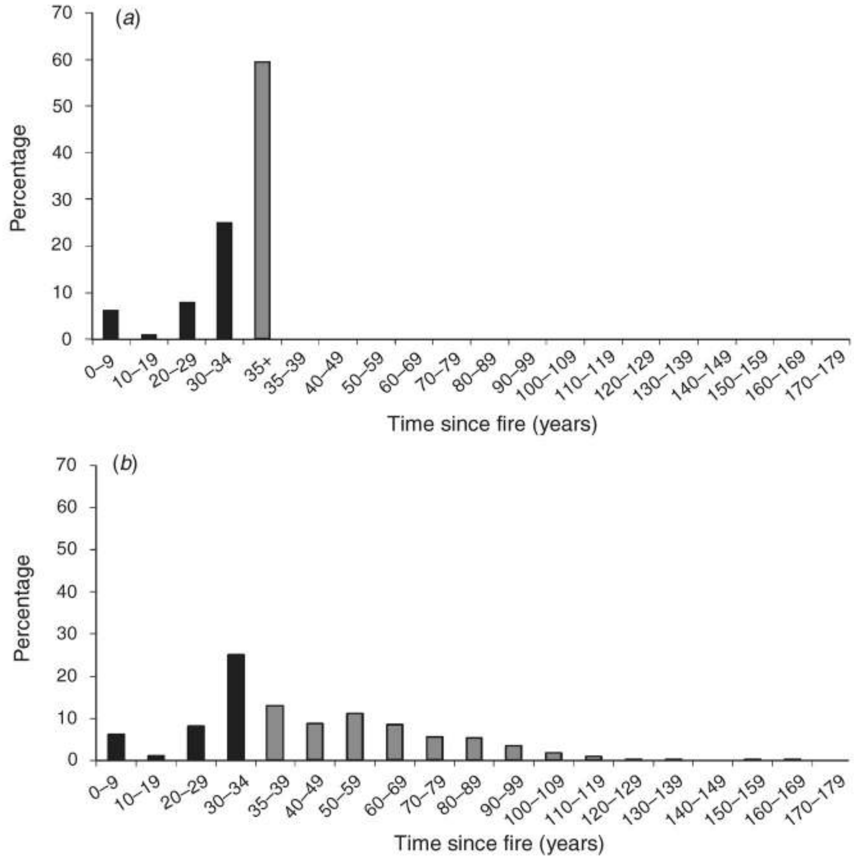

Figure 7. (*a*) Percentage of tree mallee vegetation in the Murray Mallee region of Victoria, NSW and South Australia *known* to fall into particular age classes for time since fire. Percentages were calculated from GIS maps of the region's fire history, derived from all available Landsat imagery for the region (Avitabile *et al.*, 2011) (*b*) Percentage of tree mallee vegetation in the tri-state region *estimated* to fall into particular age-classes for time since fire. Darker bars depict percentages calculated from GIS maps of the region's fire history (as above). Lighter bars depict the distribution of the >35 years age class, on the basis of the assumption that it is proportional to the age-class distribution of 346 sites whose age was predicted using the stem diameter models (figure taken from Clarke *et al.*, 2010).

Post-fire structural changes of vegetation in mallee communities

Vegetation structure influences the suitability of a site for faunal occupancy and affects fuel loads and subsequent flammability of sites, both of which are important considerations for fire managers (Haslem *et al.*, 2011). The extended chronosequence provides a method by which models can be developed for changes in vegetation structure up to 100 years post-fire. These models demonstrate a number of important vegetation changes. For example, mean depth of leaf litter increases up to ~20 years-since fire in Triodia Mallee and ~40 years-since fire in Chenopod Mallee, after which it plateaus. Density of Triodia increased to reach a peak at 35 years-since fire after which it begins to decline and the proportion of hollow bearing stems continues to increase up to 110 years since fire (Fig.8).

The extended chronosequence can also result in different perceptions of how these attributes change when compared to the scenario of only having a limited dataset up to 35 years since fire (since satellite imagery). For instance, litter depth in Chenopod Mallee continues to accumulate approximately linearly up to 35 years since fire. If no further data were available, it might be perceived that at sites >35 years since fire, litter depth would continue to increase and potentially result in much greater fire fuel loads. With the benefit of the extended chronosequence, we can see that mean litter depth plateaus, such that sites between 35 and 100 years since fire do not vary greatly in this attribute. Contrastingly, in Triodia Mallee, the proportion of hollow bearing stems, a critical resource for cavity nesting birds, remains at a very low level up to ~35 years-since fire, after which it increases linearly.

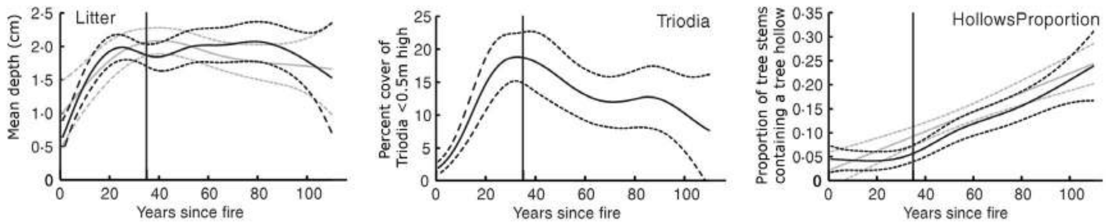

Figure 8. Examples of some modeled post-fire dynamics in habitat ⁄ fuel attributes across a 110-year time-frame. Predicted trends and their 95%confidence intervals are shown for Triodia Mallee (black) and Chenopod Mallee (grey). Vertical lines indicate the extent of temporal understanding based on satellite generated fire-history records (figure taken from Haslem *et al.*, 2011).

Post-fire changes in the occurrence of faunal species

Post-fire succession patterns of fauna, whereby different species become more or less common at different time-since-fire is documented in many fire prone systems (e.g. Fox, 1982). The preference of Malleefowl and Black-eared Miner for later succession stages being a high profile example in mallee ecosystems (Benshemesh, 1990; Clarke *et al.*, 2005).

Changes in species' occurrences were investigated over a century long time-span in the Mallee Fire and Biodiversity Project. Sixteen species of birds (out of 30 species investigated) displayed a significant response to time-since-fire (Watson *et al.*, 2011b). Different species were more common in different post-fire seral stages, 1 species was most common in vegetation <5 years since-fire, 5 species in vegetation 20 – 50 years-since fire and 10 species in vegetation >50 years-since fire (Watson *et al.*, 2011b). Comparing species' responses to time-since-fire with those of vegetation structure, the processes causing changes in occurrence of fauna could be examined. For example, the Mallee Ningaui *Ningaui yvonneae*, a small dasyurid marsupial, was found to be strongly associated with *Triodia scariosa*, and consequently the species is largely absent in recently burnt vegetation until the point where Triodia regenerates to sufficient densities to support the species (Kelly *et al.*, 2010; Kelly *et al.*,

2011) (Fig. 8 & Fig. 9). Through this project the post-fire-age preferences of species of birds, reptiles, mammals and insects have been investigated, providing critical information for conservation management.

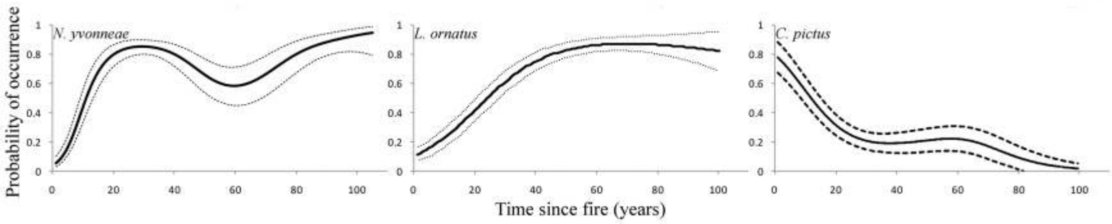

Figure 9. Examples of modelled changes in the occurrence of species with time-since-fire for three faunal species in Triodia Mallee vegetation: Mallee Ningaui *Ningaui yvonneae* (figure taken from Kelly *et al.*, 2011), Yellow-plumed Honeyeater *Lichenostomus ornatus* (figure taken from Watson *et al.*, 2011b). And the Painted Dragon *Ctenophorus pictus* (sites south of the Murray River) (figure taken from Nimmo *et al.*, 2011).

The influence of spatial properties of fires on fauna at the site scale

In comparison to studies of temporal responses of fire, there has been very little investigation of the effects that spatial properties of fire have on organisms. At the site level, the size, shape and patchiness of a fire will affect the context of a burned site and may influence faunal communities through its effects on the distance that animals must travel to escape fire, or to colonise sites from external source populations after fire (Brotons *et al.*, 2005; Knight & Holt, 2005). The patchiness of a fire may affect how a species responds to that fire event. Unburnt patches of vegetation within the fire boundary (biological legacies) may act as refuges, where organisms can escape a fire event. Additionally, these biological legacies may provide otherwise absent resources, making sites that retain biological legacies more attractive for colonisation post-fire.

To investigate how these spatial properties of fire might affect the post-fire community, the effects of the proximity to unburnt vegetation >27 years since-fire and the presence of small unburnt patches ($25m^2$ - $625m^2$) on the bird communities were examined at 72 sites that were <5 years since fire. This analysis revealed that sites further from unburnt vegetation supported fewer species, and those sites that contained small unburnt patches supported more species (Fig. 10). Because patchiness and distance from unburnt vegetation affect the site occupancy of species, we can conclude that fires of different size and configuration are likely to have different effects on the avifaunal community.

The influence of landscape properties of fire on fauna at the landscape scale

Recognition that different species prefer vegetation of diffeent post-fire age has resulted in suggestion that fire management strategies should aim for a mosaic of patches that represent diverse fire histories (Parr & Andersen, 2006). However, there has been little empirical investigation of the influence of landscape properties of fire mosaics (i.e. the extent of post-fire ages and diversity of post-fire age-classes) on biotic communities. To investigate this, the biota was compared in landscapes that varied in the diversity of post-fire age-classes and in the extent of long-unburnt vegetation. Contrary to popular theory we discovered that the richness of bird species in landscapes was positively related to the proportion of older vegetation (>35 years-since-fire), but not affected by the diversity of different seral stages (Fig. 11).

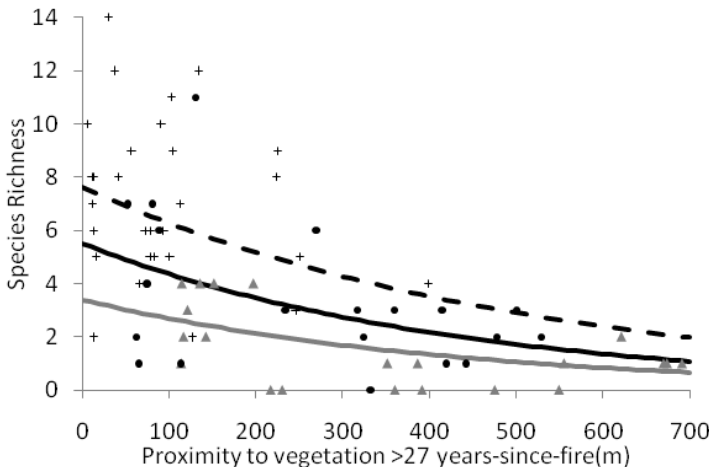

Figure 10. Relationship between species richness of birds and proximity of a site to unburnt vegetation (>27 years-since-fire) for sites <5 years-since-fire. Lines represent the modelled response and points show raw data for each level of the model: black dashed line and crosses = 3 – 4 years-since-fire and patchily burnt, black solid line and black circle points = 3 – 4 years-since-fire and uniformly burned, grey solid line and grey triangle points = <2 years since fire and uniformly burned (figure taken from Watson *et al.*, 2011a).

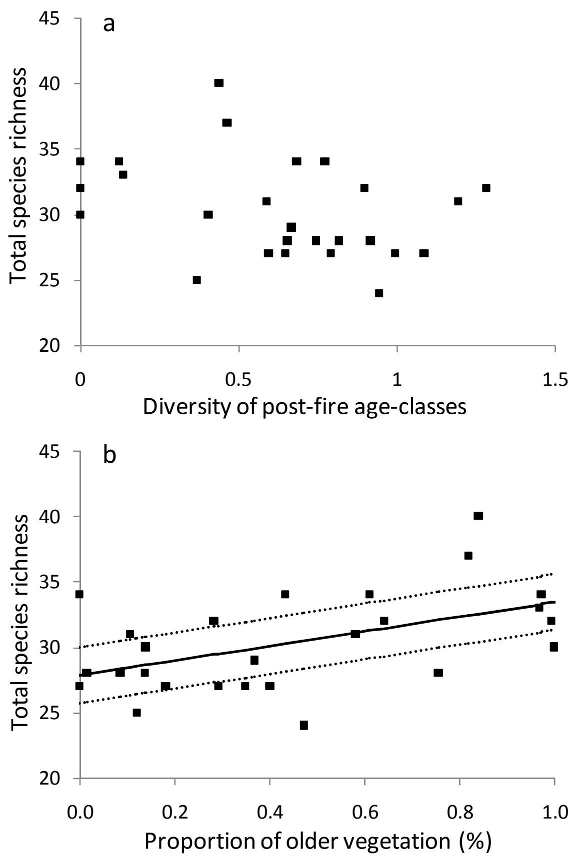

Figure 11. The relationship between total species richness in landscapes and (a) the diversity of post-fire age-classes, and (b) the proportion of older vegetation (>35 years since fire). Predicted trends and 95% confidence intervals (broken lines) are depicted for the proportion of older vegetation (for which the 95% confidence intervals of model-averaged coefficients did not include zero). Squares represent raw data (figure taken from Taylor *et al.*, 2011).

These findings have important ramifications for management. At the scale investigated here (1256 ha landscapes), promoting diversity of post-fire ages does not increase the species richness of birds. The conundrum for fire managers is, that at the site scale, species show multiple responses to time-since-fire, suggesting that fire is required to create a progression of different post-fire ages. However, the results of the landscape scale study are scale dependant, such that although at the scale of 1256 ha species richness increases with extent of vegetation >35 years since fire, at larger scales, such as the entire Murray-Sunset National Park, some level of diversity in post-fire ages will still be required. The future challenge is to gain a better understanding of the importance of diversity of fire-age-classes at different spatial scales.

Conclusion

Fire is widely recognised as an important natural disturbance (Bond *et al.*, 2005; Bowman *et al.*, 2009) and understanding the effects of fire on biota is of fundamental importance for conservation, because different patterns of fire may preserve or threaten ecological communities (Noss *et al.*, 2006; Gill *et al.*, 1999). In mallee ecosystems, bird species, such as the Malleefowl, are threatened by inappropriate fire regimes (Garnett & Crowley, 2000). Here we demonstrate the importance of fire in shaping the biota of mallee ecosystems and highlight the importance of fire management for the conservation of biodiversity in this region.

Temporal changes in species' occurrence and abundance post-fire forms the foundation of much of fire ecology (Brawn *et al.*, 2001; Fox, 1982; Keeley *et al.*, 2005) and knowledge of these patterns is critical to manage fire to benefit biodiversity (Driscoll *et al.*, 2010). The development of methods to age vegetation beyond that which can be achieved through satellite imagery or through historical documents is a key step, which has allowed development of an understanding of species' responses beyond that previously thought capable. The temporal pattern of change in the mallee biota discovered through the Mallee Fire and Biodiversity Project contribute important information for this region, and globally, as few studies have examined the responses of avifauna to fire at temporal scales of up to a century and across large regions greater than 100,000 km^2 (Clarke, 2008). Mapping the post-fire age-classes of up to a century old across the region is an important area for future research. This would thus allow a region-wide, knowledge of the age class distribution of mallee vegetation and provide a means for targeting management.

The influence of the spatial properties of fires on biota is poorly known, presenting a significant knowledge-gap for fire ecology and conservation (Driscoll *et al.*, 2010). The urgency of filling this knowledge-gap is increasing in light of a growing propensity to manage fire to promote 'diverse' mosaics (Bradstock *et al.*, 2005; Parr & Andersen, 2006; Willson, 2006). Here we show that spatial properties of fire affect the patterns of post-fire occupancy of sites in birds. We also demonstrate that the proportional extent of older vegetation influences species richness in this system. Moreover, at the scales measured here, diversity of fire-ages did not result in higher species richness. This suggests that the premise of promoting diverse fie mosaics requires further refinement, particularly with respect to the spatial scale at which diversity is a critical element.

Malleefowl are a species known to require vegetation which has not been burnt for an extended period of time (Benshemesh, 1990). The information attained, and methods developed, through the Mallee Fire and Biodiversity Project provides a useful framework to further the knowledge of how this species is influenced by fire. Applying models to predict the post-fire age of existing survey sites may assist in evaluating long-term trends in species responses to fire, while improved region-wide mapping of fire history offers a plethora of options for evaluating the influence of spatial patterns of fire on this species.

Although there remains much more to learn, the Mallee Fire and Biodiversity project has made significant advances in the understanding of the dynamic relationship between biotic communities and fire in mallee ecosystems, and provides a foundation for future research and management of fire in this region.

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15. Volunteering – Where would we be without volunteers, and can we keep them?

Ann Stokie, Secretary, Victorian Malleefowl Recovery Group

Abstract

This paper sets out to explore the role and contribution of volunteers in Malleefowl conservation and challenges some of the expected wisdom associated with the contribution that volunteers make to environmental causes.

There is a whole spectrum of volunteer structures offering different types of volunteering for frustrated gardeners to highly motivated scientific enthusiasts. All of these volunteers make a significant contribution to advancing environmental projects, but how successful are their efforts?

The context in which volunteers work is significantly influenced and determined by Government and government agencies, and a real tension exists between most volunteer groups and these agencies. Issues such as ownership of projects, attitudes to expert knowledge and valuing the contribution of "local knowledge" contribute to this tension. A question that needs to be addressed is the power of volunteers and whether volunteers have any power.

Through addressing this question, it may be possible to determine why people volunteer, and provide strategies to address ways to attract volunteers to become effective agents of change and influence. Volunteer groups always face fragility of financial pressure and forward planning in a setting where they are not always in control of the agenda or outcomes associated with their environmental issues.

If volunteer groups have real purpose and good organisation, and the trust and respect of land managers and government, then they can be significant leaders in environmental change to address climate change and threatened species extinction. If not, then why volunteer?

This presentation does not seek to give a lecture on volunteering. There are many people who know far more about volunteering than I do, and have studied and written about it.

Rather it tries, to use Julia Gillard's words, "to begin a conversation" about volunteering, to raise ideas rather than to tell you what should be done.

Clearly our interest here is volunteering as environmental volunteers. Most of you who are environmental volunteers have been volunteers in lots and lots of contexts in all of your lives. You have been volunteering for a long time and so have I. In fact one of my earlier memories was getting in trouble when I was a pre-school child helping my grandmother with the flowers in the church and deciding to baptise the altar and that was one of my earliest volunteering experiences.

I will get a bit away from conservation volunteering and talk about volunteering in a general way. I will take another volunteer organisation that I have had a lot to do with over the years, and it is very different to environmental organisations. I wondered if its success might be able to give us a few ideas as to the things we could do.

Now this organisation is Australia wide, it has got thousands of volunteers, it is extremely well supported by Federal, State and Local Governments, it is quite powerful in how it lobbies, and interestingly and differently to lots of volunteer concerns that I see and hear, its spike of members is between 17 and 35, so it has lots of young people. What I am referring to here, if people are trying to add it all up, is Surf Life Saving in Australia.

It is very different; it is big enough to have paid staff, but nevertheless it is 96% volunteers, and it has been going a long time, and it attracts a massive amount of funding - it gets corporate funding, it gets philanthropic funding. How come the Victorian Malleefowl Recovery Group doesn't?

I suppose that was my opening question. What's the difference as it were, I think Surf Life Saving has some things that we can use. First of all it has thoroughly flogged its brand. It is everywhere. It is stuck on cereal packets, stuck on tourist things. If the Koala huggers can do it why can't we? Why can't we flog Malleefowl like that, so whenever tourists start thinking – Wow Malleefowl.

Another thing that Surf Life Saving does, and does very effectively, is that it grabs its volunteers very young. It starts them at eight when they are on the beach in the holidays when kids are bored silly and mum and dad have run out of ideas to entertain them, and it provides free baby sitters, and it is called the Nippers Program. It is very carefully well thought through (I am being cynical here. I have run Nippers programs). It's a ploy. It is a way of getting the kids when they are little, and when next year they come back they all get their free packs, their free T-shirts, and all this sort of stuff and they are so excited. By the time they are twelve when they are finished the Nippers Program they are ready to do their Surf Live Saving Certificate and once they have done that they do their Bronze and then they are on the beach patrolling. That's the way Surf Life Saving replenishes its members. Quite a powerful recruiting tool, in my opinion.

Another thing that I think Life Saving manages to do, and lots of organisations are successful at too, is that they hold their members, sometimes for a life time, simply because they have a range of different things for people to do as they progress. As I read through the literature associated with volunteering, it does seem that people volunteer in different ways when they are in different age groups. The sort of mad running around with surf type stuff, which is fine for adolescents and 20 year olds, doesn't really work as well as people get older, and people want to do other things, so then people volunteer to care for the young ones, to teach as it were, to pass on skills.

You might well have seen in your lives too that sort of volunteering happening. You go through stages where you volunteer to wash the Under 8 football jumpers for a few years. You do kids things, volunteer for the children's school and work like that in your community when your children are young, and then you do things to get your children through, and then you do other kinds of volunteering.

I have kept suggesting things that might be helpful in recruiting young people in being able to keep our volunteers going by having a range of tasks and tasks suitable for persons of different sorts of ages and abilities as not everybody wants to do the same thing.

In a slightly more formal way I had a look at the things volunteers had to say in the various pieces of literature about what it was they wanted or valued in their volunteering. They said that what they wanted was recognition. Now I can hear something of the despair from in the Malleefowl Preservation Group and the North Central Malleefowl Preservation Group in Western Australia where they are not recognised. They are not valued by their agencies. It is very difficult to battle on when that happens.

So the message needs to be out there to the agency people. How do you recognise your volunteers? How do you involve them in other things in your decision making, particularly when older people with life time experiences come along to volunteer and are not necessarily impressed at being treated like children?

I have had a famous run in at one stage with one rather overweight young man who told a rather skinny me that he was here to develop (grow) my capacity. And I was rather rude, and you have to understand your Shakespeare to get this one...
The nurse said to Juliet "Women grow by men", which is what I said to him, and he didn't get it either. Obviously I had a capacity in literature and he didn't.

So people who like to get involved don't argue about decisions, they are not children. They bring a life time of experience. It may not be immediately obvious what it is they bring, but they certainly bring it and being part of decision making is something that keeps people going.

Volunteers apparently value learning opportunities. Certainly one of the things that I have valued working with Malleefowl people is that I know nothing, I am not a scientist, I knew nothing about most of the stuff when I began. So that is something which is coming out of the literature.

Volunteers are bothered by the relationship between paid and unpaid people. Again this is a general statement for things like fire people, all sorts of volunteers, and these are the things that are bothering them. The organisations on the other hand are bothered about how to get volunteers involved. What else can they do to get people involved? What's wrong? How do we manage volunteers? These are top down stuff. Volunteers are coming from the bottom up.

I have always thought, and I have spoken about this model before, the most powerful model we have is to base ourselves extensively on the principles of engineering and to work on the model of an equilateral triangle. It is the most powerful structure you can make, so if on one arm of the equilateral triangle is equilateral – equal – are the scientists, these are the people who drive the ideas. One arm are the organisers, your administrators, managers whatever word, and the third arm are the volunteers, and if you can have that equal then you have got something extremely powerful. Hard to do I know.

I have been in a position as manager in schools working with volunteer parents. It is not always easy to balance the power relationship when you are a paid person, and also if you have to answer to others further up the line if you are not getting it right. If you can get it right, I believe it is a very powerful thing.

So, branding, getting kids, getting young people involved, finding diverse ways to keep it working, and in the end, I suppose, having lots and lots of fun, enjoying it. Nobody ever does things if it's not for some reward, even horrible things like changing dirty nappies, which happens to be my bete noire anyway.

So I am going to end with a bit of writing which seems to me to sum up my enthusiasm. It says: "With intelligence, with persistence, above all with enthusiasm, with these things you can work miracles"......and that's true because I have seen it happen.

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16. A landowner's story of Malleefowl conservation in the SA Murray Mallee and the establishment of the Browns Well Landcare Group

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Abstract

On my property, seventy kilometres south of Renmark, and to the north-west of Billiatt Conservation Park, I have seen the vegetation recover since early land clearance for farming and the bushfires of 1983-1987. The area provides key habitat for Malleefowl and with around 1200 hectares of this vegetation under Heritage Agreement, the protection of these birds is a priority for my wife Trish and I. Over many years I have carried out rabbit and fox control in an effort to protect the Malleefowl and its habitat. In the 2010/11 nesting season, an active Malleefowl mound was monitored using a motion detecting camera, with the assistance of the local Bush Management Advisor Chris Grant (Department of Environment and Natural Resources). This has provided information about the activities of the birds throughout the exceptionally long laying season this year.

Landholders in the Browns Well area play a key role in Malleefowl conservation. The Browns Well Landcare Group was formed in 2007 to coordinate rabbit and fox control and has gone on to play a key role in the control of goats which are causing damage to vegetation in the area.

In January 2011, I travelled with six other Malleefowl conservationists from the South Australian Murray Mallee to Ongerup in Western Australia to share and learn about experiences in Malleefowl conservation with the Malleefowl Preservation Group.

In 2011, foxes and cats remain the key threats to the Malleefowl in the Browns Well area and are the priority for the conservation of the species.

Presentation

Back in 2006 whilst seeding one of my paddocks, we happened to see a fox stalking a pair of Malleefowl on the edge of the cropping ground. Up until this time, we may have seen a couple of Malleefowl a year.

I decided to do a fox-baiting programme. In the first 4 weeks, I lost 208 baits. Within 8 weeks and using 28 bating stations, I lost 381 baits. I realised then that maybe this was the reason we had not seen too many Malleefowl as well, as farmers were losing lambs to foxes.

In September 2007, we formed the Browns Well Land care Group with the idea of a co-ordinated approach to rabbit, fox and goat control in our area.

Working with National Parks and Wild Life and Sporting shooters in both SA and Victoria and Kelvin Barr a professional sheepherder, we have eliminated 3 – 4,000 goats in the last two years in our parks and heritage areas. Kelvin has achieved the best results so far. On one occasion, Kelvin and his son took a trip along the border when his dogs could smell goats. He released the dogs to round up the goats in the scrub but darkness fell, so he went home and got back at day break next morning to find his dogs sitting in the paddock with 126 goats rounded up.

Within two years of laying fox baits, the sightings of Malleefowl were increasing. We were seeing 25 – 30 Malleefowl feeding in 500 acres. A friend told me, back in the late 70's early 80's one afternoon they saw 34 Malleefowl feeding in a paddock bordering my property and that same night they shot 70 foxes in that paddock. That was when fox skins were worth money but how vulnerable were these birds.

Until this year, we had never seen a Malleefowl chick or a half grown Malleefowl. Since June 2010 with the help of the Department of Environment and Natural Resources (DENR), we set up a motion camera over one of our Malleefowl mounds. We have certainly learnt a lot on the preparation of the mound from moisture needed to egg laying to heating the sand. The number of foxes as well as feral cats visiting the mounds is a huge problem. We have also seen a couple of Malleefowl chicks; one appeared while watching the adult birds working on the nest. I caught one of the chicks to take photographs, and then called him Lucky Lewy wished him good luck and I hope he is still alive today. I have also witnessed in 2007 a Wedge-tailed Eagle attack Malleefowl. They abandoned the mound that year.

In January 2011, seven of us visited Sue Dennings and her volunteers in WA to see the new Malleefowl centre at Ongerup. We had the chance to see the work they are doing with Malleefowl on the few scrub blocks that are left - they have set their sights high. We thank Sue for her enthusiastic work in WA.

This past year I have monitored 15 active mounds on my property. I have had over 540 baits taken from 35 bait stations - the most ever. All 15 active mounds had signs of foxes at those mounds, especially from January to April, which coincides with the hatching season. Also at the mound with the camera, there were photos of feral cats present.

Maybe a breeding programme to set up in each state and letting them grow to adults before releasing them. Maybe an education programme for the Malleefowl through the schools.

In closing, I see foxes and cats as the biggest danger to this vulnerable bird. Fox baiting is only a part of the solution. To have a good price for fox /cat skins or a bounty on foxes could encourage more people. We need to get more people involved in the eradication of these feral pests. Farms are getting bigger and country towns are dying. People are moving to cities or larger country towns and there are less people to volunteer their time. Let us hope there is a solution before it is too late to save this unique bird.

17. Twenty years of Malleefowl conservation by the Mantung Maggea Land Management Group

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Abstract
Starting in 1981 when Les and John Evans voluntarily placed the first parcel of land under Heritage Agreement, the Mantung Maggea Land Management Group was formed in 1991 by twelve landowners with Heritage Agreement land in the Mantung Maggea area in the Murraylands of SA, including Les and John. This was the first group established to protect Malleefowl in South Australia. The group of landholders continues the work today with coordinated fox and rabbit control to protect the Malleefowl and its habitat over an area of over 18,000 hectares of heritage scrub on over 55,000 hectares of privately owned land. The group carries out rabbit and fox baiting and rabbit warren destruction. After twenty years the group is still as enthusiastic as it has ever been. Even after drought, Malleefowl numbers are remaining sustainable and with the good season we have just had, active Malleefowl mounds have increased with a large number of hatchings. Over the many years of conservation work, the group has made many observations about Malleefowl and their habits. It is this long term knowledge that the group believes could guide future conservation work.

Introduction
Les and John Evans were active Malleefowl conservationists in the Mantung area in the sixties when they were in their teenage years. They recognised back then, the importance of protecting the birds' habitat and convinced their father to stop clearing the old growth mallee for farming. In 1967 Les and John's enthusiasm for the mallee grew when they met Colin Harris, a student who came to the area to do his honours thesis on 'The Hundred of Mantung'. A lifelong friendship began between the men who shared this passion for conservation. Colin graduated and went on to work for the Department of Environment.

In 1981, Les and John, with Colin's guidance, placed a parcel of land under a Heritage Agreement, which meant that the vegetation was protected from clearance but still remained owned by the landowner. This was one of the first Heritage Agreements signed in South Australia. Colin became aware of a large patch of high quality vegetation in the Mantung area that was to be cleared by the landowner and tried to protect it. The fight was hard but resulted in the government paying compensation to the landowner for protecting the vegetation with a Heritage Agreement. The patch of land is now known as Bakara Conservation Park. This began a new era of Heritage Agreements where landowners were compensated for the loss of production caused by protecting the vegetation.

A group of twelve landholders took the opportunity to sign Heritage Agreements in the Mantung Maggea area, protecting large areas of Malleefowl habitat. In 1991 this group of landholders formed the Mantung Maggea Land Management Group (MMLMG) with the aim of managing these areas of protected vegetation. The group recognised the importance of protecting the Malleefowl that used these areas and set out to actively manage the protected vegetation in the hope of protecting these birds.

Management plans
In their first year, the Mantung Maggea Land Management Group worked with the Department of Environment and Planning to develop a publication titled *How to manage native vegetation in the Murray Mallee*, which included *A Conservation Handbook, A District Guide* and individual management plans for each of the Heritage Agreements in the area. The management plans detailed the management issues and actions required to protect and conserve the wildlife of the area.

Action

The work began and the first job was to fence the protected areas from stock. Over the next few years the group managed to fence off all heritage scrub in the area.

Rabbit numbers were high in the area and the control work was the next priority. Over the years, the group has maintained an ongoing rabbit control program of baiting, rabbit warren ripping and fumigation. Numbers have reduced and these days, the program is carried out to maintain the good work that was done in the past.

Fox and cat predation is a major threat to the Malleefowl in the Mantung Maggea area. The group was the first in SA to be given permission to use 1080 baits. The baits are laid under small sand mounds and attract the foxes but not the birds or lizards. The meat used for these baits has varied over the years from fish, chook heads and eggs, to kangaroo and small meat sausages. The group baits for foxes in September and March. Cat control is more difficult. Traps have been trialled but shooting seems to be the most effective option.

Other issues such as bird poaching have been addressed by the group, leading to tougher laws against taking native birds from nests within the Loxton, Waikerie and Karoonda East Murray Council areas.

Kangaroo numbers have grown to be over abundant in the area and the group has worked with a local Kangaroo meat processing company to keep numbers at a manageable level.

The MMLMG is an incorporated group which makes it possible to access various sources of funding to carry out its work. It holds regular meetings and an Annual General Meeting with a bush tour included.

Results

The pest control program has resulted in reduced rabbit numbers. Rabbit warrens are smaller in both numbers and size since the regular rabbit control program has been implemented. This may provide more food sources for the Malleefowl and leaf litter for mound building. Fox numbers are managed although they vary with seasons. Lambing survival rates have increased in the area which is an indication of a successful reduction in fox numbers. Foxes and cats remain a threat to Malleefowl in the area and this is an ongoing struggle.

Malleefowl numbers do vary throughout the heritage areas. Observations by farmers show an increase in some areas and a decline in others. One observation is that the birds are building their mounds in regrowth mallee where chaining and burning has occurred around twenty five years ago. They appear to be choosing these regrowth sites over old growth areas, perhaps due to more available leaf litter.

Conclusion

The MMLMG is passionate about the mallee and the dedicated group members carry on Les and John Evans' dream to protect and conserve the Malleefowl population in the Mantung Maggea area. The MMLMG now has over forty years of Malleefowl observations through quietly watching the birds in the area. This information covers seasonal conditions, numbers of birds over the years, fire history, distribution and choice of sites. The group believes that this long term information they have gathered could be vital in understanding the Malleefowl and its conservation needs.

18. Conservation genetics of Malleefowl

Keynote: Taneal Cope, PhD Student, University of Melbourne

Authors: Taneal Cope[1], Raoul Mulder[1], Peter Dunn[2] and Steve Donnellan[3]

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Extensive land clearance in Australia over the past 100 years has led to wide scale fragmentation of Malleefowl habitat. Consequently, the Malleefowl has suffered a large reduction in range and many populations now exist in small, isolated fragments. Small populations typically have reduced genetic variation because of mating between close relatives (inbreeding) or accelerated random loss of alleles over time (genetic drift). Reduced genetic variation and inbreeding can lead to reduced reproductive output causing further declines in population size and viability (Frankham, 2002). Understanding the vulnerability of Malleefowl in this regard is an essential step in planning their management strategies. This project has three main themes: 1) phylogeography and population structure, 2) mating systems and reproductive behaviour, and 3) landscape genetics. This is the first large scale investigation of Malleefowl genetic variation to be conducted.

Phylogeography and Population Structure

There has been no previous investigation into the genetic structure or phylogeography of Malleefowl and currently the questions surrounding population subdivision remain unanswered. We plan to investigate the level of population structure across the range of Malleefowl to determine:

1. Whether any subpopulations of Malleefowl exist.
2. Whether past or current gene flow is responsible for the current genetic patterns observed.

We will be addressing these questions through analysis of mitochondrial and nuclear genes. The amount of sequence divergence between populations will determine whether populations can be separated as different subspecies. We plan to analyse samples collected across the contemporary range from Western Australia, South Australia, Victoria and New South Wales.

Mating systems and reproductive behaviour

The understanding of genetic variation within a population, as well as the variation in genetic contribution of individuals to future generations, is essential for conservation and management of that species (Quader, 2005). Biased reproductive success can limit populations by reducing genetic variation (Lacy, 1987). Malleefowl have been noted as generally monogamous, although polygamy has been recorded (Weathers, 1988). In most bird species the social mating system is often a poor reflection of genetic parentage (Birkhead & Moller, 1996).

We aim to investigate:

1. Parentage of Malleefowl chicks to determine the mating system of this species.
2. Site fidelity and use of Malleefowl mounds in sequential years
3. Sex ratios of young produced in each mound

This will involve collecting samples from offspring and mound-tending adults. DNA will be extracted and nuclear microsatellite markers will be genotyped to identify the putative parents for each "clutch".

We also aim to document the primary sex ratio of Malleefowl clutches to determine the average proportion of males and females laid in each mound. Biases in the number of a certain sex produced could have large consequences on the survival of a population (for example, if only males are produced for several years).

Landscape genetics

One of the main objectives of the Malleefowl Recovery Plan is to undertake genetic investigation of populations (Benshemesh, 2000) so that management decisions can be made.

Populations of Malleefowl have been subjected to extensive land clearance leading to fragmentation and isolation of a once continuous population. The severity of the impact of this fragmentation and isolation is not yet understood, but Malleefowl are reluctant fliers and apparently do not disperse readily across open country (Frith 1962; Benshemesh 2000). Understanding if and how Malleefowl are moving between remnant patches of mallee will be invaluable in aiding management decisions on the need for habitat corridors between remnants. This part of the study will concentrate on the factors that influence gene flow between isolated fragments in South East South Australia/ North West Victoria. We will use microsatellite markers to determine population of origin and any evidence of immigration between patches.

***Note:** *It is anticipated that this study will be completed in 2012 and the results published in due course*.

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19. Effects of locust control activities on Malleefowl nesting success

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Abstract

In response to the Australia Plague Locust (*Chortoicetes terminifera*) outbreaks during the high rainfall season of 2010-2011, insecticides were sprayed across the landscape including the Murray Mallee, South Australia. A threatened bird and generalist feeder, the Malleefowl (*Leipoa ocellata*), is known to feed on scrub margins where locust control was expected to occur. In order to determine whether insecticide application impacted on Malleefowl, we monitored nesting success at 17 mounds (Malleefowl nests): 4 mounds were subject to aerial and ground-based spraying between 200 metres and 5 kilometres from the mounds (SPRAY), 4 mounds were within 4 kilometres of ground-based spraying only (LIGHT), and 9 mounds were not near any locust control activities (NO). Reproductive characteristics were monitored every 3 weeks, including egg laying and hatching rates, egg dimensions and mound temperature. Samples of feathers, scats and egg membrane were collected for chemical analysis.

Mounds close to sprayed areas had higher average clutch size and more regular laying rate compared to mounds away from sprayed areas. The average clutch size for SPRAY mounds, 44 (± 1) eggs, was almost double that of LIGHT mounds, 23.5 (± 8) eggs and NO mounds, 21 (± 3) eggs. Egg laying rate at SPRAY mounds was constant from October to early March, with eggs laid on average every 3.7 to 5.1 days, whereas at NO mounds eggs were laid on average every 5.9 to 11.4 days. Hatching success was around 60% for SPRAY, LIGHT and NO mounds when grouped together, but there was large variation between individual mounds (4% to 100% hatching success). Average estimated egg incubation time was similar for SPRAY, LIGHT and NO mounds: 41 days in late December to between 59 and 77 days in mid-May. Average egg volumes were similar at SPRAY, LIGHT and NO mounds (169.38mL, 167.34mL, 168.56mL respectively), and average egg density was highest at SPRAY mounds ($1.045 g/cm^3$).

Fenitrothion, Chlorpyrifos, Alpha-cypermethrin or Malathion were not detected in any feather, scat or egg membrane samples below the minimum detectable limit (range 0.01 mg/kg to 0.05 mg/kg). Thus, the study does not show the reproductive effects of insecticide toxicity in Malleefowl, as we cannot prove Malleefowl absorbed insecticides: either insecticides were present yet degraded or not present at all. However, the steady nesting output shown throughout and after the spraying period, with outputs at SPRAY mounds equal to or better than other mounds, suggests Malleefowl nesting success was not affected by locust control activities of spring 2010.

Introduction

During spring 2010 in south-eastern Australia, two important biological events were expected to coincide: the largest swarm of Australia Plague Locusts (*Chortoicetes terminifera*) in decades, and a productive breeding season for many fauna. Routine control of locust plagues involves aerial or ground-based spraying of organophosphate insecticides, or use of environmentally sensitive fungus, *Metarhizium anisopliae* var. *acridum*, trade name 'Green Guard'. Organophosphates are neurotoxic, and have been shown to effect behaviour of birds and other vertebrates, including a 'depressed' behaviour, where activities such as feeding, incubation and territory defence are reduced (Busby et al. 1990, see Walker 2003, Story et al

2005 for review). Organophosphates cause behavioural effects by inhibiting the brain cholinesterase group of enzymes.

A nationally threatened bird, Malleefowl (*Leipoa ocellata*), is a generalist feeder known to eat grasshoppers, to which locusts are related, as well as seeds and other insects (Booth 1986). Malleefowl have been observed feeding on scrub margins adjacent to crops (Copley and Williams 1995). Given locusts 'band' together during development often on scrub margins, locusts control was expected on scrub margins in spring 2010. This study aimed to determine: (1) If insecticides were absorbed into the Malleefowl's bodily systems, including dietary or reproductive system; and (2) If Malleefowl reproductive success differed between areas with locust control (insecticide spraying) and areas without locust control.

Methods

Site selection occurred before the onset of locust control. We aimed to study Malleefowl in close proximity, within a few hundred metres of sprayed areas, to ensure we were monitoring Malleefowl exposed to insecticides. However, without knowing in advance where spraying would occur, and without control over where Malleefowl chose to nest, we selected mounds that were as geographically spread across the region and close to scrub edges.

Monitoring occurred at 17 mounds (Malleefowl nests) across 8 different sites in the Murray Mallee, South Australia. Monitoring commenced during the week 18/10/2010 to 22/10/2010 and reoccurred at each mound approximately every 20 days until activity ceased on the mound or until 4/3/2011. Additional monitoring was undertaken during the week 4/04/2011 to 6/4/2011 and 11/05/2011 to 19/05/2011 due to the lengthy breeding season. In total, each mound was visited up to 9 times.

On each visit, the Malleefowl mound was excavated to the egg chamber. The chamber and surrounds was searched thoroughly for new eggs and hatched eggs (clump of membrane and shell). Eggs were marked at their apex with a soft pencil so the progress of each egg could be recorded over the monitoring period. New eggs were measured, including length (mm) and width (mm) (width of the narrowest of the two short axes) using callipers, and weight (gm) using a spring balance. During egg measurements and handling, eggs were kept in the same orientation as they were laid. Eggs were replaced into the egg chamber and their positions sketched in an egg chamber map. Egg membrane was identified as a particular hatched egg by the position of the membrane relative to the egg chamber map. Rotten or broken eggs were removed from the chamber. The mound was returned to its original shape.

Additional data collected at the mound included: shape of mound upon arrival, presence of Malleefowl, time and weather at start and end of mound excavation, signs of foxes (scat/footprints) and presence of locusts at mound or nearby.

In each mound, Thermo Logger™ (Thermodata Pty Ltd) temperature loggers were placed at the base of the egg chamber to record temperature at hourly intervals. On some occasions, the temperature loggers were found outside the mound, and it was assumed the bird had kicked the logger out of the chamber. Therefore, egg chamber temperatures were taken from the time placed into the chamber to the time removed or suspected to have been removed by the Malleefowl. Temperature data will be discussed in future papers.

Malleefowl samples collected for chemical analysis included: Fresh Malleefowl scats, Malleefowl feathers, and hatched egg membrane. All samples except for feathers were immediately wrapped in foil and a zip-lock bag, placed in an esky on site, and frozen at the end of the day. Feathers were placed in envelopes, the quill was cut from the feather and kept for genetic analysis, and the remaining feather part was then frozen in foil. In total, ten 50 gram frozen samples were sent to Symbio Alliance Laboratory in Queensland for analysis of Fenitrothion, Chlorpyrifos, Alpha-cypermehtrin and Maldithion. Analysis was mg/kg of sample as received (not dry weight). Membranes from the same spraying category but different mounds were grouped to reach the required 50 gram sample weight. Feathers and scats were similarly grouped.

Preliminary statistical tests were two-way ANOVAs between means (JMP version 8.0.2 SAS Institute Inc. 2009) unless otherwise stated. Further statistical analysis will follow this paper.

Results

Locust control activities in relation to Malleefowl mounds

Department of Primary Industries and Resources South Australia (PIRSA) conducted locust control activities in the Murray Mallee between 23/10/10 to 2/12/10. These events included either aerial or ground spraying of insecticides and Green Guard. However, landholders neighbouring the native scrub blocks containing our studied Malleefowl mounds commenced ground spraying for locusts earlier than October; June was the earliest report of spraying by landholders (N. Marks pers. comm., K. Berlin pers. comm.).

By considering the proximity to aerial spraying by PIRSA and ground spraying by landholders, the 17 mounds were categorised into three groups: 'Spraying', 'Light Spraying' and 'No Spraying' (Table 1). For this study, any spraying within 3 kilometres of mounds was considered as potentially overlapping with Malleefowl home ranges, which have been reported as around 4 square kilometres in the breeding season (Booth 1987). Any spraying by landholders within 5 kilometres was included, as the exact location of spraying on landholder properties is not always recorded.

Table 1 Monitored Malleefowl mounds grouped together based on proximity to areas sprayed with insecticide.

Category	Number of mounds	Geographic region	Aerial Spraying within 3 km	Landholder ground spraying within 5 km	Chemicals used
Spray	4	Mantung-Maggea	1 – 2.3 km (27/10/11 and 21/11)	200 metres – 4 km (June/July to November 2010)	Fenitrothion Alpha-cypermethrin Chlorpyrifos *
Light	4	Peebinga	No	2 km – 4.5 km (June/July to November 2010)	Alpha-cypermethrin Chlorpyrifos
No	9	Murray-Bridge	No	No	-

* Malathion (Trade name: Maldison) was aerially sprayed 4.2 km from a SPRAY mound, so was included for chemical testing to cover all possibilities.

Table 2 Results of insecticide testing on samples of Malleefowl scats, egg membrane and feathers.

<table>
<tr><th>Spray category of 50 gram samples (number of mounds in sample)</th><th>Date range when samples were collected from the field</th><th>Chemical</th><th>Result</th></tr>
<tr><td>Scat</td><td></td><td rowspan="15">Fenitrothion
Alpha-cypermethrin
Chlorpyrifos
Malathion</td><td rowspan="15"><0.02 mg/kg
<0.05 mg/kg
<0.01 mg/kg
<0.05mg/kg</td></tr>
<tr><td>Spray (4)</td><td>15/11/10 – 9/12/10</td></tr>
<tr><td>Light (4)</td><td>8/11/10 – 30/11/10</td></tr>
<tr><td>No (7)</td><td>21/10/10 – 20/12/10</td></tr>
<tr><td>Membrane</td><td></td></tr>
<tr><td>Spray (3)</td><td>22/12/10 – 01/03/11</td></tr>
<tr><td>Spray (1)</td><td>11/11/10 – 03/03/11</td></tr>
<tr><td>Light (4)</td><td>20/11/10 – 28/02/11</td></tr>
<tr><td>No (1)</td><td>11/11/10 – 04/04/11</td></tr>
<tr><td>No (7)</td><td>21/10/10 – 04/04/11</td></tr>
<tr><td>Feather</td><td></td></tr>
<tr><td>Spray and Light (8)</td><td>October 2010 – December 2010</td></tr>
<tr><td>No (8)</td><td>October 2010 – December 2010</td></tr>
</table>

Chemical analysis
Insecticides were not detected in any scat, feather or membrane samples, from SPRAY, LIGHT and NO Spaying mounds, below the minimum detectable limit (Table 2).

Reproductive measures
Reproductive measures of nesting success are compared between spray categories as total outputs of the season and over time. All averages are reported ± 1 standard error. For the SPRAY category n = 4, LIGHT n = 4, and NO n = 9 unless otherwise stated.

Clutch size
Across 17 mounds, Malleefowl laid 463 eggs in the 2010-11 breeding season. The average clutch size for SPRAY mounds, 44 (± 1) eggs, was significantly larger than, almost double, that of LIGHT mounds, 23.5 (± 8) eggs and NO mounds, 21 (± 3) eggs (ANOVA, $F_{2,14} = 7.63$, $p = 0.0057$).

All four mounds in the SPRAY area had total clutch sizes larger than 40 eggs, and laying rate was constant from October to early March, with eggs laid on average every 3.7 to 5.1 days (Figure 1). Egg laying slowed from early March to early April. Egg laying at LIGHT mounds was more varied, with clutch sizes ranging from 4 to 42. Eggs were laid on average every 4.1 to 5.5 days from October to early January, and then slowed to early April. In areas without spraying, 'NO mounds', egg laying varied throughout the season. Clutch sizes ranged from 8 to 37, and eggs were laid on average every 5.9 to 11.4 days until early April.

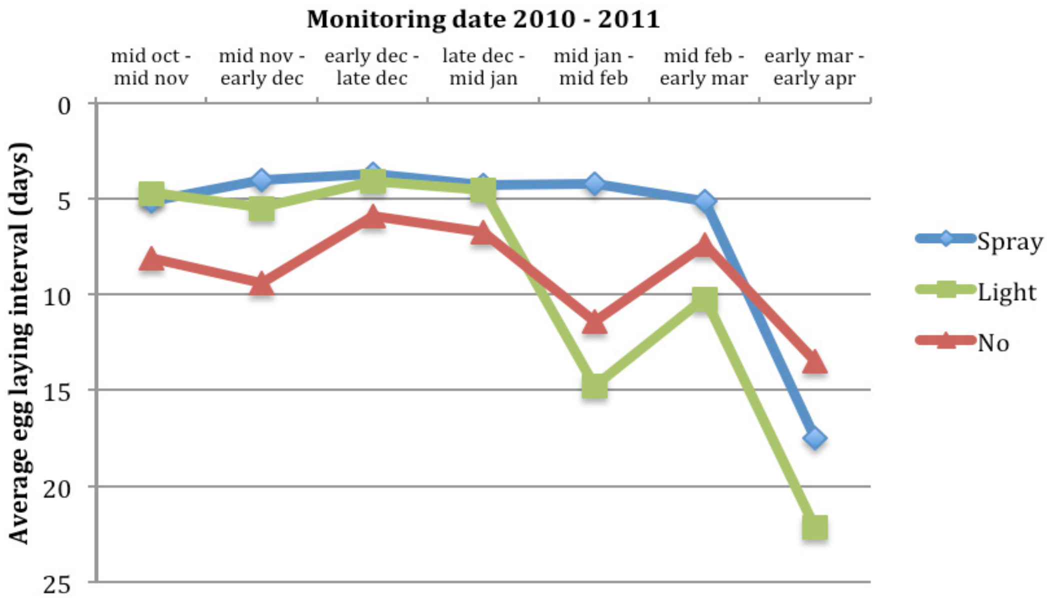

Figure 1. Average egg laying interval of Malleefowl in areas close to different levels of locust control (insecticide spraying). Spray n = 4, Light n = 4, No n = 6 (3 No mounds were not monitored between October and January).

Fate of eggs
Hatching success for the overall 17 mounds was 58.5%. Between categories SPRAY, LIGHT and NO, there was little difference in average hatching success, which ranged from 56.5% and 60.2% (Figure 2). The fate of eggs that did not hatch included eggs that were found rotten, broken, infertile or undeveloped, and these differed between mounds, and therefore between categories. For example, in one SPRAY mound, 94% of all eggs were infertile. A major predation event occurred at one of the LIGHT mounds, where foxes took all eggs (11 eggs) in the mound at that time, in early February 2011.

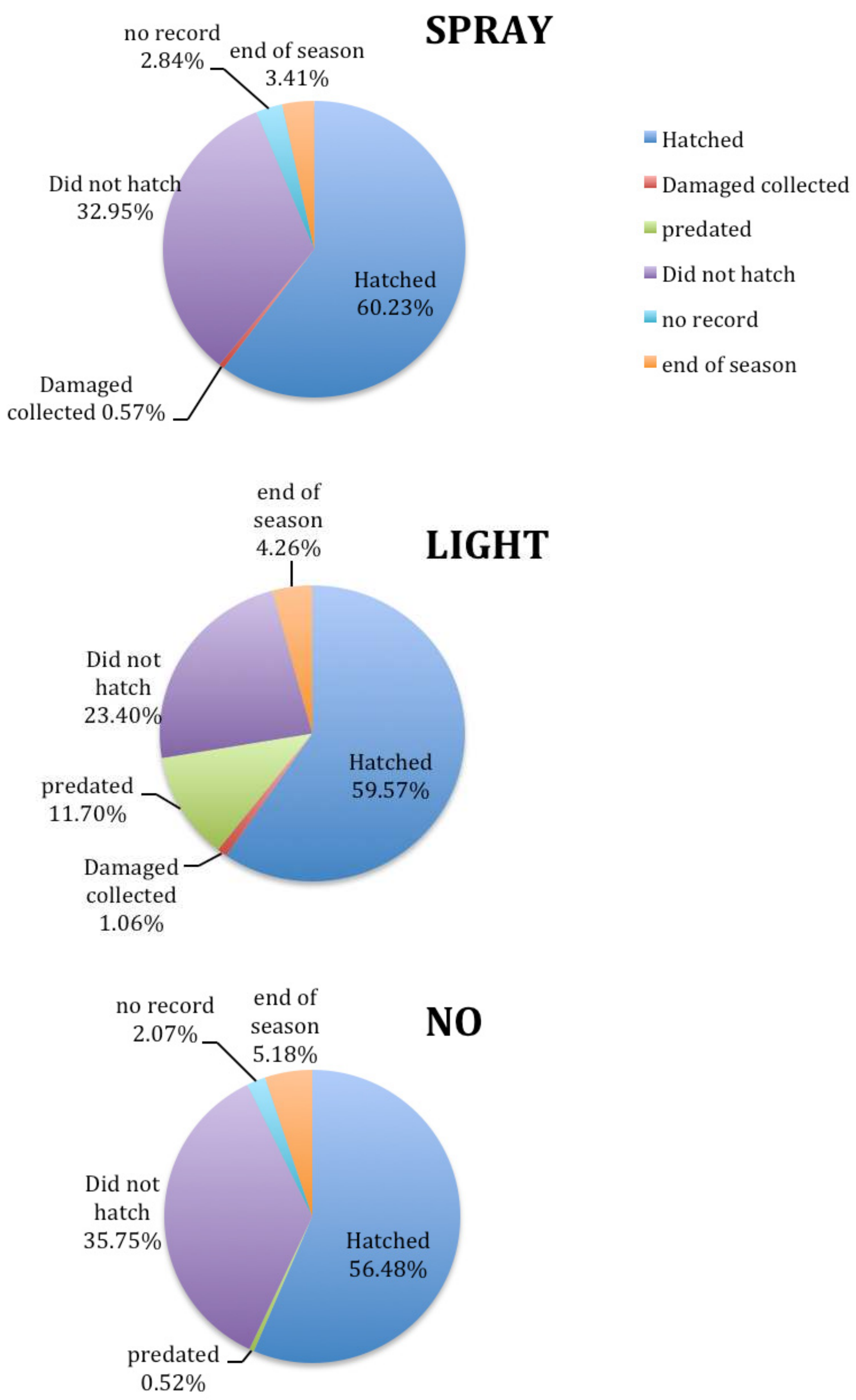

Figure 2. Fate of Malleefowl eggs in the 2010 - 2011 breeding season in different areas of locust control (spraying insecticides).

Productivity
Those mounds with the largest clutch sizes in SPRAY, LIGHT and NO areas showed best productivity (number of chicks hatched), except for one mound with 94% infertility in the SPRAY area. The average productivity of SPRAY, LIGHT and NO mounds when grouped into the spray categories was not statistically different (Log_e transformation, ANOVA $F_{2,14} = 0.49$, $p = 0.6236$), as variation in productivity was between mounds rather than between categories (Figure 3).

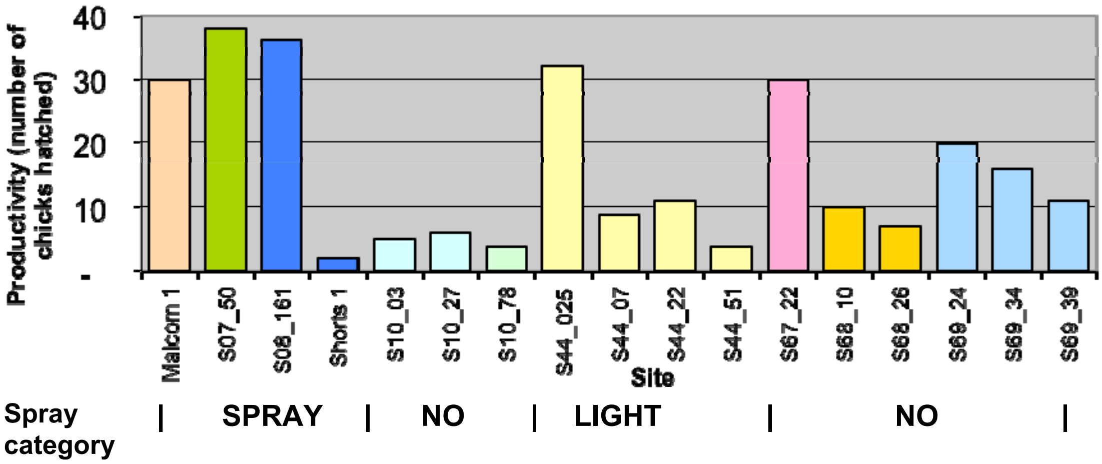

Figure 3. Productivity (number of Malleefowl chicks hatched) over the 2010 - 2011 breeding season at 17 monitored mounds.

Chicks hatched across the whole study area from November to May. Over time, productivity (average number of chicks hatched per monitoring period) at SPRAY mounds remained constant from October to December, between 2.5 and 3 chicks, then peaked from January to early April above 4.5 chicks. At LIGHT mounds, productivity increased from below 1 to a peak in January above 3, then remained constant until May. A similar trend was observed for NO mounds, where productivity increased to a peak of 2.5, remained constant until early April then declined (Figure 4).

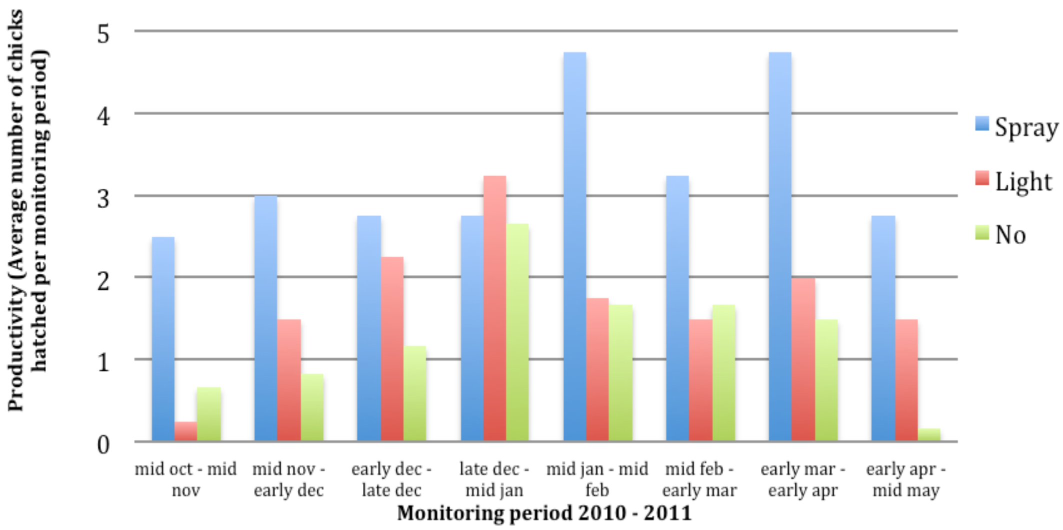

Figure 4. Malleefowl productivity over the 2010 – 2011 breeding season at different areas of locust control (insecticide spraying).

Egg volume and density
Average egg volumes were statistically similar at SPRAY, LIGHT and NO mounds (2 outliers removed, ANOVA, $F_{2,450}$ = 2.04, p = 0.1316) (Table 3). Average density of Eggs was higher at SPRAY mounds than at LIGHT mounds, with average egg density at NO mounds midway between.

Table 3. Average Egg Volume Index and Egg Density Index for Malleefowl eggs in different areas of locust control (spraying insecticides).

Spray Category	Number of eggs	Volume Index (mL)		Density Index (g/cm3)	
	n	average	s.e.	average	s.e.
SPRAY	171	169.38	0.77	1.0452	0.0022
LIGHT	92	167.34	1.40	1.0362	0.0023
NO	192	168.56	0.94	1.0404	0.0032

Egg incubation
Estimated egg incubation time was similar for SPRAY, LIGHT and NO mounds: the average incubation time for all three categories ranged 41 days in late December, and increased over time to between 59 and 77 days in mid-May.

Discussion

No traces of insecticides were detected in any Malleefowl scat, membrane or feather samples. The negative result does not exclusively show insecticides were not present, as they generally have 1 to 2 week half-lives, so may have degraded in the environment before sample collection and chemical analysis. This is a possibility for egg membranes, which are in mounds for approximately 60 days, which is longer than the insecticides' half-life. However, samples of feathers and scats were relatively fresh, yet chemicals were not detected.

Nesting success, taking into account the variety of reproductive measures monitored during the 2010-11 season, was best in certain mounds rather than in certain spray categories. All SPRAY mounds were highly and constantly productive except for one mound with 94% of eggs infertile. In the first monitoring visit in mid-October 2010, infertility was suspected, as all eggs contained no embryo (age determined by candling eggs in the field). Aerial and landholder spraying occurred near this mound in November, after infertility was suspected; therefore, it is unlikely that spraying of insecticides is linked to the egg's infertility in this case.

Other productive mounds occurred in LIGHT and NO spraying areas in addition to SPRAY mounds. The nesting success across spray categories may be linked to the likely increase in food resources, due to the wet season, rather than the presence/absence of spraying. Extra food resources include locusts; for example, locusts were found at mounds in the SPRAY and LIGHT areas, as well as at one mound in NO spraying area, on the edge of the Locust Plague area. This particular NO spraying mound was highly productive, with clutch size of 37 eggs and 81% hatching rate.

Similarly, poor nesting outputs occurred across the spray categories, and different factors such as predation or infertility were present at different mounds, rather than dominant in one spray category. These factors require further research to ensure Malleefowl can successfully reproduce and survive in the long term.

We cannot confirm with certainty whether Malleefowl came into contact with the specific insecticides sprayed during locust control, as the insecticides were undetected: either they were present yet degraded or not present at all. Thus, the study does not show the reproductive effects of insecticide toxicity in Malleefowl, as we cannot prove Malleefowl absorbed insecticides. However, the steady nesting output shown throughout and after the spraying period in the SPRAY and LIGHT areas, suggests Malleefowl nesting success was not affected by locust control activities of spring 2010.

PIRSA did not aerially spray insecticide directly on native scrub blocks containing our studied Malleefowl mounds, and in cases they used a buffer zone of 'Green Guard': a more environmentally-friendly fungus that targets grasshoppers and locusts rather than all insects.

These precautionary actions may have saved the Malleefowl from any ill effect. In such a productive season, Malleefowl may have had sufficient food resources to keep within the scrub blocks and not feed in the adjacent cropping fields. On the whole, less insecticide was sprayed close to mounds than was expected before the start of the locust control period.

Recommendations

The benefits of this study are numerous:

(1) provides evidence that Malleefowl nesting success in locust control areas was no worse than in areas without locust control;
(2) supports the strategy of employing preventative measures (avoiding scrub/using buffer zones) during locust control, as Malleefowl may not have come into contact with insecticides in spring 2010 given insecticides were not detected in scat, feather or egg membrane samples;
(3) provides new information about breeding characteristics across the Murray Mallee, which has experienced declines in breeding activity over the last decade; and
(4) provides additional Malleefowl membrane and feather samples for use in a University run Malleefowl genetics study, to further assist Malleefowl conservation.

Caution remains about the use of insecticides and Malleefowl conservation. No insecticide traces were found in Malleefowl samples, so they may not have come into contact with insecticides, and thus were not affected in their reproduction. Other studies have shown negative behavioural effects of organophosphates on birds and other vertebrates (see Walker 2003, Story et al 2005 for review). In future, toxicology samples should be obtained as soon as possible (days) after spraying events. An effective biomarker for exposure to and toxicity from organophosphates is inhibition of brain cholinesterase, but this requires capture of specimens, which for threatened species is not often possible. Future locust plagues are likely to coincide with above average rainfall and improved food resources for Malleefowl, and as a threatened species Malleefowl require every opportunity to be productive. Thus, a cautionary approach is recommended for future locust control activities, which is to avoid spraying within 3 kilometres around known Malleefowl nests, to avoid overlapping with their home range.

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20. Adaptive management of Malleefowl

Keynotes: Dr Joe Benshemesh, La Trobe University, Victoria, and Dr Michael Bode, University of Melbourne

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Abstract

Adaptive management (AM) is a pragmatic process of 'learning by doing' that takes an experimental approach to management and evaluates the effectiveness of management actions through continuous monitoring. Its main aim is to reduce uncertainties in management while simultaneously taking effective remedial action.

Such uncertainly certainly exists in how to best manage Malleefowl populations. For example, two separate studies have recently examined the national Malleefowl monitoring data and shown that fox control, the most widely used management intervention for Malleefowl, does not increase Malleefowl populations. This illustrates that we don't know as much as we thought we did, and highlights the need for better ways of identifying management practices that are beneficial and effective. Our uncertainty in what constitutes effective, reliable and cost efficient management is also likely to increase as result of climate change.

Rather than allow our uncertainty to become an excuse for inaction, an AM strategy allows both management and learning to proceed at the same time. It uses an ongoing flow of monitoring data to test current management beliefs and propose interventions that balance immediate population benefits with future learning.

While simple in principle, dealing with numerous issues simultaneously requires sophisticated mathematics, and successful implementation requires a high degree of collaboration between scientists, managers and the community.

We explain how we envisage AM working for Malleefowl conservation and outline the process. We have applied for ARC funding to develop an AM strategy for Malleefowl across its range and if successful, believe that this program can capitalise on the species' extensive and ongoing research and monitoring programs, improve both the efficiency and transparency of Malleefowl conservation, and provide renewed purpose and focus to the management and monitoring community.

Introduction

Conservation management is faced with two conflicting demands. One the one hand, threatened species and ecosystems need to receive immediate life-support. Populations are declining, ranges are contracting, and threats are increasing and multiplying. Managers needed to begin management decades ago, with double their current budgets. On the other hand, most ecosystems are very poorly understood, and scientists and managers aren't entirely sure what should be done to conserve them. On closer inspection, many of the ecosystems and species we thought we understood, we hardly understand at all. For example, a recent analysis showed that tens of billions of dollars had been spent restoring degraded water systems in the USA, with no apparent benefit (Bernhardt et al. 2005). For conservation to proceed, managers need to improve their understanding of their ecosystems and species, while at the same time do more, immediately to preserve them. This is the conundrum of modern conservation.

Adaptive management offers a solution to both of these problems. Most people may have heard the term 'adaptive management' bandied around in management plans and it may well seem that everybody is doing it. Adaptive management is often called "learning by doing", simply another way of saying that management will change (adapt) if observations show it's not working. However, in the ecological literature**,** adaptive management has a more specific meaning and relates to a large body of theoretical work that has developed the process of adaptive management (henceforth AM) to a high degree of sophistication (Holling 1978, Walters 1986, Walters and Holling 1990, McCarthy and Possingham 2007, McDonald-Madden et al. 2010). Rather than referring to any *ad hoc* means of learning from one's mistakes, formal AM has been refined into a package of mathematical techniques that help managers to experiment with and learn from their management while keeping the goal of conservation firmly in sight. The approach involves a repeated cycle of goal-setting and system modelling, carefully planned management interventions, monitoring of outcomes, and evaluation. During this final stage of the cycle, our understanding of the system is updated and management is adapted accordingly. AM is a rigorous scientific process, rather than an aspiration, and aims to balance the need for management actions now, with the equally important need to assess the success of these actions and gaining understanding of how the system works so that improved management can be planned for subsequent AM cycles. It is in this more formal sense that we use the term 'adaptive management' in this paper, rather than the more colloquial and loosely define sense.

Recently, in conjunction with colleagues Drs Brendan Wintle, Libby Rumpff (Melbourne University) and John Wright (Parks Victoria) we have developed a project that aims to implement formal AM to the conservation of Malleefowl. The project has gained the support of the National Malleefowl Recovery Team, state agencies and volunteer groups, and is backed financially by grants from mining offsets in Victoria and by Parks Victoria. The application is currently being considered for funding in the ARC Linkage Grants program, and if successful, we believe that this work will represent an important advance in the conservation of Malleefowl.

Here, we attempt to explain what AM and the pending project is all about, why it's appropriate for Malleefowl conservation, and how we envisage the project, if successful, will unfold.

What AM is

AM is a structured and iterative process of learning by doing that is highly pragmatic. Science has historically progressed by experimentation – each hypothesis is trialled in a limited, controlled setting. Early conservation management proceeded in a similar manner, testing alternative interventions and then applying those that worked at a larger scale. AM was devised because we rarely have the luxury of the time and resources needed for this approach. In AM, the experiment takes place during the management, with different actions taken simultaneously. In doing so, AM offers managers the benefits of both immediate action and learning. However, because it is multidisciplinary and holistic, and because it operates on a large 'real world' scale and over many years, AM requires a high degree of collaboration between all stakeholders, institutions flexible enough try multiple interventions, and managers confident enough to take calculated risks so that they and the management community can learn.

The basic idea (Figure 1) is that the process starts with a set of beliefs (or models) of how the ecosystem in question will respond to various management interventions. These beliefs are then tested by applying each of them at a large scale to different locations in the field while observing (monitoring) how the system responds. The approach sounds straightforward in theory, but in practice requires three key behaviours. First, the managers have to be willing to implement a number of different management actions, including those they don't think are the best option. This requirement can prove difficult for managers used to applying only the 'best practice'. Second, the managers have to closely monitor the results of their management in the different locations. While this may sound straightforward, ecological management is replete with examples of datasets that were collected but never analysed. Third, at some point the manager has to decide that enough has been learned, and that the best management intervention needs to be rolled out across the entire ecosystem. To do so, they have to trade-off the rate at which they're learning with the different performance of the management alternatives. The result is that we learn not only how good the management intervention is, but also how credible our initial beliefs were, and we adapt our management and beliefs accordingly. The cycle is then repeated with the updated beliefs and improved management interventions being tested in the real world. The AM process can thus be visualized as rapidly spiralling toward more effective management solutions as learning and improved management results from each AM cycle. This notion of constant improvement in management is important and provides a great advantage over other styles of management because it enables adaptability in a changing environment: if environmental conditions change, AM may spiral towards new solutions. Natural ecosystems are inherently complex and variable, and this is especially the case in today's world where ecosystems have been severely disrupted due to human activities, species extinctions and introductions, and where the prognosis over the next few decades is for unprecedented environmental upheaval due to climate change.

AM is a simple and appealing concept that has its conceptual analogues in many disciplines. In fact, some scholars argue that a simple form of AM has been used for thousands of years by some pre-technological societies to alter their environment (Berkes et al. 2000): these societies tested ideas about the environment by undertaking actions, observed and recorded the results through story and songs, and codified practices through rituals and taboos, in a continuous cycle of assessment and improvement from which developed an effective understanding of their environment.

While the basic concept of AM may be old, it was only introduced into ecology and environmental management as a formal and sophisticated process, and the term coined, in the late 1970s (Holling 1978). In this modern and rigorous embodiment of AM, often termed 'active' AM to distinguish it from 'passive' forms that do not involve experimentation, mathematical modelling is used to encapsulate beliefs and prior knowledge. Statistics replaces intuition as the measure of effectiveness of management actions, and to assess the credibility of beliefs. Decision theory takes the place of personal judgement about when to stop experimenting and learning and only apply the best-practice intervention. These developments have greatly increased the power of the AM, while retaining its essentially intuitive structure and holistic nature, and AM is widely held up as the most logical and elegant framework for continuous improvement in natural resource management.

Our project aims to apply this formal and rigorous AM approach to Malleefowl conservation. We aim to use as many of the monitoring sites as possible – there are currently 113 monitoring sites across the continent registered on the National Malleefowl Monitoring Database- to provide a firm basis for learning at the appropriate scale and variety of contexts needed for Malleefowl conservation. In many ways, observing the responses of Malleefowl to management at 100 sites is equivalent to observing the responses at one site for a century, providing some idea of the potential power of the intended approach. Using multiple sites is vital for accelerating our learning about how best to manage Malleefowl, but also complicates matters and is the reason why mathematics and statistics are essential for interpreting the flow of data, designing interventions, and making the best decisions. In short, a simple AM program could be designed for a small number of sites, but would lack power and would require many decades to provide reliable results, whereas an AM program that is a powerful and relatively speedy in providing results requires many sites and the mathematical tools to deal with the complexity.

What AM is not

1. AM differs from the conventional scientific approach

AM is a process that integrates the often disparate approaches of management, research and monitoring in order to improve management of a process, such as the conservation of a species. Therein lies its first strength, and sets it apart from the conventional scientific approach.

By integrating science and management, AM allows management interventions to proceed even where there is insufficient information available to be sure about how effective the management may be. This is a distinct advantage in cases where some urgent action is considered to be essential, such as in the conservation of a declining species, because in AM the lack of information does not delay the beginning of management action.

In contrast, the more conventional approach to uncertainty in management is to postpone actions until appropriate scientific studies have been instigated and completed, thereby avoiding possible deleterious effects and potential wastage of funds. These are certainly valid concerns as funds are always limited, ecological systems are notoriously complex and well meaning management may backfire in reality (e.g. the recent removal of cats to protect wildlife on Macquarie Island backfired when the rabbit population consequently increased to levels that threatened the entire ecosystem (Bergstrom et al. 2009)). But experimental science can take a long time, and rarely provides certainty. In conservation, there is simply not enough time to wait before management needs to act at an appropriate scale: small-scale experimentation costs time and money that would often be better spent taking immediate action since we know that waiting may have serious consequences for the species or ecosystem in question. AM provides a simple (but not necessarily easy) solution. We do not have to wait for knowledge to accumulate before we manage: we can act now and learn from our actions as we go.

Another problem with the conventional approach to devising management solutions is that science is typically reductionist by nature and conducted at a small scale over a limited time. Transferring the findings of such studies to large scale situations is often problematic because the results are to a certain extent context- and scale-dependent. The findings of well designed scientific studies are highly relevant in AM in developing models and expectations, in planning management action, and in testing specific ideas or components, but because the process involves testing the effectiveness of management at a large scale, not everything hinges on such studies. Thus, AM offers a more holistic approach to solving a problem than the reductionist approach of traditional science, while still providing the rigour required to supply reliable answers to the questions it addresses.

2. AM is not "trial and error" management

AM is often misunderstood as simply learning from mistakes - trial and error management - but formal AM differs markedly from this more ad hoc approach. Trial and error management is a common approach whereby managers adopt what is considered as 'best practice', which is often based on opinions, anecdotal information, or implications of scientific studies that may be incomplete. Management continues implementing 'best practice' until it is felt to be inadequate for some reason, perhaps because observations or monitoring shows that the approach is not working. The management intervention may then be changed, or abandoned altogether, but rarely with much reflection on why the management did not work as hoped; whether it was the wrong option, or the right option applied at an inadequate intensity, for example. This change of approach therefore produces very little new information to guide future management decisions apart from the intuition of managers. Much of what is commonly (and loosely) regarded as AM is more appropriately regarded as trial and error. While trial and error does at least entail some flexibility, it's not an efficient strategy and provides little opportunity for learning, leaving managers with little understanding of why the management action did not work, or what to try next.

AM differs from trial and error management in many ways, but perhaps the most fundamental difference is how it deals with uncertainty. Rather than applying what is regarded as 'best practice' and being disappointed (and a bit lost) if things don't work out as hoped, in AM there is explicit recognition that there are many unknowns in developing effective management; the main goal of AM is to maximise management outcomes in light of these uncertainties. In some situations, AM may emphasise the benefits of learning and experiments, whereas in others 'best practice' may be preferred (perhaps because of strong prior beliefs, or time or budget constraints). Thus, in AM, learning is highly valued and is built into the very fabric of the approach. This is achieved by developing competing system models that distil alternative views into quantitative predictions about how the system will respond to management, and testing these models with interventions and monitoring.

A medical example of AM

In addition to conservation and natural resource management, AM has been applied to answer more familiar questions, including medical research. Imagine a group of people suffering from an inoperable cancer, being treated with three different varieties of chemotherapy, A, B, and C. These three different concoctions represent three proposed models of the human body and the cancer – one of them will provide the best outcome for patients. Perhaps one of these types of chemotherapy, A, is thought to be the most effective based on animal experiments: the 'best practice' treatment. However, the two alternatives have not yet been sufficiently trialled for this to be 100% certain. Instead of consistently treating all the patients with the chemotherapy A, an adaptive manager would start by placing the majority of patients on chemotherapy A, with a smaller number on B and C, and would then start to monitor the three groups carefully. Based on their responses, the adaptive manager would update his relative belief in the three treatments, and may begin to switch patients from an underperforming treatment to a more successful one. The outcome of these patients to the change in treatment would also be monitored. Finally, as one of the treatments becomes clearly superior – but before he was 100% certain – the adaptive manager would place all the patients on the best treatment. At this point, the diminished potential benefits of learning more about the system (e.g., prior chance events reversed the treatment ranking) would be outweighed by the better predicted outcomes of putting all the patients on the best drug.

Is AM right for Malleefowl?

Malleefowl declines are well documented and the species is threatened by a range of factors (as outlined in the National Recovery Plan) and is clearly in need of improved management. AM is an appealing strategy for learning how to manage systems in a more efficient and effective way, but is it right for Malleefowl? We think it is for a number of reasons and we briefly outline these below:

Firstly, there is currently uncertainty about the effectiveness of management actions in reversing declines, and in the role of environmental factors. For example, although fox baiting is the most widely applied management action for Malleefowl conservation, two separate studies have recently concluded that, contrary to widely held expectations, fox baiting as currently practiced does not increase Malleefowl populations (Benshemesh et al. 2007, Walsh et al. (submitted)). Although this may not necessarily mean that baiting doesn't benefit Malleefowl at all, it does illustrate how little we know about Malleefowl management, and highlights the need for more efficient ways of identifying management practices that are demonstrably beneficial and effective. Climate change, and the long-term effects of fragmentation, will most likely amplify these uncertainties in the future and exacerbate local threats. The adaptive management approach embraces and provides a means of resolving such uncertainties.

Secondly, monitoring, which is a key ingredient in AM, is already in place and is providing consistent data on Malleefowl trends from over 100 sites across Australia. This extensive monitoring program has provided insights into Malleefowl population trends and management, but is currently under-utilised. Fortunately, the existing monitoring program provides a major leg-up for the development of an AM strategy for Malleefowl because the cost and difficulties involved in implementing suitably wide-scale and regular monitoring programs are precisely where many attempts at AM fail (Walters 1997, Possingham 2001, Stankey et al. 2005, Wintle and Lindenmayer 2008). Apart from providing an ongoing flow of monitoring data to test current management beliefs, the monitoring data collected in the past provides an excellent baseline for generating ideas and hypotheses within the AM framework.

Thirdly, while there is considerable and justifiable concern about the conservation of Malleefowl, the species appears relatively resilient compared with many other threatened species. Malleefowl still occurs over much of its uncleared range (Benshemesh 2007a), providing opportunities for replicating management treatments and controls (non-treatment sites). Moreover, the current network of monitoring sites, which would provide the core data necessary for AM, represents only a tiny proportion of the species range and varying management treatments at these sites to test the benefits of management actions and increase learning is unlikely to compromise the conservation of the species as a whole.

Fourthly, there is already a strong community involvement in Malleefowl conservation and an evident enthusiasm for collaboration with agencies, land managers, and scientists. Community volunteers organise and conduct most of the Malleefowl monitoring that occurs in southern Australia, often through the efforts of local contacts, while agencies manage these sites in varying ways. Close collaboration between communities, managers, scientists and other stakeholders is a key ingredient in AM, and is already happening (as demonstrated in this forum), and will provide a firm basis upon which to design and implement an effective national program. Many attempts at developing AM have in fact failed due to social or political difficulties in bringing diverse stakeholders together; however, there is good reason for optimism within the Malleefowl community.

And finally, an AM approach would provide an organising framework at a national level with which to integrate Malleefowl research and management, improve conservation outcomes and efficiency, and involve all stakeholders. At the core of AM is a clearly stated, quantitative management objective. The process of debating and formulating this objective can itself provide unparalleled clarity to stakeholders, and focus to researchers. Any steps in this direction are highly desirable; even if AM stumbled at some unforeseen technical, social or political hurdle, we would argue that the exercise would nonetheless be of great value to Malleefowl conservation by bringing managers, scientists and volunteers together, and by providing the national monitoring program with a unified purpose.

Overview of how AM for Malleefowl will unfold

Careful planning is of critical importance in developing AM. It is during the design and planning phase that objectives are determined, models are constructed, experiments are designed, and suitable means of assessing outcomes and adapting management is systematised. The application we have before the ARC largely deals with this aspect of AM over a three year period, and it is a natural place to start an overview of how we envisage the development of an AM cycle (Figure 1) for Malleefowl.

The Design and Planning phase

Successful implementation of AM depends on the involvement of a broad range of people and groups, and it is important that these stakeholders collectively determine the appropriate objectives of the AM program. It is also important that stakeholders have an opportunity to contribute their understanding of how management may be used to benefit Malleefowl, and for those developing the AM strategy to understand exactly what management options may be acceptable at each of the potential study sites across the country. Given the large number of monitoring sites that are already providing data, and the great range of organizations and individuals that are already involved in Malleefowl conservation, this first step in developing an AM program is itself quite a challenge.

We intend to host a series of workshops with key stakeholders including managers, researchers, and volunteers, to identify management objectives. It will also be necessary to hold workshops to elicit and explore potential management options at specific sites. This will firstly involve documenting past and current management practices and perceived threats at each of the hundred or so monitoring sites across Australia. With this information at hand, the workshops will identify management and monitoring options at a site level and examine possible alternatives.

Workshops will also provide a means of collating the range of perspectives about Malleefowl ecology and management, augmenting information already available in scientific papers and reports, but also allowing the knowledge of experienced observers to be incorporated. This information from a variety of sources will be synthesized and represented in mathematical models that will attempt to encapsulate existing knowledge and the range of views that are held by managers, scientists and others.

Models occupy a vital and central role in AM, but are often misunderstood. In its simplest form, a model may just represent a concept, or idea, about how something might work. For example, the idea that “rain makes grass grow” is a simple conceptual model, as is “predation by foxes will undermine Malleefowl populations”. Models are just simplified representations of expected relationships between ecological entities, and they are useful because they make predictions that can be tested in experiments.

Mathematical models are simply conceptual models translated into a different language, but mathematics' internal logic provides a much more powerful platform for prediction and experiment, and has the advantage that assumptions about how the system operates are made very explicit, transparent and accountable.

While AM is simple in principle, dealing with numerous issues simultaneously requires sophisticated mathematics. In AM for Malleefowl, mathematical models will be used to encapsulate our current knowledge of the species' population processes, the effects of threatening processes, and the ecosystem dynamics in general. These models will then be used to predict the benefits of implementing various management actions under the full range of environmental conditions, and the accuracy of these predictions will be tested in the field by the monitoring program. The models will also be useful as learning tools to determine which system processes are most amenable to management, and what critical uncertainties limit our ability to make good predictions, information that is essential for designing efficient management experiments.

Finally, the design and planning phase of AM will also require the development of a 'decision support' framework that uses the ongoing flow of monitoring data to test current management beliefs, propose interventions that balance immediate population benefits with future learning, and determine when the current level of understanding is advanced enough for experimental management to cease. Once again, sophisticated mathematics may be required, but it's a necessary step if important and complex decisions are to be made objectively in regard to available evidence, and for these decisions to be thoroughly accountable.

With collaboration facilitated, knowledge synthesised and modelled, management options documented and explored, and a decision framework in place, the stage is set for the AM cycle to begin.

Act/Manage

While mathematical modelling is the primary tool for describing and synthesising what we know, management experiments are the primary tool for probing the system, and addressing any critical uncertainties (many of which will be determined through modelling). In the design and planning phase, realistic and acceptable management interventions will have been identified on a site-by-site basis in close collaboration with managers, and this cooperation must continue throughout the AM program. However, implementing management is essentially the province of managers: their commitment and faith in the process, and capacity to implement recommended interventions, will be paramount to ensuring the success of AM. As management interventions may take several years to show effects on Malleefowl populations, a long term commitment to the process is essential.

Extra resources for implementation will probably be required to reap the greatest rewards from the AM program; however, it would be mistaken to conclude that the adoption of an AM approach will necessarily require additional large investments in Malleefowl conservation. Much could be achieved by re-organising the existing funding and effort in a way that would provide both clarity of the benefits of interventions, and opportunities for learning. For example, rather than providing low level predator control over most Malleefowl populations, concentrating the effort on just a few sites would provide opportunities to examine the benefits of this intervention in a statistically meaningful way (Benshemesh 2007a).

Monitor

Monitoring is essential in AM and provides the feedback required to test the effectiveness of management interventions and the veracity of the models that suggested them. But it is also one of the most difficult steps to put in place due to the considerable logistic and cost issues involved in instigating an effective and appropriately wide-scale, on-going program. In the case of Malleefowl, such a system is already in place and is providing consistent data on Malleefowl trends from over 100 sites across Australia.

The AM project will build on the existing flow of data from the Malleefowl monitoring program. This program is largely undertaken by community volunteers, often supported by state agencies and NRM bodies. It has a long history, and although it was always intended as a resource for research and management (Benshemesh 1992), this goal has never been attained or even attempted at an appropriate scale.

While a major hurdle for most attempts to develop AM programs, monitoring is one the of the least concerns in developing an AM program for Malleefowl due to the efforts of a large number of volunteers over many years and especially over the past five years. Substantial improvements in the monitoring program over the last few years (such as the introduction of national standards and protocols, a national and centralized web-based database, stringent and effective quality control, and more regular and rigorous data collection) have made the program more ready than ever before to provide high quality input into scientific approaches such as AM.

Nonetheless, the requirements of the AM program may necessitate some changes to the existing monitoring program. In particular, it is likely that the AM program will require additional data on the abundance of predators, competitors, and food resources (Benshemesh 2007b). Modelling may also highlight the importance (or otherwise) of other potential forms of monitoring, such as population turnover and recruitment of young into the adult population (Benshemesh 2007a). The need for such additional data, whether community based programs might be expanded to capture the extra information or other solutions need to be found, will be examined during the AM design and planning phase and involve extensive consultation with community groups, managers and researchers.

Evaluate
The framework for evaluating the effectiveness of management interventions will be prescribed in the design and planning phase of the AM project, as already outlined above. An important outcome of the ARC Linkage project will be to develop and pass on the tools and the structure of the AM framework to the National Malleefowl Recovery Team. By enabling the AM strategy to continue beyond the three year life of the ARC project, monitoring will allow management to improve and adapt for as long as the program continues.

Conclusion

We all want to get on with effective on-ground works that make a difference to Malleefowl conservation, rather than engage in endless research and monitoring. However important research and monitoring are providing information about the plight of Malleefowl and proposing remedial actions, in themselves these activities cannot alter the environment or affect Malleefowl directly.

On the other hand, ineffective management is a waste of time and money, regardless of how well intentioned it may be. Even worse, ineffective management may also distract us from the real issues by providing a false sense of security that appropriate actions are being taken. Without research and monitoring, management is blind and without direction.

AM provides the opportunity to combine management, research and monitoring in a way that creates a highly effective approach to simultaneously learning about, and also undertaking management of, an ecosystem about which there is much uncertainty. It is in the synthesis of management, research and monitoring that the greatest benefits are realised as the synergies between these activities are released. Despite its conceptual simplicity, AM is not the easiest path and its reliance on cooperation and collaboration among stakeholders, and a shared, long term vision provides ample opportunities for problems. Furthermore, it does not magically reduce uncertainty, nor does it mean that initial management actions will not be misdirected. However, it does provide the most effective approach to uncertainty in management, and it uniquely synthesises action and learning.

Walters (1997) identified several main classes of impediment to successful AM programs, including: problems arising from the treatment of the modelling phase; the cost and logistic problems involved in collecting long-term monitoring data; and social or political issues arising from self-interest and risk-aversion of stake-holders (particularly research or management organisations), and from disagreements over what outcomes were acceptable.

In regard to these issues and the development of an AM strategy for Malleefowl, we are very confident that the mathematical and modelling difficulties are tractable, while the problems involved in establishing long term monitoring program have in a sense already been solved. We are also optimistic that the social and political issues listed by Walters (1997), which include failures of implementation and lack of a shared vision, can be avoided by thorough consultation with all stakeholders and genuine collaboration and openness among all those actively engaged in the process. Our hope, and an enormous potential benefit of this project, is that a successful application of AM to Malleefowl will provide a template for the method's application to other threatened species and communities. Of all the species on Australia's lengthy threatened lists, Malleefowl provide one of the best opportunities for AM to be successfully implemented – a goal that has to a large extent eluded Australian conservation managers for the reasons outlined by Walters (1997).

AM provides a coherent and effective way forward for Malleefowl conservation and management, and in many ways represents the best possible use of the existing monitoring system, and the culmination of previous Malleefowl research and monitoring across the species' range. By thinking carefully about the best suite of actions, AM can improve both the efficiency and transparency of Malleefowl management. By demanding that our understanding of the system be stated explicitly openly, AM can help to realise the value of unharnessed knowledge in the existing monitoring data and in the Malleefowl community. Finally, because AM stresses foresight and pre-emption, its application can help to provide renewed purpose and focus to the management and monitoring community.

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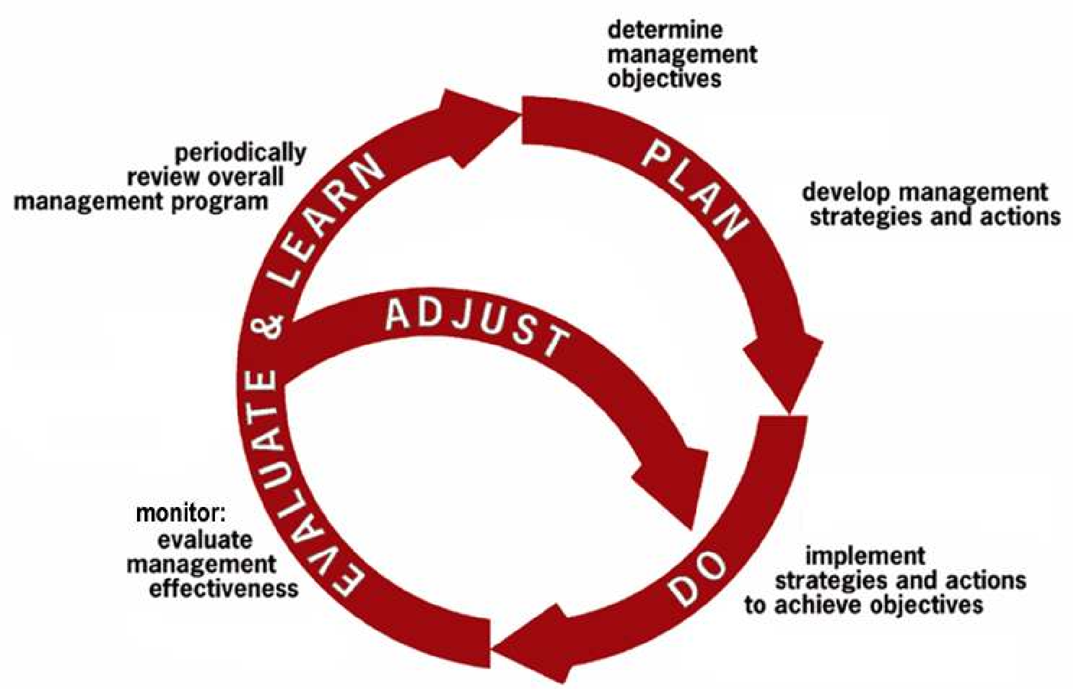

Figure1. The adaptive management (AM) cycle.

21. Distribution of Malleefowl nesting mounds and vegetation attributes in remnant habitat in western New South Wales

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Abstract

Surveys in western New South Wales by the Lachlan Catchment Management Authority indicate that Malleefowl *Leipoa ocellata* within Mallee woodlands are clumped in their nesting distribution. The aim of this project was to map the distribution of Malleefowl within private and leasehold lands within the Lachlan Catchment that contain remnant Mallee woodland, and deploy strategies to secure the survival of these populations. Distribution data was collected and used to begin analysis of habitat preferences for nesting sites within remaining mallee woodlands of western New South Wales. Surveys to map the distribution of active and inactive mounds commenced in 2009 using helicopter transects followed by ground-truthing. Vegetation plots (40 x 100 m^2) to investigate differences between sites with active mounds, inactive mounds and sites without current or historical nesting activity were set-up during the Spring of 2010. These vegetation plots were also designed to monitor grazing activity before and after removal of feral goats (*Capra hircus*) within nesting mound sites.

Two new populations of Malleefowl were located during the surveying of 51,000 ha of private and leasehold lands between 2009 and 2011. These populations form clusters within mallee woodland used for grazing by both domestic and feral goats and sheep. A total of 62 mounds in four clusters were discovered, of which 25 mounds were active during the breeding season of 2010/2011.

Initial analysis to investigate structural differences in vegetation between sites with active mounds, inactive mounds and no mounds has not revealed statistically significant differences in floristic composition of the ground layer or shrub layer, but general trends indicate that active mounds are surrounded by a greater number of plants. The lack of significance at these sites may be the result of current grazing impacts by goats across the catchment. Although extensive areas of mallee woodland remain in western New South Wales, very little of this habitat is suitable for nesting. Further investigations are required to fully understand the variables in floristics that define suitable nesting areas. It is hoped that once this is achieved, better management of the mallee will be possible to stabilise populations of Malleefowl.

Introduction

Although Malleefowl are listed nationally as Vulnerable under the *Environment Protection and Biodiversity Conservation* (EPBC) *Act* 1999, within New South Wales, this species is recognised as Endangered under the *Threatened Species Conservation Act* 1995. There are at least 4 primary threats and one potential threat that have been identified as the causes behind the decline of the Malleefowl (Benshemesh 2007). The first of these threats is clearing and fragmentation of habitat for the purpose of agriculture, primarily concerning wheat and sheep production, but also for the harvest of broombush (*Melaleuca uncinata*). Fire has been listed as a primary threat because of its potential to destroy vast areas of mallee habitat in single events that can then take 30 to 60 years to recover to a state suitable for Malleefowl (Bradstock et al. 2005). The third threat is that of grazing by both feral and native species such as goats, sheep, rabbits and kangaroos (Frith 1962). The latter species have in recent decades increased in numbers because of increased agricultural watering points but in addition to natural grazers there are now vast numbers of feral grazers living within Malleefowl habitat. These species directly compete for foraging resources as well as changing habitat structure through selective browsing. The final current threat is predation and has been well documented as a serious cause in the decline of the Malleefowl (Priddel and Wheeler 1997, 2007). Foxes have been the major species considered as a threat but there is also concern regarding increasing cat numbers (Wheeler and Priddel 2009). Climate change is now recognised as a potential threat to the future recovery of Malleefowl in New South Wales. Resultant shifts in rainfall patterns and temperature changes are predicted to lead to substantial declines in Malleefowl populations across their current range and will require adaptive management as the shifts manifest.

The general decline of Malleefowl across Australia is unfortunately reflected in the current status of the species in the Lachlan Catchment region, which includes the DECCW monitoring sites of Yathong, Round Hill and Nombinnie Nature Reserves. Reporting of the species has drastically reduced from 75 sightings between 1981-1991 to only 11 during 2000-2005 (Benshemesh 2007). These Nature Reserves were thought to represent some of the largest continuous expanses of mallee habitat in New South Wales and potentially hold the most important genetically viable population of Malleefowl for the state. But, private/leasehold lands around the margins of the reserves also hold populations of Malleefowl (Lewis, unpublished data). Recent helicopter surveys by the Lachlan CMA have provided data to indicate that the distribution of Malleefowl within these private lands is patchy and/or clustered, suggesting that Malleefowl may be much lower in density than previously estimated.

This paper reports on the first stage of the Lachlan Catchment Management Authority's obligation to address targets in both Federal and NSW State Legislation to address the conservation of threatened species. A critical development in adaptively managing this threatened species will be to better understand the habitat parameters that lead adult Malleefowl into deciding where to construct/re-use nest mounds and maintain breeding territories. Understanding why aggregations of this species occur across what appears in our interpretations as uniform mallee woodland, will perhaps allow more informed positive conservation efforts and greater success in future introductions of captive bred individuals to establish new breeding populations. The following paper presents the initial stages of investigations into vegetation differences between active and inactive territories (mounds present but not used within 3 years).

Methods

Study Area

The study area (55 H 401546 6330022) was located on private land about 50 km northwest of Hillston in western New South Wales, Australia. This is one of four private/leasehold properties within the western Lachlan River Catchment known to contain Malleefowl, from a total nine properties surveyed between 2009 and 2010. The area covered by regular research visits and containing all known Malleefowl nesting activity for this paper was about 17,000 ha and at the time of the study contained ten (10) active mounds and 29 inactive mounds. The soils are predominately red-sand formed over ancient sand hills. Mallee woodland vegetation covered most of the area although a thin strip of grassland dissected the northern and southern portions of the property. This cleared area contained mixed native and introduced grasses but had been cropped in past decades and is now lightly grazed with sheep. These sheep have access to the mallee woodland but appear to only occasionally occupy the edges for shelter. However, the woodland contained moderate numbers (several hundred) of introduced feral goats and there was a small population of feral fallow deer (*Dama dama*) in the southern third of the property.

The mallee woodland vegetation where Malleefowl were located was dominated by an over-storey of Slender-leaf Mallee (*Eucalyptus foecunda*) and Pointed Mallee (*Eucalyptus socialis*). A mid-storey of shrubs consisted predominately of Pinbush Wattle (*Acacia burkittii*), Awl-leaf Wattle (*Acacia subulata*), Tar Bush (*Eremophila glabra*), Wedge-leaf Hopbush (*Dodonea cuneata*), Mallee Bush-pea (*Eutaxia microphylla*), Sand-sage (*Dicrastylis verticillata*), Cactus Pea (*Bossiaea walkeri*), and Broombush (*Melaleuca uncinata*). Groundcover was dominated by a diverse mixture of grasses and forbs including, Variable Daisy (*Brachyscome ciliaris*), Clustered Everlasting (*Helichrysum semipapposum*), Sticky Everlasting (*Helichrysum *viscosum*), Rough Speargrass (*Stipa scabra*), Lavender Blue-flower (*Halgania cyanea*), Woolly-head Mat-rush (*Lomandra leucocephala*), Spreading Flax-lily (*Dianella revoluta*), Toothed Raspwort (*Haloragis odontocarpa*), Small Poranthera (*Poranthera microphylla*).

Mound locations
In April 2009 aerial surveys were conducted using grid based techniques to determine locations of active and inactive nesting mounds. 66Transects were flown in north south directions as recommended by the National Malleefowl Monitoring System (Victorian Malleefowl Recovery Group 2007) to avoid difficulties caused by the sun at low angles to the horizon. Pathways for the survey were coordinated and plotted using Garmin Mapsource 2.58 and supplied to the helicopter pilot prior to departure. All coordinates were recorded in GDA, in accordance to Lachlan CMA GIS protocols, using three handheld Garmin eTrex Summit HC GPS units. Flight speeds during the survey were about 106 km/h (n=500 flight legs, mean = 106.21 km/h, std = 34.20 km/h) at an altitude of 178 m (n = 500 flight legs, mean = 177.81 m, std = 9.41 m). Distances between transects were 100 m (n = 50, mean = 97.74 m, std = 12.98 m) to allow a surveyor-viewing envelope of 50 m either side of the helicopter. When nesting mounds were located the helicopter would circle back to the site and hover over the mound while three waypoints were recorded and a photograph was captured.

Ground-truthing and collection of nest mound data
Nesting mounds located during aerial surveys were reassessed by walking into each site using the coordinates collected from the helicopter. Ground-truthing was conducted during the week following aerial survey and during an additional period in September 2009. Data describing nesting mound condition as prescribed by protocols for the National Malleefowl Monitoring System (Victorian Malleefowl Recovery Group 2007) was then collected at each site. In addition to this information, photographs of the area and field notes describing the vegetation condition were collected.

Vegetation Monitoring Sites
A total of 30 vegetation assessment sites were deployed between the 22nd November 2010 and 7th December 2010 to investigate if differences existed within the vegetation structure between areas containing active nest mounds, inactive mounds and sites where mounds were not evident after thorough aerial surveying. These plots were arranged in a paired design to allow Repeated Measures ANOVA to improve statistical testing between areas with limited sample size.

All sites consisted of a 10 m x 10 m quadrat, marked by four galvanised stakes in each corner with aluminium name-tags and location points collected in GDA94. Vegetation data collected at each site consisted of total number of plant species, total number of plants for each species, species vegetation cover, total ground leaf cover and the average heights of tree, shrub and ground cover layers. Growth stages of plants were assessed and assigned to classes: dormant (5); tip growth (4); flowers (3); buds (2) and seeds (1). Grazing impact at each site was also assessed for future research not presented in this paper.

Results

Mound Distribution
Mallee woodland of western New South Wales rangelands where this study was conducted consists of a continuous "U" shaped belt about 20 km in width for a length of about 200 km. This substantial portion of uninterrupted habitat contains four known clusters of Malleefowl, but this number should increase as the remaining 50% of the eastern side is surveyed. These clusters of nesting mounds are a mean distance apart of 32.80 km. Within the cluster where this vegetation study was conducted the mean distance between all mounds (active and inactive) was 1.80 km (n = 42, std dev = 0 99 km) and the mean distance between mounds that were active in the summer of 2010 was 2.19 km (n = 11, std dev = 0.50 km).

Vegetation attribute comparison
Comparison of general vegetation attributes recorded within treatment sites (inactive mounds, active mounds and control sites without mounds) found no significant differences (Table 1,

graphs 1-7). In general the study area contained high levels of ground cover made up of leaf litter and a diverse species range of forbes and grasses. A diverse species assemblage was present across all sites (Appendix 1). The vegetation growth was high with average plant heights (excluding tree species) ranging between 30 –50cm across all sites. All plant species were actively growing and either producing new growth, seed or flowers at the time of data collection. Several non-significant trends were indicated by the data that will be used to refine future research directions. These trends include about a 10% lower level of vegetative cover at control sites (Fig 1), and a reduced number of total plant species near active mounds (Fig 4) which, was probably also influenced by a slightly higher number of ground cover species at inactive mounds (Fig 5).

Table 1. Means, standard deviations and standards errors for vegetation parameters collected at sites containing active Malleefowl nest mounds, inactive nest mounds and at locations where no nesting activity (past or present) had been recorded.

Treatment	N	Percentage Ground Cover		
		Mean	Std.Dev.	Std.Err
inactive mound	10	61.2	15.1	4.8
active mound	10	69.1	29.1	9.2
control no mound	10	51.3	28.9	9.2
		Plant height (excluding Eucalypts)		
inactive mound	10	37.0	6.4	2.0
active mound	10	53.5	30.4	9.6
control no mound	10	41.9	6.1	1.9
		Growth stage		
inactive mound	10	4.2	0.3	0.1
active mound	10	3.9	0.3	0.1
control no mound	10	4.0	0.4	0.1
		Total number of plant species		
inactive mound	10	20.6	2.1	0.7
active mound	10	17.4	5.8	1.8
control no mound	10	20.5	2.8	0.9
		Number of ground cover species		
inactive mound	10	10.6	1.9	0.6
active mound	10	6.4	3.6	1.1
control no mound	10	8.1	1.9	0.6
		Number of shrub species		
inactive mound	10	8.4	1.8	0.6
active mound	10	9.5	2.9	0.9
control no mound	10	10.6	1.9	0.6
		Number of tree species		
inactive mound	10	1.6	0.5	0.2
active mound	10	1.5	0.5	0.2
control no mound	10	1.8	0.4	0.1

Discussion

Malleefowl are not distributed uniformly throughout what has in the past been assumed appropriate habitat. The distribution of mounds at this larger scale is clumped possibly because of an unknown variable in the landscape, such as topography or resources such as food. Knowledge of why this distribution has occurred is of paramount importance for the future survival of the species. Although we found no differences in vegetation adjacent to active mounds, mounds that have not been active since the commencement of the study, and sites where no nesting activity is evident in this initial investigation, this work provides a valuable first step and we will now be able to better refine our methods of data collection.
The sampling design of the project may also have been a source for difficulty in finding significant results. Primarily it is difficult to find vegetation differences at a landscape scale if

the sampling points are either too small or inadequate in number. At the time of designing the sampling we considered a 100 m^2 quadrat appropriate in size and manageable for fieldwork. We are now trialling a transect technique to address this issue.

The lack of significant findings in our results may be an artefact of the extensive heavy grazing throughout the region from goats and rabbits (*Oryctolagus cuniculus*). These species have probably caused significant structural changes to the vegetation over the past decades. Goats in particular have increased in numbers at this site in recent years after the Malleefowl had selected the area for nest building. The advent of these competitors post nest-building decision making by Malleefowl could very easily mask important vegetative differences between sites, if they selectively foraged on the plant species that were also selected by Malleefowl. In particular it was interesting to note the trend of higher plant cover and reduced plant species diversity at active mounds. This may be due to the activities of the Malleefowl themselves around the general area. Survey sites were not within 25 m of nests but the foraging methods of Malleefowl may improve the competitive abilities of some plants and reduce the seed abundance available for germination in other species.

In completing the on-ground fieldwork we noted that the vegetation contained what appears to be a varied diversity of ground cover species including grasses and shrubs. There were signs of goats within all sites and areas contained very large numbers of rabbits. Their impact across the vegetation structure has probably been dramatic but this is difficult to measure without locating areas where rabbits have never impacted. It is suspected that rabbits have been a primary factor in changing Mallee vegetation structure for many years and may be a significant underlying cause for the decline of the Malleefowl. Malleefowl are a browsing species apart from also eating seeds/fruits and insects mostly occurring within leaf litter. High densities of rabbits remove the vegetation available for a browsing Malleefowl but perhaps over the long-term and even more significantly, have a secondary impact on insect abundance and seed/fruit availability. Rabbits are highly efficient grazers and generally consume vegetation at a rate that prevents grasses setting seed or shrubs producing fruit. In addition, the leaf litter is reduced so detritus-feeding insect populations decline. Further, the removal of the shrub layers and leaf litter expose hatchling Malleefowl to predators, thus decreasing their chances of survival. Overall, the impact of rabbits may be far more influential on the survival of the Malleefowl than has previously been considered.

It is probable that the mallee habitat of sites such as the one investigated in this paper have always been marginal for the Malleefowl (Priddel 2006) and that the carrying capacity for this species will be lower than many of the other sites around Australia that have been used for comparison or benchmarks. This could be another reason for finding clumped distribution patterns across what appears to be uniform mallee habitat. Priddel (1989) found that when chicks were released into enclosures at Yathong that were both predator proof (foxes and cats) and had not been exposed to grazing by feral pest species such as goats, only chicks supplemented with seed survived. If this is the case we cannot logically expect any increase in the Malleefowl population size past maintenance levels. The next experimental step may be to artificially alter the carrying capacity of these populations through the addition of feeding resources while at the same time increasing the effectiveness of feral pest control. The addition of higher quality food in a readily available form should not only improve the chances of chicks surviving after hatching but will also improve the nutrition available to adults. Higher quality protein for hen Malleefowl during the pre-egglaying and egglaying periods will increase the number of eggs produced and the health of both the embryos and hatchlings (Blount *et al.* 2003, Gorman 2005).

Passive management through the securing of large tracts of land and monitoring nest activity does not ensure that a population will survive. This approach has certainly been a valuable first step in our efforts to conserve the Malleefowl and has built the profile of this species into iconic proportions, but, we now need a multi-pronged direct management approach. In order to achieve this we must adaptively manage at a landscape scale, not just pest control but also in understanding the ecological constraints that Malleefowl consider during life-strategy decisions. Species distribute themselves around resources in order to breed and feed. Females may associate with habitat that supplies either themselves with nesting sites or food for their young, while males may simply clump around females. Knowledge at this level could allow management of critical resources in a manner that is both financially efficient and at the same time far more successful for ensuring that population numbers increase.

It has in the past been the prime focus of Malleefowl management to implement control measures against high risk predators or feral competitors. It is not understood if the lack of recovery in Malleefowl is the result of one of these pest species or because of negative interactions between the Malleefowl and multiple combinations of pests. It is also possible that an unknown variable, yet to be considered, such as environmental stress resulting from the prolonged drought has also lead to the observed lack of population growth. Unfortunately, it is impossible to draw meaningful conclusions about the lack of population growth from census data. Monitoring certainly needs to be maintained but this data will only reach its maximum value if it is in association with robust, experimental on-ground management.

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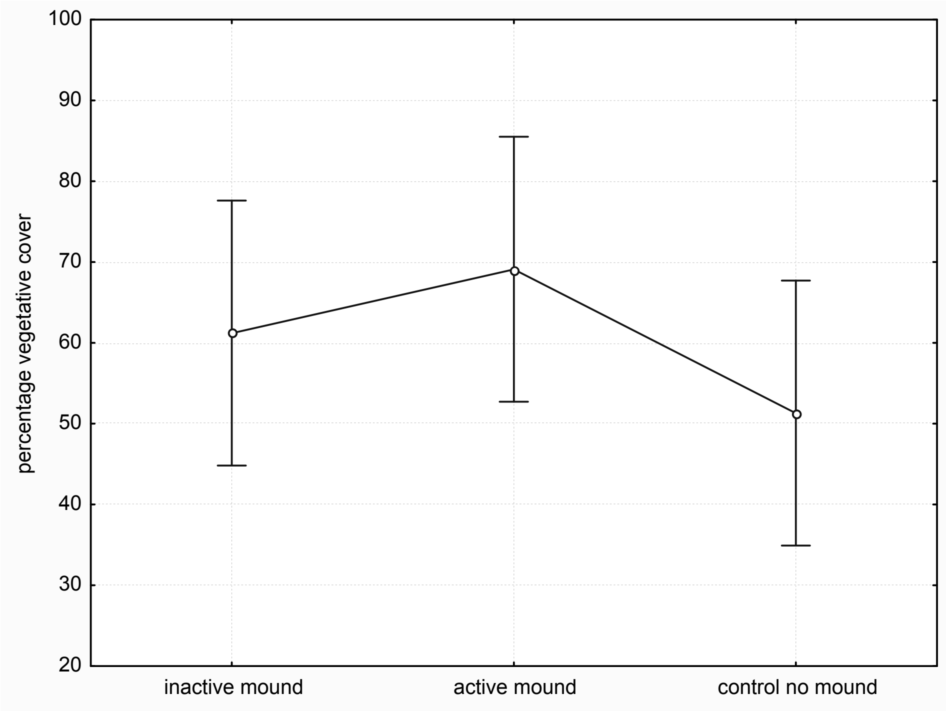

Figure 1. Percentage ground cover (excluding overhang by Eucalypts) at sites containing active Malleefowl nest mounds, inactive nest mounds and at locations where no nesting activity (past or present) had been recorded.

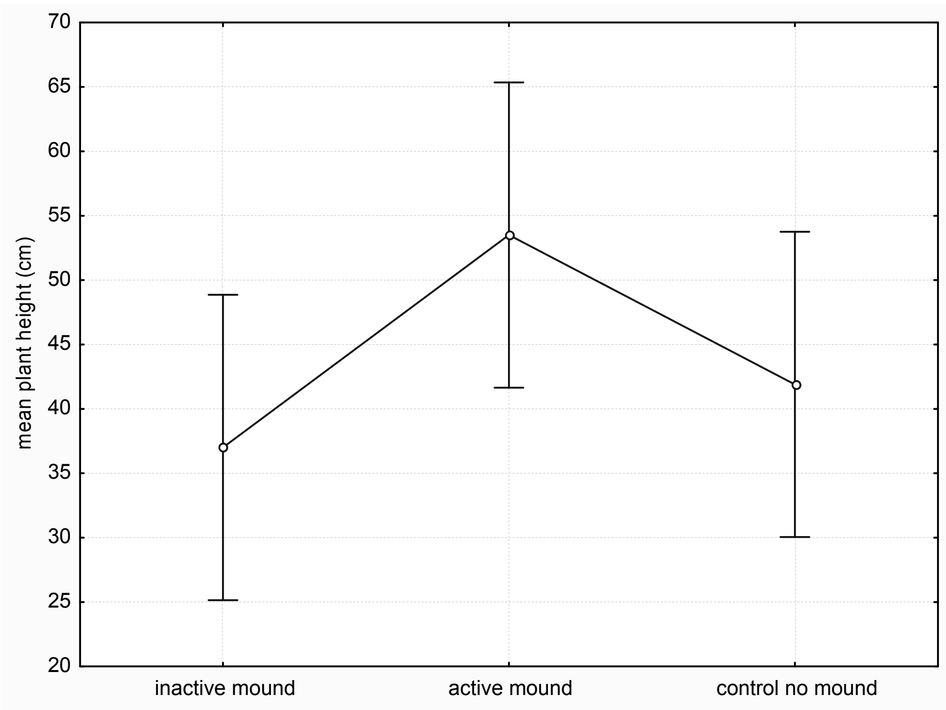

Figure 2. Plant height (excluding Eucalypts) at sites containing active Malleefowl nest mounds, inactive nest mounds and at locations where no nesting activity (past or present) had been recorded.

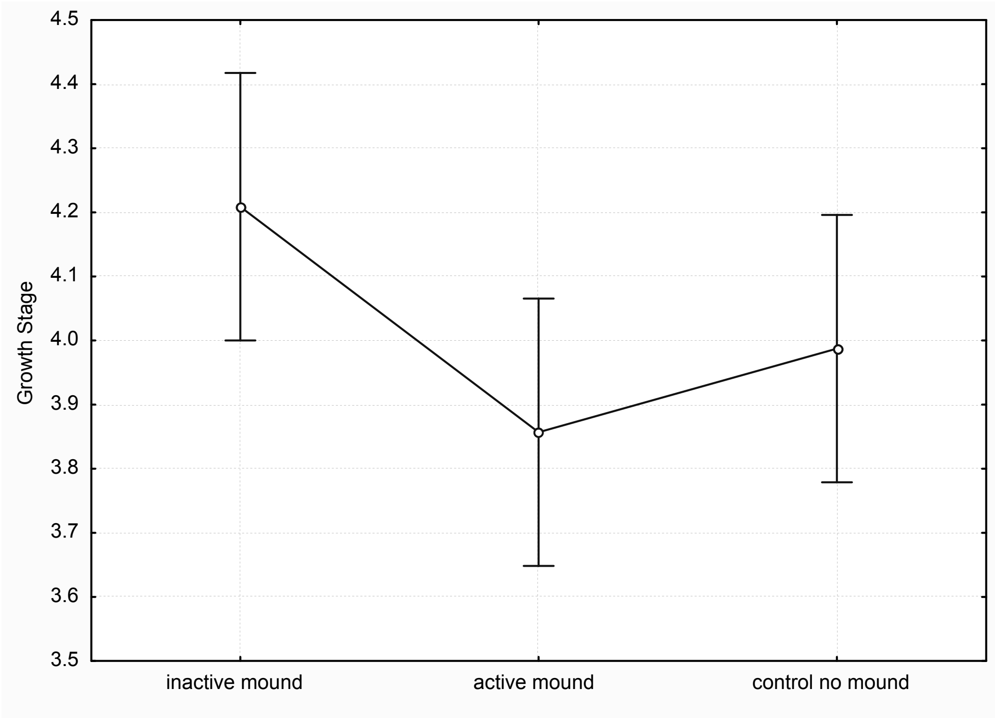

Figure 3. Growth stages of plant species recorded at sites containing active Malleefowl nest mounds, inactive nest mounds and at locations where no nesting activity (past or present) had been recorded.

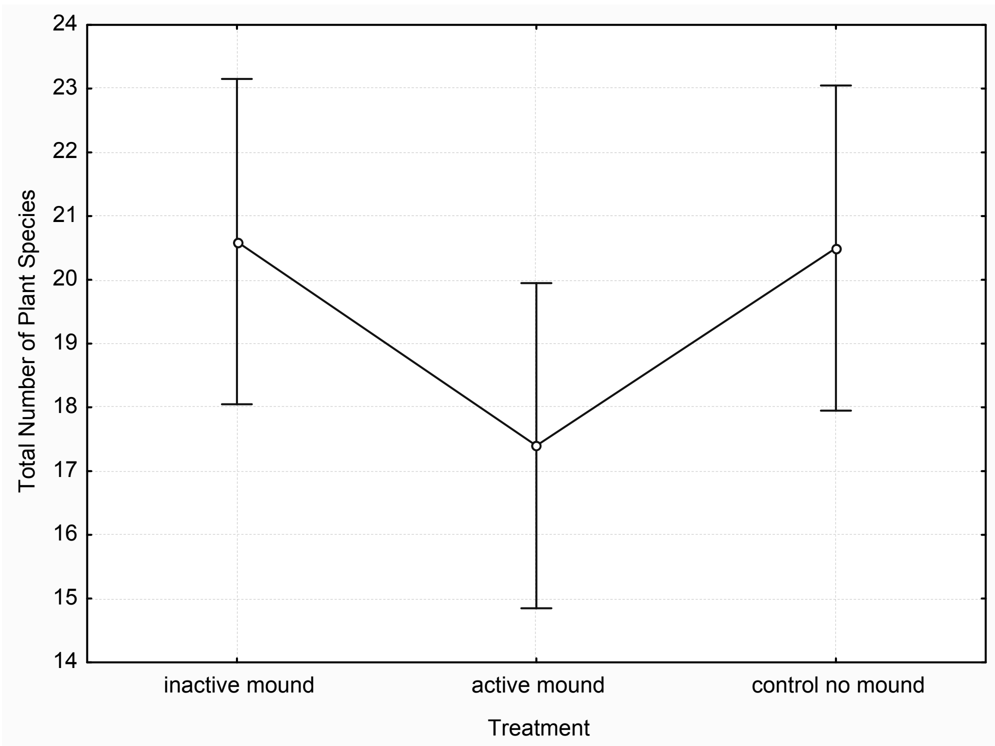

Figure 4. Total number of plant species recorded at sites containing active Malleefowl nest mounds, inactive nest mounds and at locations where no nesting activity (past or present) had been recorded.

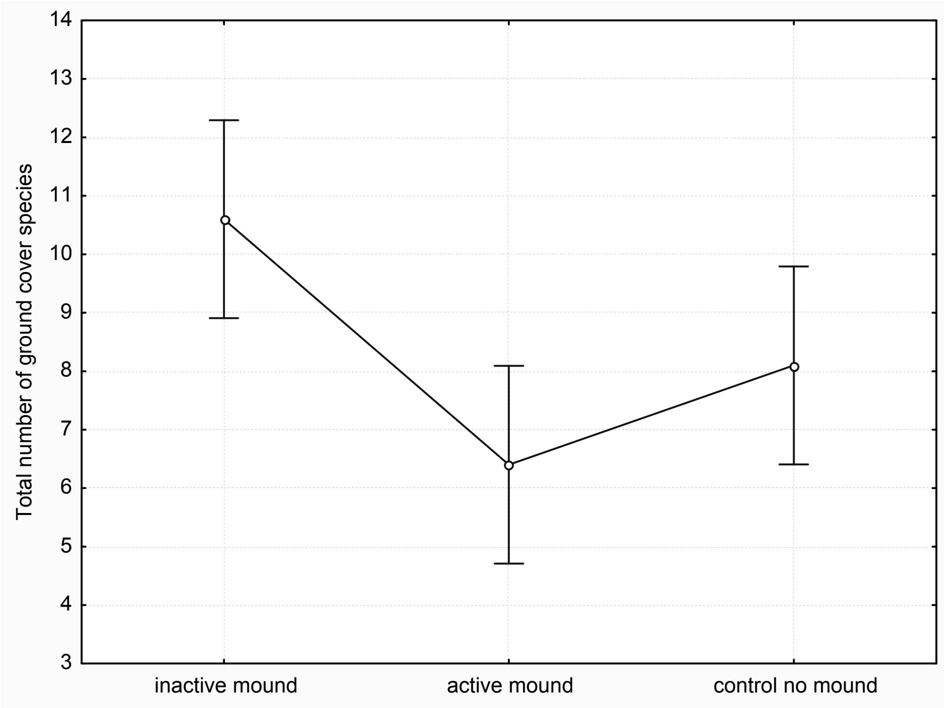

Figure 5. Total number of ground cover species recorded at sites containing active Malleefowl nest mounds, inactive nest mounds and at locations where no nesting activity (past or present) had been recorded.

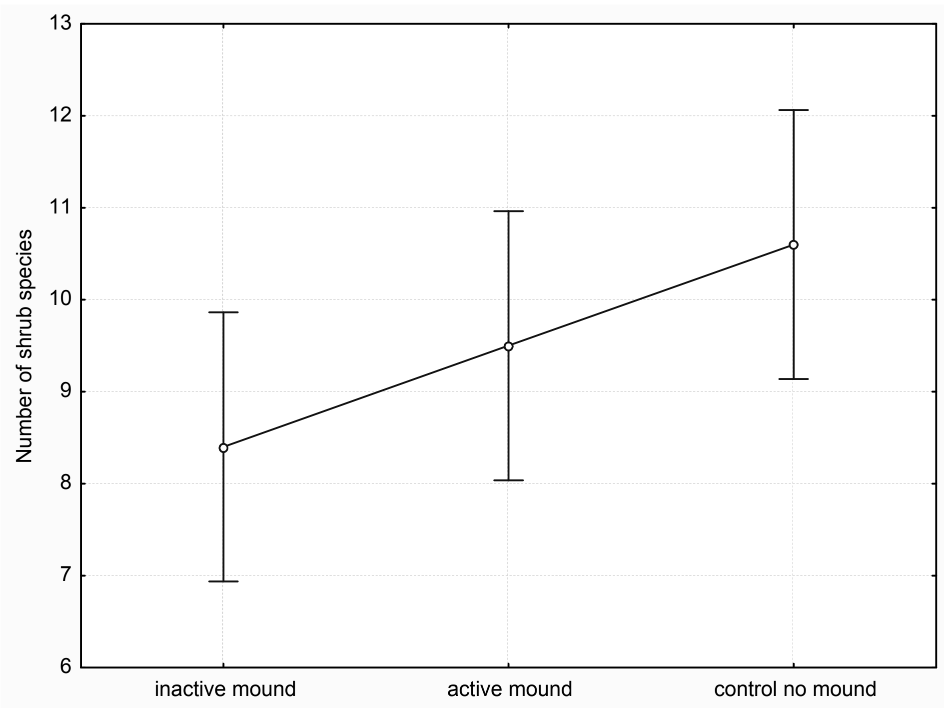

Figure 6. Total number of shrub species recorded at sites containing active Malleefowl nest mounds, inactive nest mounds and at locations where no nesting activity (past or present) had been recorded.

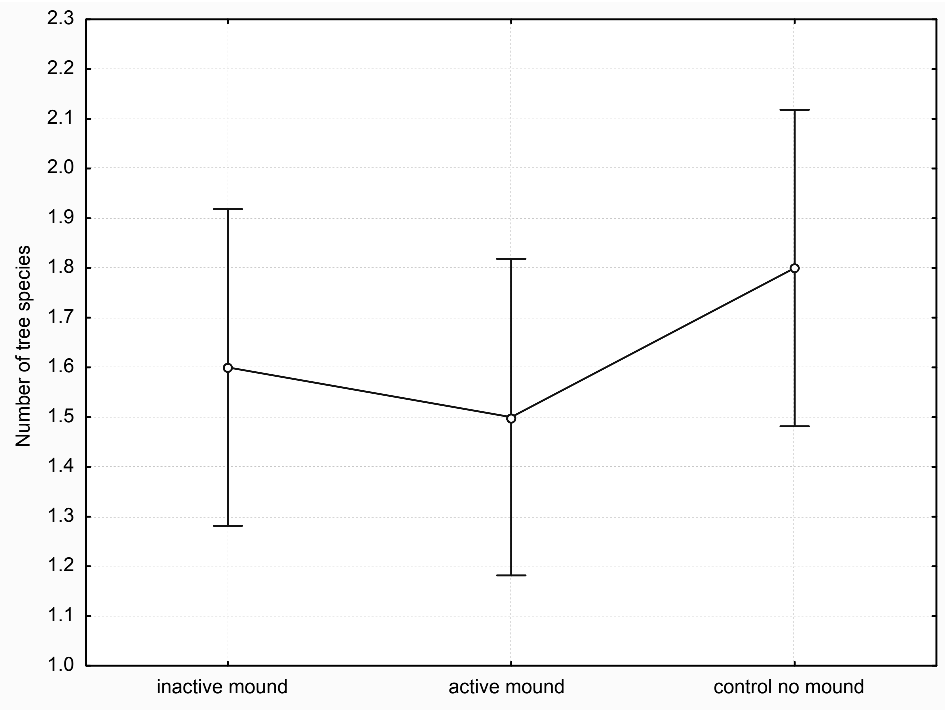

Figure 7. Total number of Tree species recorded at sites containing active Malleefowl nest mounds, inactive nest mounds and at locations where no nesting activity (past or present) had been recorded.

Appendix 1 Plant species recorded within all vegetation sites.

Plant Species	Number of Plants	Height cm	Growth Stage	*Plant Species*	Number of Plants	Height cm	Growth Stage	Plant Species	Number of Plants	Height cm	Growth Stage
Acacia burkittii	20	92	4	*Dillwynia sericea*	26	76	5	*Pterostylis biseta*	1	20	2
Acacia calamifolia	7	125	5	*Dodonaea cuneata*	59	76	5	*Ptilotus atriplicifolius*	1	30	5
Acacia subulata	55	100	4	*Eremophila glabra*	60	87	5	*Ptilotus elderi*	7	10	5
Acacia tetragonophylla	1	60	5	*Eucalyptus foecunda*	91	486	3	*Ptilotus exaltatus*	4	35	4
Acacia triptera	23	130	2	*Eucalyptus morrissi*	12	500	3	*Ptilotus gaudichaudii*	1	30	4
Aristida calycina	6	23	2	*Eucalyptus socialis*	163	492	3	*Ptilotus nobilis*	28	8	2
Alyssum linifolium	1	130	5	*Eutaxia diffusa*	10	130	4	*Ptilotus obovatus*	32	42	4
Atriplex stipitata	42	40	3	*Eutaxia microphylla*	69	66	5	*Ptilotus seminudus*	13	13	4
Bassia bicornis	409	17	5	*Galium gaudichaudii*	111	21	2	*Rhagodia gaudichaudiana*	13	26	3
Bassia decurrens	120	15	5	*Geranium solanderi*	1	20	4	*Rhagodia spinescens*	33	22	2
Bassia lanicuspis	107	14	5	*Goodenia sp.*	3	43	4	*Rhyncharrhena quinquepartita*	108	42	3
Bassia parviflora	104	20	5	*Grevillea huegelii*	5	80	4	**Santalum acuminatum**	7	60	2
Beyeria opaca	1	70	5	*Halgania cyanea*	1388	16	4	*Scaevola aemula*	67	19	4
Bossiaea walkeri	45	106	4	*Haloragis odontocarpa*	48	36	4	*Scaevola humilis*	237	23	4
Brachycome Ciliaris	1845	16	4	*Helichrysum semipapposum*	263	29	4	*Senecio cunninghamii*	12	43	4
Brachycome ciliocarpa	27	18	5	*Helichrysum viscosum*	235	37	4	*Sida corrugata*	32	18	3
Brachycome multifida	17	12	4	**Helipterum floribundum**	4	25	4	*Solanum coactiliferum*	51	107	5
Callitris columellaris	6	122	3	*Helipterum stuartianum*	2	12	4	*Sonchus oleraceus*	8	36	4
Calotis anthemoides	51	15	4	*Hybanthus monopetalus*	25	40	3	*Stipa scabra*	685	24	5
Calotis hispidula	109	13	5	*Lomandra leucocephala*	140	25	2	*Stipa tuckeri*	39	33	5
Calotis integrifolia	8	19	4	*Medicago polymorpha*	53	16	5				
Calotis lappulacea	9	18	4	*Melaleuca unicinata*	88	216	4	*Stipa variabilis*	544	25	5
Cassia oligophylla	6	150	2	*Myoporum platycarpum*	37	113	4	*Stuartina muelleri*	87	11	3
Cheilanthes tenuifolia	4	30	2	*Oxalis corniculata*	43	7	4	*Swainsona burkittii*	5	12	4
Convovulus erabescens	6	21	3	*Panicum laevifolium*	2	20	2	*Taraxacum officinale*	8	20	5
Cuscuta campestris	83	11	4	*Panicum prolutum*	1	30	5	*Templetonia aculeata*	11	38	5
Danthonia caespitosa	35	23	5	*Paspalidium constrictum*	51	24	4	*Thysanotus baueri*	115	35	4
Danthonia eriantha	1	25	5	*Paspalidium gracile*	14	10	5	*Tricoryne elatior*	268	13	5
Danthonia linkii	1	20	5	*Phebalium glandulosum*	2	15	4	*Triodia irritans*	246	52	5
Danthonia setacea	3	27	4	*Phebalium obcordatum*	45	34	4	*Triodia mitchellii*	11	20	5
Dianella laevis	82	31	4	*Podolepis jaceoides*	101	18	4	*Westringia rigida*	44	53	3
Dianella revoluta	272	46	4	*Podospermum resedifolium*	4	15	4	*Zygophyllum glaucum*	8	30	2
Dicrastylis lewellinii	5	45	5	*Poranthera microphylla*	664	9	4				
Dicrystalis verticillata	407	30.5	3.6	*Prostanthera microphylla*	10	75	5				

22. Tracking Malleefowl in the Little Desert National Park: A preliminary study of Malleefowl activity in the park

Ralph Patford, Member Victorian Malleefowl Recovery Group

Authors: Ralph Patford, Ron Wiseman (President, VMRG), Joe Benshemesh (consultant), Doug Parke (President, VMLCG)

Abstract

The Little Desert NP stretches 95 km east from the Victoria – South Australia border, south of the Western Highway. Malleefowl are known to occur in the park but their distribution has never been systematically mapped. Until recent years the VMRG has had minimal involvement in the park, with one long-term monitoring site and two more recent sites established in or adjacent to the park.

Our aim was to investigate the distribution and abundance of Malleefowl in the Little Desert with a view to establishing further monitoring sites.

A simple but innovative sampling approach was developed. This approach utilised electronic data collection and allowed for the field work to be conducted by non-professional volunteers whilst maintaining scientific integrity. The activity was conducted in partnership with the Victorian Mobile Landcare Group.

The project showed that the methodology was a suitable technique in sandy country for establishing both the existence and the distribution of Malleefowl in potential Malleefowl habitat. It also showed that it has the potential to increase the awareness of Malleefowl among the wider community. The paper concludes by indicating that the methodology could be used as an effective tool in further Malleefowl research.

Introduction

The Victorian Malleefowl Recovery Group Inc (VMRG) monitors Malleefowl activity throughout Victoria. Monitoring sites are established in all of the National Parks and a number of Flora and Fauna Reserves within the Mallee environment. Sites are strategically placed and, by and large, cover Malleefowl country reasonably adequately – with one noticeable exception. With only two sites established, the vast Little Desert National Park has been a stand out omission from the activities of the VMRG. This paper describes the innovative approach the VMRG used to assess possible locations for the establishment of further monitoring sites in the Little Desert.

As much as the VMRG wanted to know about the extent of Malleefowl activity with the Little Desert, this paper is more about the methodology used and, as such, attempts to scrutinise that methodology as a worthwhile tool for future research.

The Little Desert National Park

The Little Desert stretches eastward from the South Australian border for about 95 km and is bordered by the Western Highway to the north and the Wimmera Highway to the south. The north to south width averages about 15 km, with a maximum of about 22 km. The 130,000 hectares are divided into three blocks – the Western, Central and Eastern blocks. The Western block is largely classified as 'Remote and Natural'. Most recreational activities take place in the Central and Eastern blocks (see Fig. 1).

The park is criss-crossed with tracks, mainly requiring 4WD vehicles, although some are suitable for conventional vehicles. There is about 1000 km of track altogether. There are also a number of designated hiking tracks, mainly within the Eastern Block.

The vegetation varies considerably throughout the park, and the fire regime over recent years has been quite extensive.

The Little Desert Lodge, established by Whimpey Reichelt, is situated to the northwest of the Eastern Block. It is the only private body registered to breed Malleefowl in Victoria and it has done much to further the cause of the Malleefowl.

Why search the Little Desert

The Little Desert contains many areas with the potential to support Malleefowl populations. The VMRG has had minimal interaction in the Park. For many years now it has monitored a site in the Hateley Flora and Fauna Reserve, on the northern edge of the eastern block. However, due largely to a fire that burned most of the reserve a number of years ago, the Malleefowl population has long since disappeared.

In recent years the VMRG began the process of establishing a monitoring site in the vicinity of Mt Turner, virtually in the centre of the central block. Likewise, the group has done the same with a site in the Nurcoung Flora and Flora Reserve to the south of the eastern block, but separate from the National Park.

Ray 'Whimpey' Reichelt, founder of the Little Desert Lodge and associated complex, (now incorporated into the Little Desert Flora and Fauna Foundation) has had a long association with Malleefowl in the park but the emphasis of his work is quite different to that of the VMRG.

Vegetation of the Little Desert

The vegetation of the Little Desert is quite varied and not all is suitable for Malleefowl activity. The Parks Victoria website contains the following description:

> *More than 670 species of native plants have been recorded in the Little Desert, representing about one fifth of Victoria's indigenous flora. The eastern block contains extensive heathlands, with banksia, tea-tree and sheoak, and many spring flowering species. Woodlands of Yellow and Red Gum with Slender Cypress-pines, and swamps and clay flats of Bull-oak and melaleuca are of particular interest in the western block. Some twelve plant species are considered to be rare or significant. The central block contains elements of the vegetation types of both the other blocks, with extensive areas of stringybark. Three plant species are considered rare or significant.*
> *Scattered throughout sandy areas of the park are ridges of iron-rich sandstones on which Broombush can be found.*

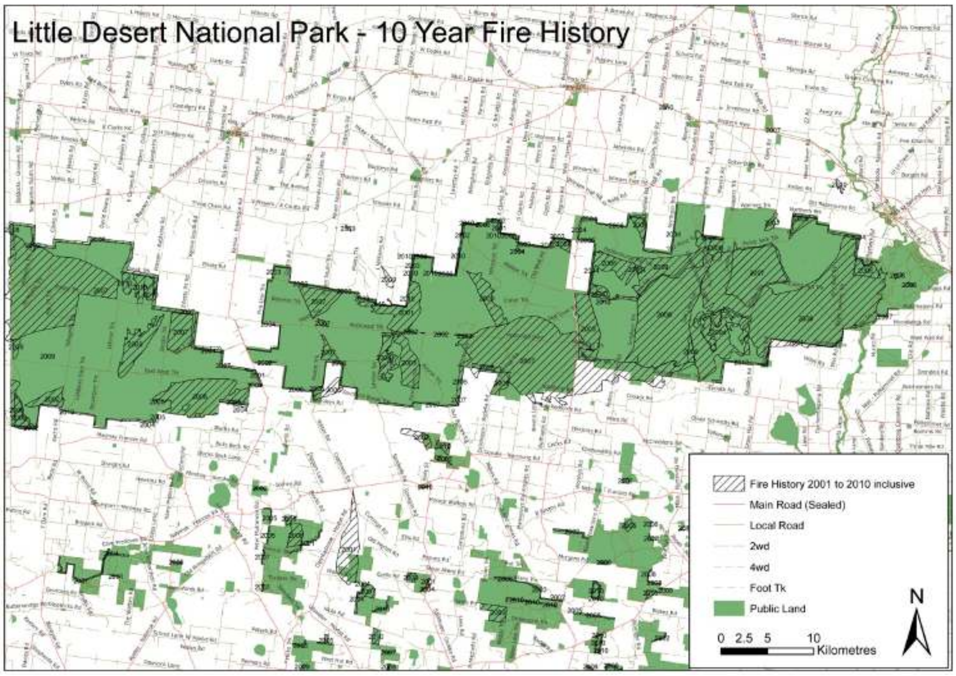

Figure 1. Fire history in the Little Desert NP.

Fire in the Little Desert
The Little Desert has been extensively burnt in recent years, a combination of wildfire and prescribed burning (Fig. 1). The VMRG is getting increasingly involved in the decision making process in this regard and is very concerned with requirement to burn 5% annually of all crown land in Victoria (see Fig. 1).

How best to search the Little Desert
Searching the Little Desert in the time-honored method of line searching was out of the question. The park, at 130,000 ha, is large and much of it quite obviously unsuitable for Malleefowl activity. The park is also very elongated in shape, adding to the difficulties and, as mentioned above, contains about 1000 km of largely sandy tracks. The solution was to search for the signs of Malleefowl using a sampling approach, enabling a broad overview to be obtained which, in turn, would lead to the targeting of specific areas based on the outcomes of the search.

The Methodology
The methodology decided upon centered on the use of mobile teams of observers assigned to search designated tracks. Each transect (the term used for each designated track) was divided into sequential units of 1 km. The first 850 metres of each unit was driven and the last 150 metres walked by a team of at least 2 observers.

There were 14 transects identified initially and in September 2009, 60% were searched (Part 1). In April 2011 another 12 transects were identified and 70% were searched (Part 2). These transects were a combination of incomplete transects from Part 1, a second look at some of the more promising areas and some additional areas added in response to knowledge gained in the interim (see Fig. 2).

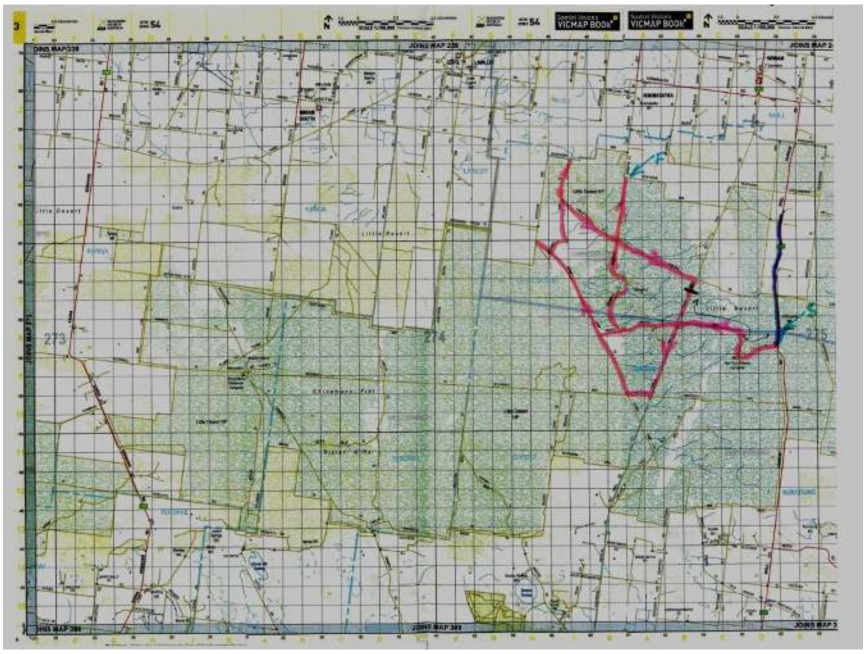

Figure 2. (Red – transect route, Blue – access routes).

Observers were asked to look for animal tracks, particularly Malleefowl, and to attempt to identify the species. GPS records were taken at the start and end of each walking unit and of any Malleefowl prints seen elsewhere. Photographs were taken of the first example observed of a species during each walking section. A scaling card was included in each photograph to allow for easier verification at a later stage, and an identifying letter (typically the first letter of the name of each species) placed on each card. Question marks were added where observers were unsure. Photographs were also taken of the vegetation at the end of each walking section. These provided additional information when the data was being examined for possible monitoring sites. It was also hoped that they would provide a 'snapshot in time' of the condition of the vegetation within the park. At the end of each walking section observers were also asked to record the Track Condition, estimated in 25% increments, of the ability of the track to show prints.

Recording the data
The data was recorded in the Cybertracker program. Observers used either the older Palm/GPS combinations familiar to many monitors, or the newer, more compact Mobile MapMakers. Observers were also equipped with printed forms, to be used if they preferred or if the technology came unstuck. It was pleasing to note that this was unnecessary on both counts. Teams were also equipped with a modified track identification manual, to aid in identifying fauna tracks.

Providing the resources
Much of the funding for the project came from the Wilderness Society via their WildCountry Small Grants Program. Members of the VMRG provided much of the expertise necessary for 'reading the signs', and a significant number volunteered their services for both parts of the project.

Providing an adequate number of both people and 4WD vehicles was beyond the resources of the VMRG, so a partnership was formed with the VMLCG (Victorian Mobile Landcare Group).
Whist the VMLCG is unapologetically part of the broader 4WD movement (they began as an off shoot of the LandRover 4WD Club), they are also committed to the care of the environment and their many environmental projects take them all over the state. Catering was provided by VCE students from Lalor Secondary College.

The involvement of these groups is consistent with the aims of the VMRG, in which community involvement and education is strongly emphasised.

Training
Training was largely conducted on site prior to the commencement of the activity. Training consisted of an outline of the purpose of the activity and detailed instructions on the methodology, and the use of the technology. A 'Modified Tracks Manual', specifically targeting species likely to be in the Little Desert, was produced and provided to each team. Detailed instructions were provided in the form of an 'Operations Manual', produced in-house specifically for the project. Safety requirements were emphasised and protocols put in place. However, with the experience of the participants involved, safety was not a large concern.

Problems
The weather turned out to be the most significant problem. Rain caused the cancellation of the first proposed date in April 2009, and it caused disruptions to the collection of data on the two project days, September 2009 and April 2011. In September 2009 the rain occurred just prior to the start of the search and in April 2011 the rain caused a premature end to the search. Whilst not heavy in either case it was sufficient to limit the ability of observers to find and identify tracks.

The experience gained in Part 1 indicated that the transect lengths were too optimistic. Consequently, for Part 2 the transect lengths were reduced by about 40%. For Part 1 the average transect length was 58 km and for Part 2, 34 km.

The base for the project was the Kiata Camping Ground in the north-east of the park. This meant that teams appointed to transects in the west had considerable distance to travel to and from their search area. However, this could not be avoided due to the lack of any other suitable base camp.

Findings

General
The methodology proved itself to be a useful method for searching large areas quickly. Malleefowl abundance was disappointing but the project did provide adequate data for further investigation of future search sites as part of the annual monitoring program.

The Methodology
As a method of searching a large area with limited resources in a relatively short period of time the methodology was adequate. Whilst a longer walking section on each sequence would have been of more benefit, the '850 m drive – 150 m walk' combination proved to be adequate from a sampling point of view.

The methodology lent itself well to cooperation with community groups, conditional upon the provision of sufficient expertise in each team. Detailed preparation and training were paramount to the overall success of the project.

The Malleefowl
The presence of Malleefowl was observed in only a small number of areas and these, by and large, tended to correspond with observations and information previously gathered. In all likelihood, the extensive recent fire regime, both prescribed and wild, has had a detrimental impact on the Malleefowl, as evidenced in the Hateley Flora and Fauna Reserve.

Recommendations
"That the methodology, as described, be endorsed as a suitable tool for the preliminary assessment of the distribution and abundance of Malleefowl and other species in large areas of potential habitat."

"That the methodology be endorsed as a tool for community engagement and Malleefowl awareness."

Acknowledgements
Dr Joe Benshemesh – Consultant
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Doug Parke – VMLCG President
Darcy Prior – Fire Planner (South West Area), Dept. Of Sustainability & Environment.

23. Mallee and Malleefowl Restoration at Monarto Zoological Park

Vaughan Wilson, Monarto Zoo, Zoos SA

Authors: V.K. Wilson[1], B. Horner[2], M. Post[1], B. Backhouse[3],

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Abstract

Malleefowl populations in the Fleurieu Peninsula region have declined significantly, with Ferries McDonald Conservation Park likely to hold the last remaining wild population. In response, Zoos SA are working to establish an insurance population for their region on their 1000 ha Monarto Zoo property. A large scale restoration project is underway to rebuild suitable habitat for the Malleefowl and other locally extinct native species. One of the aims of this project is to have a viable wild population of Malleefowl breeding onsite in the restored habitat. This will be achieved with an upgrade to the perimeter fence, broad scale habitat restoration and revegetation, the removal of feral predators, a reduction in competition from feral herbivores and the release of captive bred animals.

This season three eggs have been retrieved from three different mounds at Ferries McDonald Conservation Park and successfully artificially incubated and hatched. These and other birds collected in a previous season will become some of the foundation stock for breeding for release on the property. The holding of a viable breeding population in a captive situation will also provide insurance genetics in the event that a wildfire consumes the isolated Ferries McDonald Conservation Park, allowing re-introductions of provenance stock back into the area.

The captive birds will also be used to take advantage of the large visitor base at the zoo to promote an increase in public awareness of the plight of Malleefowl and other species under threat in the region.

Background

The Monarto area has been farmed for well over 100 years including the large scale clearance of native vegetation for broad acre farming. In the 1970's a large proportion of the area was compulsorily acquired by the then State Government for the development of a "Satellite City", an area planned for Urban Development. This plan did not, however, come to fruition; subsequently a large proportion of the land was sold back for farming.

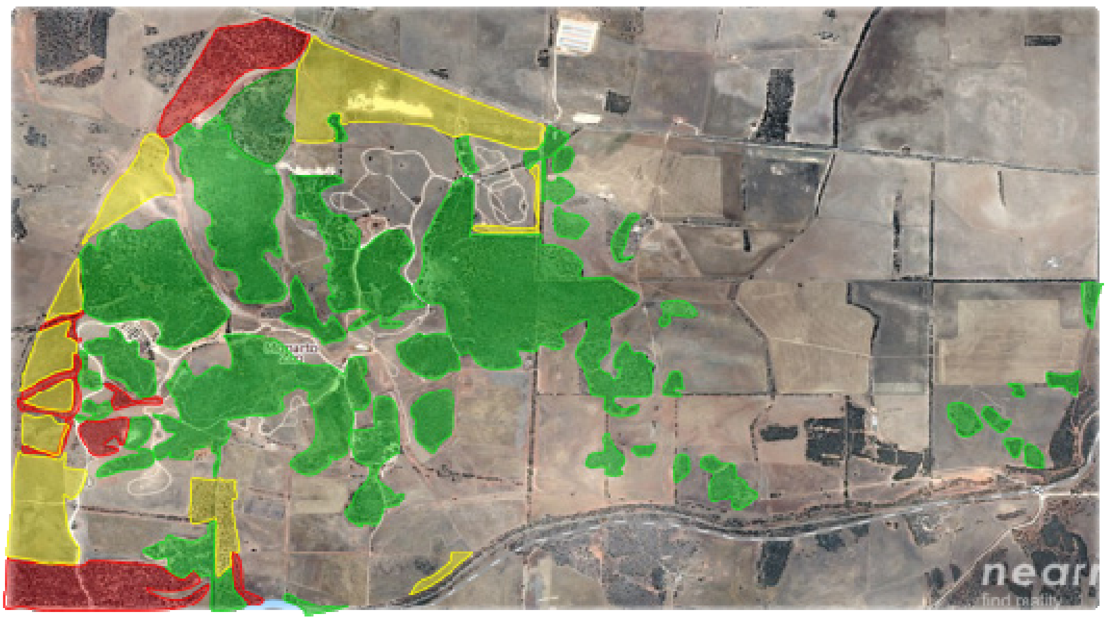
Nevertheless, 1000 ha of the land which had a higher percentage of native vegetation remaining was retained and is the property which is now leased by Zoos SA and has become Monarto Zoological Park. Currently Monarto Zoo has six grassed areas for ungulates with some re-vegetation along fence-lines and in islands within the enclosures. A further two areas contain carnivores where some habitat restoration can occur within the enclosure. Recently Zoos SA has also purchased an adjoining property of some 500 ha, eventually to become "Wild Africa", which is likely to include tented overnight accommodation.

Monarto Zoological Park is at the transition point between Open Woodland Formation (more common to the west as part of the Mount Lofty Ranges) and Mallee Open Scrub (more common to the east as part of the Murray Mallee region) with rainfall of approximately 350mm per annum. It is gently undulating land with a thin soil layer over limestone, Rippon Calcrete and Kanmantoo Schist. It is the rocky outcrops found throughout the property which were predominately left uncleared, with the sandy loam valleys between being predominately cleared for farming. This clearance pattern has left only a subset of the original habitat. In addition, the existing remnant has been degraded as a result of overgrazing by rabbits and kangaroos, weed species invasion and soil disturbance.

Monarto Zoological Park and Wild Africa

Once domestic livestock were removed from the property in the 70's, natural regeneration began to occur within the rocky outcrops. Some areas of the property were also planted by the Monarto Commission in readiness for the Satellite City. The plants used were all Australian natives however mostly Western Australian species.

In more recent years re-vegetation has been continuing using seeds sourced from the natural vegetation on the property and grown into tube stock by Monarto Zoo volunteers and partner organisations such as Trees For Life. The islands of rocky outcrop vegetation are slowly being connected and areas of sand and loam soils being revegetated to endeavour to return the property to as near a natural ecosystem as possible.



Green=Natural Vegetation. Red=Monarto Commission Plantings. Yellow=Recent revegetation.

Addax and revegetation.

Ferries-McDonald Conservation Park
With an average annual rainfall of 370mm Ferries-McDonald Conservation Park (CP) lies on the Murray plains. The park comprises about 845 ha, and is situated 10 km south-west of Murray Bridge and approximately 10 km south of Monarto Zoological Park. Open scrub is the dominant plant community in this park which comprises a wide variety of shrubs with a generally sparse understorey, while on heavier clay soils with limestone close to the surface tall shrubs of *Callitris* are common.

In recent years approximately one third of the park has been surveyed for active Malleefowl mounds by DENR staff and/or their volunteers. In this section of the park the number of active mounds identified per year in recent years has ranged from zero to eight.

Aims of Project
There are three main aims of Monarto Zoos present project with Malleefowl.

- **Insurance Population of Malleefowl for Ferries McDonald Conservation Park**
  Being such an isolated colony, there is a very real risk that a significant fire event could do serious damage to the population of Malleefowl within Ferries McDonald. To ensure the genetics of this population continue we would like to house an insurance population of Malleefowl with founders all originating from Ferries McDonald CP.
- **Display & Education**
  The captive birds will also be used to take advantage of the large visitor base at the zoo to promote an increase in public awareness of the plight of Malleefowl and other species under threat in the region due to habitat loss and predation by feral animals. New interpretation graphics are currently being designed to facilitate this.
- **Breed for release**
  The establishment of a captive breeding colony of Malleefowl will hopefully provide a large number of captive bred young which could be released to natural environments.

Monarto Zoological Park is home to a range of locally endemic species. A variety of birds inhabits and migrates into Monarto Zoo. Terrestrial and arboreal species living within the park include Red Kangaroo, Western Grey Kangaroo, Euro, Brush-tailed Possum and Emu, however at present the park is lacking in smaller terrestrial species. Animals such as Bilby, Bush Stone-curlew, Numbat and Brush-tailed Bettong are all endemic species planned for eventual release. The Malleefowl is another species that should be part of the ecosystem hence our plans to re-establish this species on the site.

Over the past twelve months, in response to an amazing year of rain and growth, we have leapt into action for the Monarto Restoration Project by planting another 20 ha of habitat. Some of this area has been set aside as part of a pilot study to identify treatments that will reduce weed competition for revegetation. A patchwork of plots have been created with each plot undergoing one or more spraying, grading or burning treatment to reduce the amount of weeds that could provide competition to our new plants. An Honours student has been measuring weed germination rates after these treatments to determine whether any will reduce competition for revegetation.

Countless hours of work from volunteers, school students and our Green Corp team have provided us with large quantities of seed. Some of this has been used to grow plants in our propagation facility and some has been sown out directly on our revegetation sites. In addition to the direct seeding we have planted around 5,000 plants. These plants were either grown in our own propagation facility or donated by Trees For Life. These new sections of habitat will provide a great start to our restoration work on the property and take us that next step along the path to restoring biodiversity and habitat health in the Monarto region.

Work will also hopefully commence soon on the upgrade to the perimeter fence. The original fence covering some 11 km was constructed to a height of 2.4m, and included barbed wire and electric fencing, and in some areas a ground skirt. While this fence has gone a long way towards protecting the inhabitants of the property, it has not proved to be completely vermin proof. Planned upgrades to the fence include installing rabbit proof skirting and a fox and cat proof cap along the entire fence line.

Malleefowl egg collection

In the mid 1990's the first re-introduction trials of Malleefowl into Monarto Zoological Park were commenced. Several birds bred at Adelaide Zoo were transferred to a purpose built aviary in the middle of native mallee scrub near the centre of Monarto Zoological Park. These birds were acclimatised for many months within the aviary before being released into the park. Through radio-tracking the welfare and fate of these individual was monitored. During the first release in 1995 four individuals were released with 2 succumbing to feral predation within days. The other two were recaptured. Work continued on feral predator control prior to a second release trial in 1996. Of the four birds released in 1996, one died from injury sustained from an ungulate, one died likely from a native raptor attack, one succumbed to a feral predator some months later and one was last seen five months after release, after the radio transmitter had failed. Some of the lessons learned from these releases include:

- The need for major feral predator control prior to release.
- That adult birds raised in a captive situation can lose or reduce their natural instinct to roost in trees at night. This may be overcome by maintaining them with a nocturnal mammal species (e.g. Brush-tailed Bettong) which may encourage them to continue to roost in trees. This could also be overcome by releasing young birds which still retain the instinct to perch.
- That birds raised in a captive situation may have a reduced fear of open areas, subsequently are more likely to be predated on by raptors or to come into contact with other species.

In 2009, Adelaide Zoo and Monarto Zoo staff were able to collect eggs from several mounds at Ferries-McDonald CP. A large percentage of the eggs inspected were infertile, however several fertile eggs were removed and subsequently hatched. This was filmed by Channel 7's TV program "The Zoo" which was subsequently aired nationally and assisted in highlighting the plight of Malleefowl. An unrelated pair of birds was subsequently raised to adulthood and these now reside in a display aviary in the heart of Monarto Zoo (originally constructed as the release aviary). These two-year-old birds have recently started to dig a depression however at this stage little attempt has been made to create a mound.

In 2010, permission was again given for Adelaide and Monarto Zoo staff to collect eggs from Ferries-McDonald. Collection did not proceed until fairly late in the season and a large number of infertile eggs were again found. Two birds were successfully hatched and reared from eggs collected and are currently housed at Monarto Zoo.

It is hoped that several more birds can be obtained from Ferries McDonald in coming years to ensure that a sufficiently diverse gene pool is available for the establishment of the captive breeding component. A broader range of genetics may also be required for the release program to ensure that a sufficiently large gene pool is available for the long term viability of the free range population.

Conclusion

A lot of work has been done nationally for the conservation of remnant populations of Malleefowl. Where-ever possible perhaps the range of Malleefowl could be extended with re-introductions. Our aim to establish a free ranging population of Malleefowl at Monarto Zoological Park is one small step towards ensuring this species' conservation in its natural environment, but one that may have long term ramifications for the re-establishment of the species into other parts of their range where they are now locally extinct.

Acknowledgments and Thanks

I would like to thank Briony Horner and Brett Backhouse for photos and input; the keeping staff at both Adelaide Zoo Bird Department and Monarto Zoo Native Fauna Section for their support and help, and particularly the staff of DENR and the volunteers working at Ferries-McDonald Conservation Park.

24. How Habitat 141 contributes to Malleefowl conservation

Ben Carr, Development Coordinator, Habitat 141 Project; Greening Australia, Victoria

Abstract

Habitat 141 is a landscape scale restoration project that aims to produce “more and better habitat” in the area straddling the Victorian-South Australian border. Habitat 141’s vision is “to work with communities to conserve restore and connect habitats for Plants and wildlife on a landscape scale from the outback to the ocean.”

This paper will introduce the Habitat 141 concept and its current governance and organisational structures. The role of Habitat 141 as a multi-sector, multi-partner collaboration in the conservation of Malleefowl will be broadly examined in a number of areas, including:

1) Explanation of the vision, function and governance of Habitat 141.
2) Collaboration with and between organisations and the particular challenges facing community based non-government organisations within Habitat 141 will be briefly explained. The role of the 9 landscape zones in Habitat 141 as the regional scale collaborative structures for participatory planning and collaboration that develop and deliver on-ground conservation projects will be examined.
3) Participatory planning using the Conservation Action Planning (CAP) process in Habitat 141 to adaptively manage and achieve desired conservation outcomes will be described. I will briefly look at the CAP process in Habitat 141 and how that is using an environmental system-based approach to plan for species (Malleefowl!) outcomes.
4) The Ecological basis for planning and some early on ground outputs towards developing a large scale restoration project – the “Malleefowl Corridor” in Zone 2 of Habitat 141.

***Note:** *This paper was not available at the time of printing.*

25. Nganamara Maralingala: Monitoring of Nganamara (Malleefowl) in the arid zone ecosystems of Maralinga Tjarutja

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Abstract

In the Maralinga Tjarutja Aboriginal Lands (10% of the area of South Australia) Nganamara are rarely recorded due primarily to remoteness and limited access. The records from sightings and track monitoring in the Maralinga Tjarutja indicate a sparse and/or a patchy distribution. At one nest site with unusually enhanced and reliable food resources automatic 24hour/7days cameras with both still and video capacity have recorded prolonged nest activities by both parents over several months in dry to drought conditions. The observed occurrences in the Maralinga Tjarutja Lands possibly reflect relatively small local accretions of pairs and their offspring in areas of enhanced resource availability (in particular food), and possibly also reduced predation pressure. The pattern of occurrence and the Maralinga Airfield nest observations provide support for the working hypothesis that Nganamara in Maralinga Tjarutja (and probably more generally in the arid zone) are largely restricted to 'islands' of enhanced resources in 'seas' of relatively poorly resourced habitats that none-the-less are and need to be traversed during dispersal. The presentation at the Nganamara Forum included three compilations of a large number of significant still images.

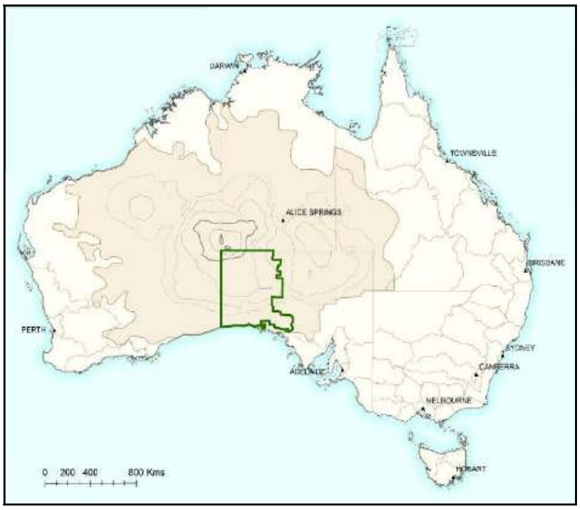
Introduction

The Maralinga Tjarutja (MT) Aboriginal Lands comprise about 10% of the area of South Australia, and these Lands are the central part of the Alinytjara Wilurara Natural Resource Management (AWNRM) Region (see Map 1). Nganamara monitoring activities in the AW NRM Region have been reported by Robinson *et al* 2003, Benshemesh 2007a, Southgate *et al* 2007, Paltridge *et al* 2007, Partridge 2008, Ward and Bellchambers 2008, Southgate *et al* 2009, and Schmucker 2011. Nganamara have been recorded in the AWNRM Region (see Map 2) and the MT Lands at relatively few sites relative to their large areas (see Maps 3 and 4). This is due in part to the inaccessibility and remoteness of the area to observers, and the very limited number of access tracks until very recently.

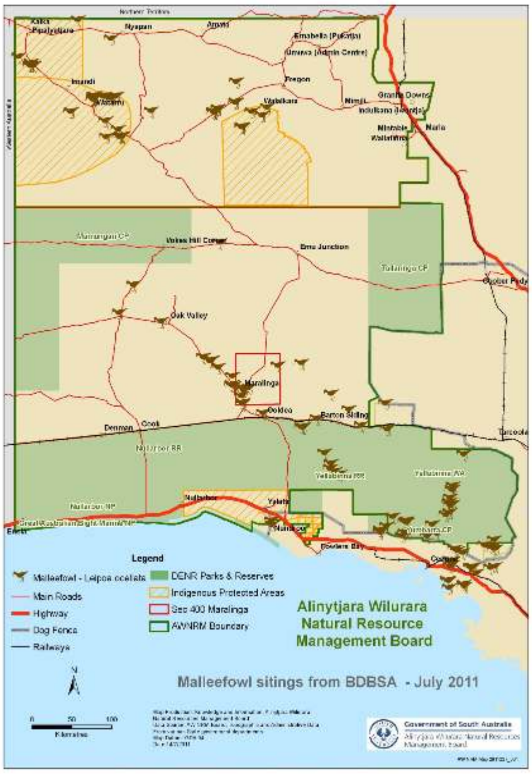
For a general account of Malleefowl ecology see Ehmann (2006). In their entire range Malleefowl are generally considered to be in decline (Benshemesh 2007b), including in the Anangu Pitjantjatjara Yankunytjatjara Lands (APY Lands) where they are sparsely distributed (Partridge 2008). From the work of Ward and Bellchambers (2008) Nganamara distribution and detectability in the Maralinga Tjarutja Lands is similar to that in the APY Lands. Ward and Bellchambers (2008) recommended monitoring Nganamara in the WA NRM Region using a standard quadrat as the unit for sampling to arrive at an 'area of occupancy' measure rather than the pair, nest and breeding success –based methods described in *The National Manual for the Malleefowl Monitoring System: standards, protocols and monitoring procedures* (Victorian Malleefowl Recovery Group, 2007). Ward (2008) has further developed these recommendations into monitoring guidelines specific for the AW NRM Region.

A comprehensive case has been made by Ward and Bellchambers (2008) for continuing and further developing the monitoring of Nganamara in the Maralinga Tjarutja Lands. Their compelling case is based on long term and immediate benefits for Anangu, on ecological and conservation reasons and on legislative imperatives.

The monitoring activities reported here were carried out with the same methodology as recommended in the available literature, and the results provide additional insights to inform on-going field work.



Map 1. The dark outlined area in the west of South Australia is the Alinytjara Wilurara Natural Resource Management (AW NRM) Region. It is bounded on the east by the pastoral rangelands and is about the size of Victoria.



Map 2. Most of the recorded occurrences of Nganamara in the AWNRM Region. The Maralinga Tjarutja Lands are in the horizontal middle of this Region and they are bounded to the north by the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands and by the Indian-Pacific railway line in the south. This map includes the sites reported by Ward and Bellchambers (2008).

Figure 1. Adult Nganamara (presumably the male) part way through closing the mound. This image is sequentially located between images 1 and 2 of Fig. 5.

Monitoring methods

The detection and monitoring methods for Malleefowl are well documented (Victorian Malleefowl Recovery Group, 2007). Ward (2008) has developed guidelines specifically for the AW NRM Region. In the AW NRM Region Rick Southgate, Pip Masters and others have developed a systematic method for monitoring and recording animal tracks in defined and standardized sand plots (Moseby, Nano and Southgate, 2010). These are 200 m x 100 m in area and are located 5 km apart at sites near to (but that do not include) access tracks and roads (ideally with a 10 to 20 m buffer space to the nearest edge of the plot). The entire area of each plot is walked and searched in 30 minutes for tracks which are recorded (including their condition) both during and at the end of the search, as well as weather and other factors that can affect the nature of animal tracks. Anangu monitors from Oak Valley and Tjuntjunjarra assist the western monitors/recorders in this work and all known animal tracks are recorded (see Moseby, Nano and Southgate, 2010 for method details and field forms).

The range of natural resource management field projects in the AW NRM Region frequently provide opportunities for trained AW NRM staff and Anangu workers to observe, record and monitor the tracks and traces of many animal species including Nganamara. Tracks and traces are routinely recorded with standard data, and photographs where-ever possible. When any signs of Nganamara are found the protocol outlined by Ward and Bellchambers (2008) and Ward (2008) is additionally and usually followed.

This involves spending one hour actively searching at the site for any further signs of Nganamara. Depending on the staff and Anangu present the effort can vary from one to ten work-hours. Nganamara searches involve visually checking for nests, feathers and primarily tracks and associated forage scratching on all sandy surfaces in an area of at least 500 m by 500 m around a focal point. This is usually the initial detection point of tracks and/or traces. Further recordings are made of any additional tracks and traces (incl. nests). Nganamara tracks are followed for as far and as long as possible (up to an hour) to try to locate any nearby nest mound and also other signs.

One active Nganamara nest was found by Robin Mathews (Caretaker, Maralinga Village) in 2009 close to the main runway of the Maralinga Airfield. This nest was opportunistically monitored over a period of 18 months, and for some of this time four Moultrie Gamespy cameras were positioned sufficiently near the mound (see Figure 2) to record both high quality still images as well as low quality video footage in 30 second takes (ambient light by day) or 15 second takes (infrared when dark). These are automatic 24hour/7days cameras with a large battery capacity which provided coverage for up to two months between changes. Only two of these cameras continued to function for a sufficient time to record reportable data. The failures were probably due to the high temperatures these units were exposed to from long periods of direct summer sunlight. Each image and video clip also has the following data recorded with it: date, time, moon phase, temperature (of the camera), and the camera identification code. These data are displayed below the image (see Figure 2).

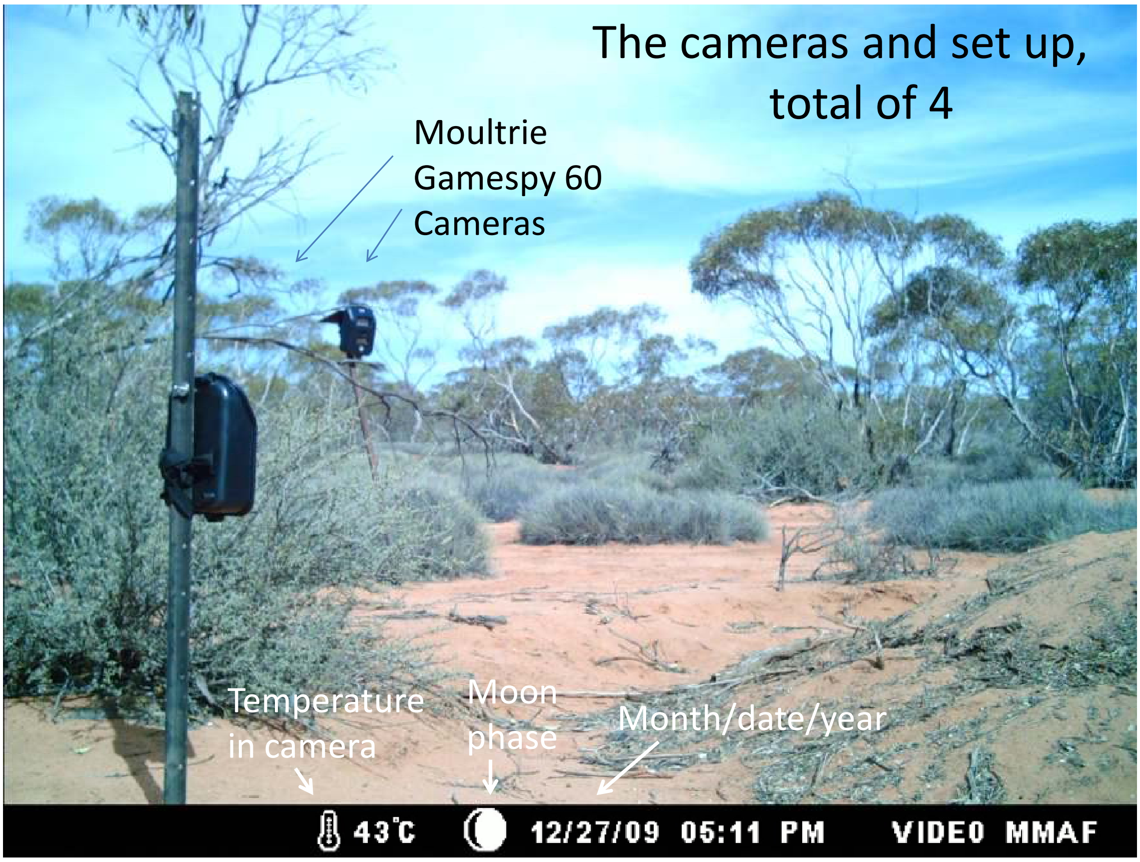


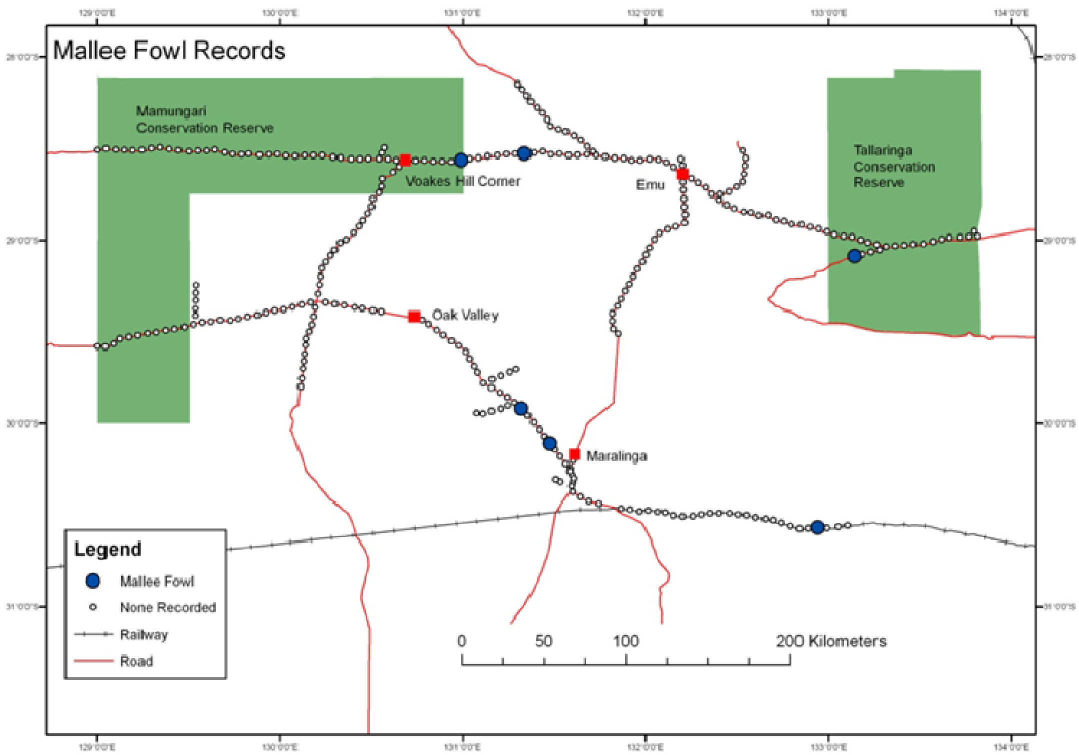
Figure 2. Two of the four Moultrie Gamespy cameras positioned near the mound to record high quality stills and lesser quality video footage (see Methods). The third camera was to the right of the view and the forth camera took this image. Each image and video clip also has the data as seen above with the last (VIDEO MMAF) being this camera's identification code.

Results and observations

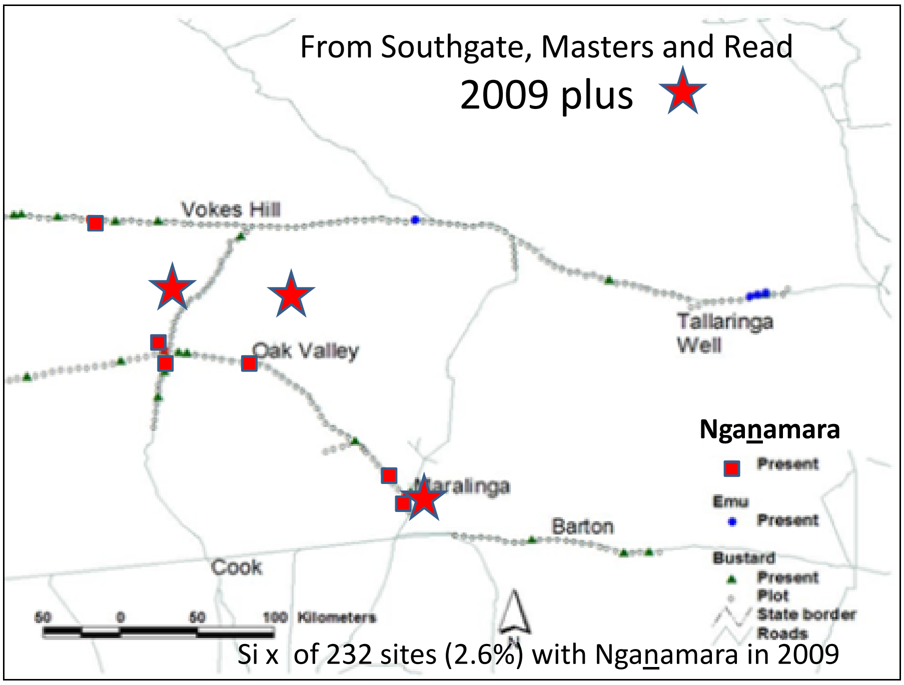
Maps summarizing Nganamara and predator records from reports by Southgate *et al* (2007, 2009) and Paltridge *et al* (2007) are reproduced as Maps 3, 4 and 5 below. Three additional Nganamara locations were found in 2009 namely one at Maralinga Airfield (nest, see below) and two by the author during other field work (tracks only) and they are added to Map 4. Map 5 shows predator records (from Paltridge *et al* 2007) and these data demonstrate the relatively high potential predatory pressure that exists for Nganamara.

Nganamara sightings are frequently reported in the general vicinity (up to 25 km) of the Maralinga Airfield and Village (Robin Mathews *pers. comm.*, and *pers. obs.*). During about 18 months of observations at the Maralinga Airfield nest the birds have returned in two successive seasons, and the breeding seasons (based on mound activity) lasted five and seven months. For most of these 18 months the area was in drought or very dry conditions. Such sustained breeding activity in such dry conditions in an arid area indicates factors that in particular provide high and stable food supply.

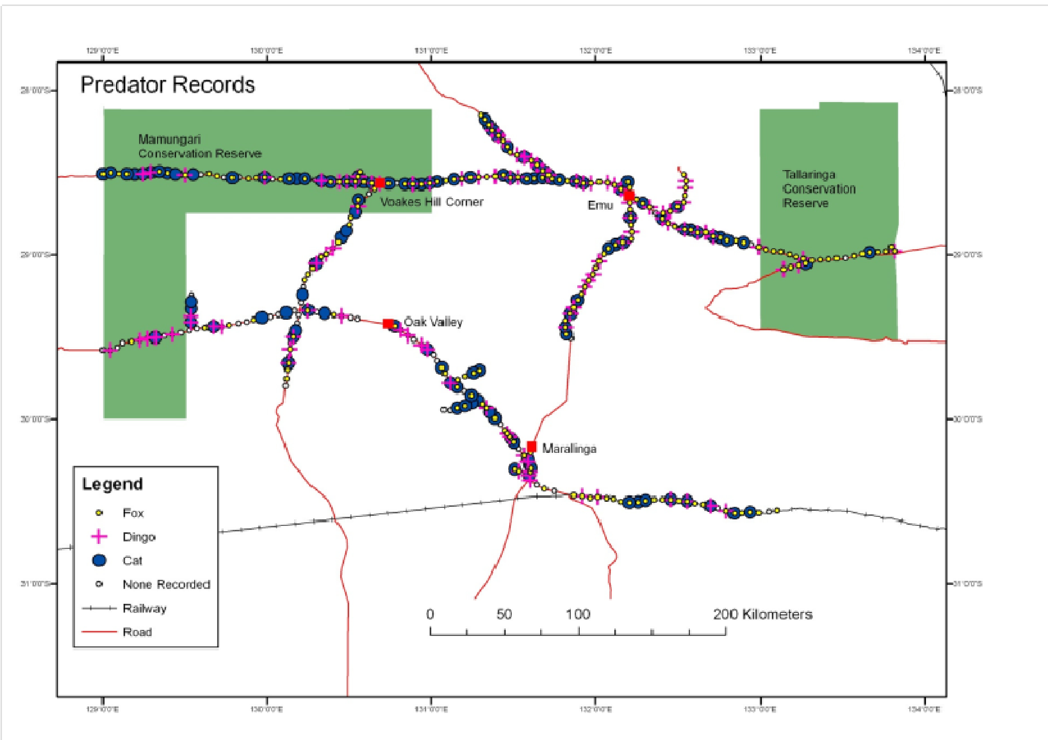
The unique situation at the bituminized Maralinga Airfield that can provide high and stable food supply is enhanced water availability due to rainfall run-off from the sealed runways and taxiways. Most of this water is shed to the habitats around its edges, much the same as occurs along the edges of sealed Outback roads. Even small amounts of rainfall in drought conditions can provide sufficient run-off to sustain the receiving fringing habitats at higher productivity levels than exist beyond the run-off receiving zone. The sheer size of the 2.5 km long Maralinga Airfield and its associated 2.5 km of sealed taxiways (with an adjacent average 100 m wide watered fringe) means there are as many as ((2.5 + 2.5) x 0.1 x 100)) = 100 hectares of fringing habitats (mostly mallee) that can provide relatively higher and more stable food supplies for Nganamara.



Map 3. Nganamara track records in Maralinga Tjarutja Lands found during track plot monitoring in 2007 at six out of 300 track plots (from Paltridge, Eldridge and Southgate 2007, and published in Moseby, Nano and Southgate, 2010). Note that only one of these sites (approx 25 km NW of Maralinga) also had Nganamara tracks in or near it in 2009: compare with Map 4.



Map 4. Nga<u>n</u>amara track records in Maralinga Tjarutja Lands found during track plot monitoring in 2009 at six (squares) out of 232 track plots (from Southgate, Masters and Read 2009). The stars are three additional sites where tracks were opportunistically found by the author in 2009. Note that only one of these track plot sites (approx 25 km NW of Maralinga) also had Nga<u>n</u>amara tracks in it or near it in 2007, and note also the clustering of Nganamara tracks sightings in the vicinity of Maralinga: compare with Map 3.



Map 5. Predator track records in Maralinga Tjarutja Lands found during track plot monitoring in 2007 at 290 out of 300 track plots (from Paltridge, Eldridge and Southgate 2007). Note the high number of fox (58%), cat (31%) and dingo (26%) records compared to Nga<u>n</u>amara (2%): compare with Map 3.

Furthermore, a considerable proportion of the 180 km of sealed roads in the whole of the Maralinga Section 400 Prohibited Area pass through mallee habitat, particularly those in the vicinity of the Village. The 33 km of sealed road south of Section 400 to Watson also runs through a large section of mallee before crossing onto the Nullarbor Plain. These sections of sealed road shed water in similar but lesser fashion as at the Airfield, but they none-the-less provide enhanced productivity that Nganamara can also utilize. If only half of the 180 km of sealed roads have an adjacent 10 m wide enhanced run-off water supply then there are (0.5 x 180 x 0.01 x 2 x 100) = 180 hectares of higher than average productivity habitat available to Nganamara. This probably helps to explain the relatively frequent sightings made of Nganamara along the sealed roads that pass through mallee habitat in and near the Maralinga Section 400 Prohibited Area.

Sequences of still images of a Nganamara opening and closing the nest as well as covering the nest before nightfall are presented in Figures 1, 3, 4, 5 and 6. The automatic 24hour/7days cameras recorded prolonged nest activities by both parents in quite varied weather conditions over several months. The presentation to the Renmark Nganamara Forum included three large sequences of significant still images showing mound adjustments by a single bird presumed to be the male.

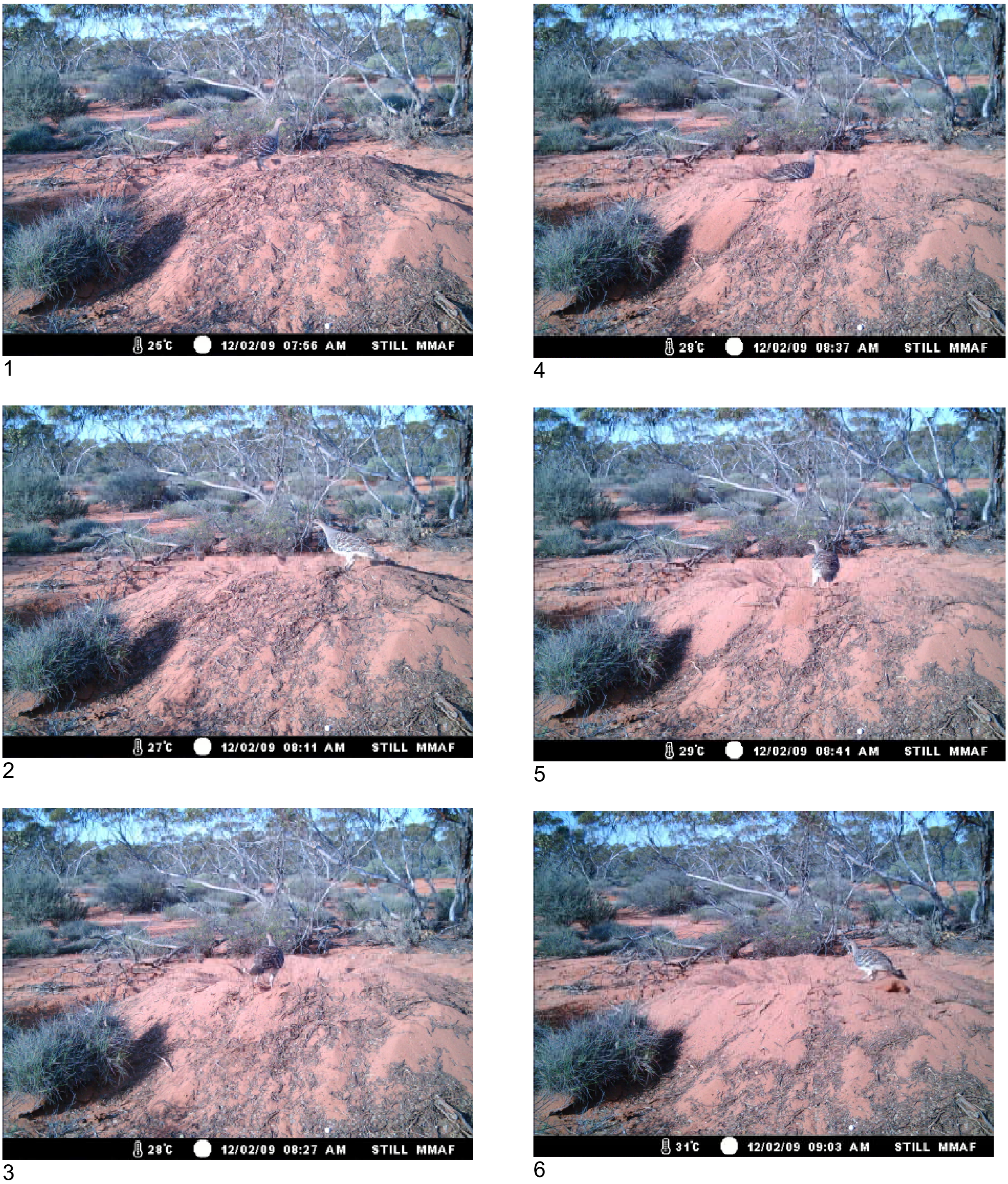


Figure 3. First six images of the nest opening sequence. For details see caption for Figure 4.

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Figure 3 (previous page) and 4. Images 1-9 are from most of the opening of the mound over 84 minutes. The bird then took a 44 minute break before completing the opening in a further 11 minutes. Why did the adult leave the nest for 44 minutes? To cool off? To allow a chick (not detected by camera) to escape?. To allow heat stabilization of nest? The nest was then left a further 21 minutes before being closed again (see next sequence in Fig. 5).

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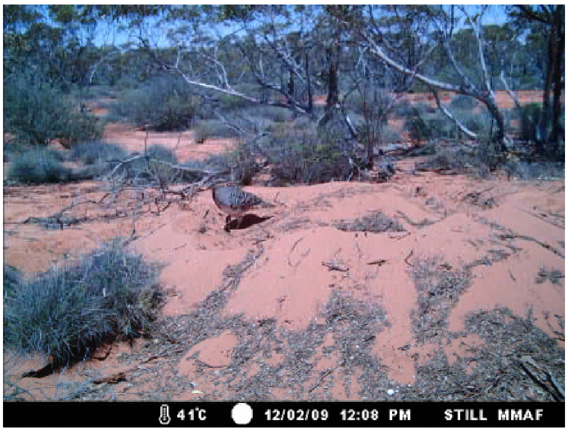

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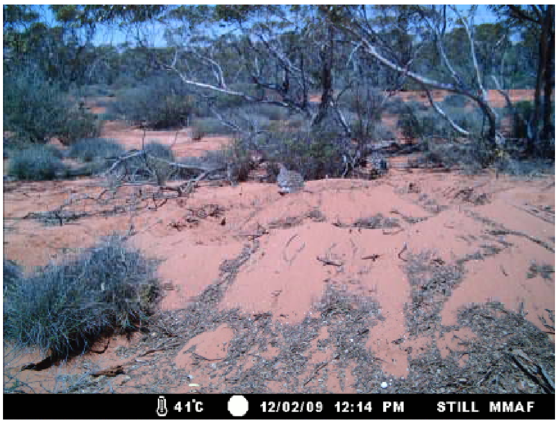

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Figure 5. Images 1 to 6 are of the nest closing sequence which took a total of 100 minutes and was uninterrupted by a period of absence.

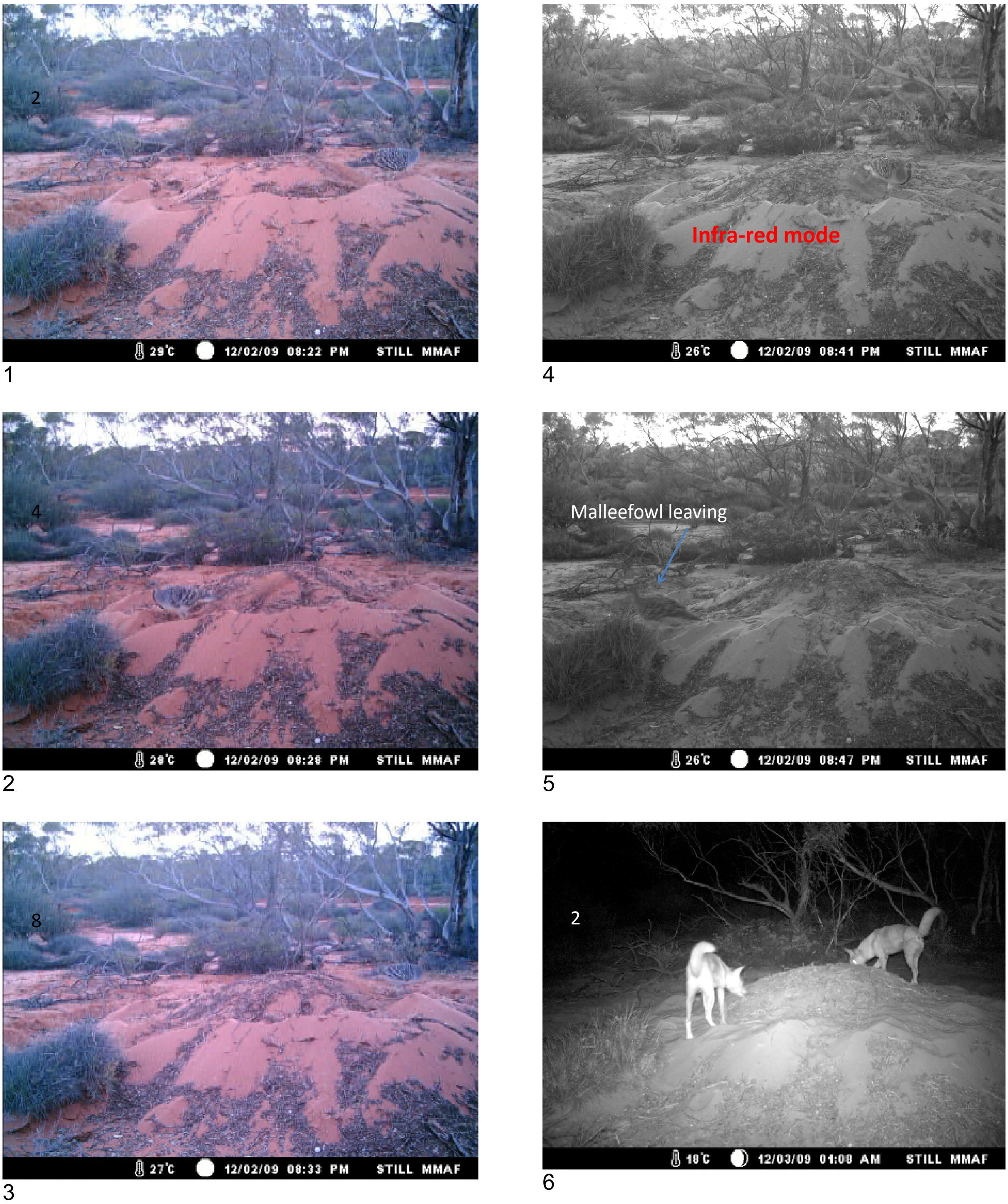

Figure 6. Images1 - 3 are in the evening of the sequences in Figs 3, 4 and 5. They are of the Nganamara adding cover to the mound at dusk with sufficient daylight. Images 4 and 5 continue the sequence with infrared lighting. The entire covering sequence took 25 minutes and was without interruption. Image 6 is of a brief approximate 2 minute visit to the mound by dingoes.

Discussion

Several significant factors and considerations influence Nga<u>n</u>amara monitoring in the Maralinga Tjarutja in general. The Lands are remote, vast and largely inaccessible, and the access tracks (of which there are now many more due to recent much increased mining and petroleum exploration) are the most practical transects. Furthermore the 100's of established animal track sand plots (see Southgate *et al* 2007, 2009) constitute a good basis for developing and fine-tuning the monitoring methodology advocated by Ward (2008). Ongoing sand plot monitoring will very likely increase the number of specific Nga<u>n</u>amara sites that can be monitored to get improved 'area of occupancy' measures.

Monitoring units and refinements

Ward (2008) recommended measuring Nga<u>n</u>amara persistence over time using 10 km x 10 km grid cell units that are adjacent to existing access tracks. Reporting is to be based on the percentage of such grid cells in which Nga<u>n</u>amara are recorded in the total number of grid cells that are adjacent to existing access tracks and which are searched in the monitoring period. This method provides for the calculation of an 'area of occupancy', a criterion used by the International Union for the Conservation of Nature (IUCN) in determining conservation status (IUCN 2010).

The size of the recommended 10 km x 10 km grid cell unit presents significant challenges particularly for determining whether an absence score can be reliably attributed to a grid cell of $100km^2$ when at best it might be possible to actually search $4km^2$ of such a grid cell. Smaller grid cell units that can be reliably attributed an absence score (by virtue of a complete search for tracks) seem more appropriate, and having a set number (say 4) of smaller search areas within each grid cell may be workable.

The currently available general track monitoring sand plots (200 m x 100 m = 0.02 km^2, Southgate *et al* 2007, 2009) are probably too small, and the main axis of 200 m is only a fraction of the potential one to ten day foraging distance/range of Nga<u>n</u>amara in the Maralinga Tjarutja Lands. (The range of a one to ten day period for foraging distance/range of Nga<u>n</u>amara is chosen as the possible to potential age of detectable tracks.) Past experience indicates that an area of 500 m x 500 m (=0.25 km^2) can be effectively searched with currently available resources (Ward and Bellchambers 2008, *pers. obs.*).

For a search not based on an opportune finding of a sign or track on the day Ward (2008) recommended that the perimeter of a 500 m square be walked for Nga<u>n</u>amara signs, with the walked squares being aligned with an access track and spaced at 500 m intervals. The general track monitoring sand plots that in the past had transient signs of Nga<u>n</u>amara could be central to a 500m x 500m search grid cell unit. In any case, if a 500 m square perimeter search does yield transient signs of Nga<u>n</u>amara then an additional 500m x 500m search (incl. a one hour track follow-up) can be done for nesting activity.

The success of the grid cell unit method to arrive at 'area of occupancy' measures lies in having high confidence in the finding of <u>and</u> the absence of signs of Nga<u>n</u>amara, and this means that initial detections need to be optimal and maximized. Most detections are transient signs of Nga<u>n</u>amara that are first noticed on and at the edges of access tracks and roads, particularly those with recent soil disturbance such as road works and erosion. It would be worthwhile making a careful and detailed study of the usage by Nga<u>n</u>amara of all road and track features to better design the initial detection methods and effort. Nga<u>n</u>amara tracks along road works and erosion disturbances seem to persist in the one direction for longer and there are more foraging scratch outs than are seen in undisturbed habitat (*pers. obs.*), suggesting that roadside detection efficiencies could be maximized with refined technique.

Nature of the distribution of Nga<u>n</u>amara in Maralinga Tjarutja and adjacent lands

Ward and Bellchambers (2008) determined a total of 44 sites from Maralinga Tjarutja, Yellabinna and Yumburra (i.e. the southern part of the AW NRM region) where Nga<u>n</u>amara have been recorded, and about 17 of these were new. The three additional locations reported in this study bring the total to 47. These records from sightings and track monitoring in the Maralinga Tjarutja indicate a sparse and a patchy Nganamara distribution.

The roads and tracks near which Nganamara tracks and sightings were made by Southgate *et al* (2007, 2009) could be considered as transects. These pass through a number of habitats that are unsuited for Nganamara and it is estimated that only about 65% of the averaged number of sand plots checked in 2007 and 2009 [0.65(300 + 232)/2 = 173] could be expected to have Nganamara signs present. Nganamara were detected at 11 different sand plot sites in 2007 and 2009 (i.e. 6 + 6 – 1 = 11, see Maps 3 and 4), or at 6.4% of the averaged number of suitable habitat sites. If the author's three additional sites (out of a total examined of 23) are added the percentage increases to 7.1% (14/196). If Ward and Bellchambers' (2008) new positive 17 sites (this figure is calculated from their data, and is part of their 44 additional novel sampled sites) are added, the percentage increases further to 13% (31/238).

These figures provide one means of calculating an estimate of the 'area of occupancy', and they also indicate a sparse and a patchy distribution when considered in conjunction with the mapping. The accretion of sightings data taken at different times will result in an increased estimate of 'areas of occupancy', so that the 13% estimate may well be too high, or at best at the upper limit of reliability. Conversely the 6.4% estimate of 'areas of occupancy' may be low because the track monitoring sand plots are too small. The one common and 10 different sand plots at which Nganamara were detected over the two years by Southgate *et al* (2007, 2009) suggests the birds have relatively high mobility or foraging ranges that well exceed a track plot quadrat, particularly in drier and drought conditions.

Ward and Bellchambers (2008) "…observed track patterns [that] varied from single birds foraging ... for several kilometres … to relatively small, high use areas by several birds, associated with nest mounds or feeding habitat." The severe and long drought until late 2010 could be expected to have resulted in clustered occurrences of Nganamara in refuge or stronghold areas. Such areas very likely have compounded habitat values including (one or more of) quality and quantity of food, shelter, and possibly reduced fox and cat predation (this could occur where staple prey species are depleted by drought e.g. rabbits). The observed occurrences in the very dry years of 2007 to 2010 probably reflect local aggregations of Nganamara as pairs (possibly breeding), some of their offspring and other adults that effectively reside and persist in areas of enhanced resource availability (in particular food) and possibly also reduced predation pressure.

The frequent reports of Nganamara in the general vicinity of the southern parts of Maralinga Section 400 Prohibited Area, and the sustained Nganamara breeding at the Maralinga Airfield despite drought conditions support the hypothesis that the sealed airfield and sealed road run-off provides higher and more stable food supplies over a significant area. This situation is reflected in Morton's (1990) conceptual model for the nature of distribution patterns of refuge-dependent wildlife in arid Australia.

The above observations and discussion support the working hypothesis that Nganamara in the Maralinga Tjarutja Lands (and possibly in the arid zone generally) are largely restricted to 'islands' of enhanced resources in 'seas' of relatively poorly resourced habitats (see also Ehmann and Tynan 1996 reproduced in Ehmann and Tynan 1997). These 'islands' contract in drier and drought times and expand in wetter times, with presumably associated decreases and increases in Nganamara numbers. Due to the displacement of individual Nganamara during times of increased survival such birds would be forced to risk traversing the 'seas' of relatively poorly resourced habitats during dispersal attempts to other 'islands'.

Conclusions

The AW NRM Region and the Maralinga Tjarutja Lands in particular are significant for a national understanding of Nganamara population dynamics, ecology and evolution. The vast areas of potential Nganamara habitat are undisturbed by clearing and have had only marginal past stock grazing, they are as near to pristine as possible, and they constitute a most natural wilderness reference area. Nganamara have a sub-optimal (compared to wetter mallee areas elsewhere) but an ongoing presumably dynamic presence in the Region. The species has evolved with extreme climatic conditions/changes (see the genetic evidence reported by Taneal Cope, this Forum), and droughts of the severity currently experienced in the region are almost certainly not a novel challenge. Anthropogenic climate change is likely to challenge Nga_n_amara in the Region, which is therefore a natural laboratory for Nga_n_amara species robustness and dynamics.

The unique situation of enhanced habitat for Nga_n_amara in the vicinity of the Maralinga Airfield and the sealed roads associated with Maralinga Section 400 Prohibited Area is a valuable large-scale unintended experiment in resource manipulation which can provide useful and detailed understandings of the species' ecology, as well as providing pointers for building resilience into Nga_n_amara management in the face of climate change.

Taken together, the above factors and opportunities strongly recommend Nga_n_amara in the Region as a sensitive candidate focus species for monitoring and assessing climate change impacts. This potential is a further reason that can be added to the three already argued by Ward and Bellchambers (2008) to support on-going and improved monitoring of Nga_n_amara in the Maralinga Tjarutja Lands.

Acknowledgements and thanks

To A_n_angu Nga_n_amara monitors in Maralinga Tjarutja: Noleene Bridley, Audra Bridley, Joyce Brown, Glenda Hanson, Della Mathews, Margaret May, Mabel Queama, and Ada Hart. Hughie Windlass, Richard Brooks, Barka Bryant, Trevor Bryant, Roger Williams, Graham Yatjita, Mark Young, Russell Gibson, Alan Jamison, Tony Brown, Vincent Brown, Leon Brown, Kenneth Ingomar, Lance Ingomar, Chris Dodd, David Lionel, Lindsay May, Quentin Brown, and Milton Kugena.

And to piranpa (non-A_n_angu) Nga_n_amara monitors in Maralinga Tjarutja and others who assisted in various ways: Rachel Paltridge, Pip Masters, Katherine Moseby, Thalie Partridge, Amber Clarke, Teresa Gurney, and Philippa Schmucker. Keith Bellchambers, Joe Benshemesh, Graham Carpenter, Matt Daniel, Steve Eldridge, Paul Gregory, Robin Mathews, Rick Southgate, John Read, Mark Walsh, Matt Ward, and Adam Wood.

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26. Vision Statement, Charter & Guidelines for project applications for Malleefowl Offset Monies

Stephanie Mitchell, Environmental Advisor, Iluka Resources

The Murray Basin Stage 2 mining project will impact upon habitat utilised by Malleefowl (approx 29 ha). Iluka Resources are committed to providing $700,000 funding over seven years to fund Malleefowl conservation projects as a financial offset to this impact. Iluka have convened The Malleefowl Management Committee to oversee the management of these funds.

The Malleefowl Management Committee consists of six voting members from the following organisations:

- The Victorian Malleefowl Recovery Group (VMRG),
- Parks Victoria,
- The Department of Sustainability and Environment (DSE),
- The Department of Sustainability, Environment, Water, Population and Communities (DSEWPC),
- The National Malleefowl Recovery Team (NMRT),
- Iluka Resources.

The Malleefowl Management Committee may approve funding to Malleefowl conservation projects which contribute to implementing one or more of the priority actions outlined in the recovery objectives and actions set out in the National Recovery Plan for Malleefowl, and also deliver significant benefits to Malleefowl in the Victorian Mallee Region, but not to the exclusion of other areas and other states.

Eligible applicants include Universities, NGOs, Governmental Agencies, Volunteer groups and Charities. Funding is also available to individuals who can demonstrate their project meets the guidelines.

The type of funding available includes:

- One-off costs
- Ongoing costs over a number of years
- Core funding
- Capital Expenditure

Higher priority applications are projects that use the funds to leverage additional funds from other sources, and proposals unlikely to be funded by Government and/or agencies.

Habitat enhancement projects are not eligible for funding under this scheme.

Successful applicants are required to submit a quarterly report to the committee to update progress on the work and expenditure on the project. A report template will be sent out when the applicant is notified of their successful application. Subsequent payments on larger projects may be tied to the completion of milestones identified in the application; each project will be assessed individually.

The first year of funding has already passed. Four projects have been funded totaling $112,812. Project funding ranges from $16,500 - $30,000. The projects include:

- Improvements to the National Malleefowl Monitoring Database (two phases)
- Support to the Fourth National Malleefowl Forum
- Adaptive Management of Arid and Semi Arid Ecosystems research project
- Analysis of fox scats collected by VMRG volunteers

There will be two funding rounds per year – May and November. Applications must be received no later than the first business day of the month (May / November).

Applications can be received via post – Malleefowl Management Account, Attn Mine Manager, Iluka Resources, PO Box 140 Ouyen VIC 3490.

Or via e-mail – kulwin@iluka.com (please include 'Malleefowl Management Account' in the subject title).

All information for the application must be on the application form. Please request an electronic copy via the e-mail address above. Any queries contact Stephanie Mitchell on 03 50912109, or via e-mail - Stephanie.Mitchell@iluka.com.

PRESENTATIONS - Poster

1. Private landscape restoration for Malleefowl

Bernie Fox, Member Victorian Malleefowl Recovery Group

Authors: Bernie Fox, Sue Hayman-Fox (VMRG)

A 1552 acre Lowan Sands Mallee block less than 10 km south of Victoria's Big Desert Wilderness was completely 'chained and rolled' in 1995 with over two-thirds ploughed and prepared for pasture. In May 2003, an ambitious restoration project commenced. It was hoped the habitat could be improved such that the Malleefowl could be reintroduced at some time.

The block, 'Mali Dunes', had an uncleared road reservation and uncleared vegetation to its south, an uncleared road reservation along part of its eastern boundary and a 600 acre bushland reserve abutting its north-east corner. The unploughed area was located in the south-east. It was envisaged that a restoration of Mali Dunes would result in a very large 'island' of habitat in a farming landscape with good quality road reserves linking back to the Big Desert.

Direct-seeding and planting of local provenance together with extensive warren destruction and rabbit control complemented the natural regeneration allowed by the complete removal of stock.

In 2003, nearly a quarter of Mali Dunes' most degraded central area was direct-seeded. Some of this seeding used a bitumen mulch which saw excellent establishment of some of the finer seeded vegetation. Extensive areas in the northern area were directed-seeded and planted as part of the iconic 'Project Hindmarsh' in 2004, 2009 and 2010. These actions have been supplemented by other plantings throughout.

In December 2006, a Malleefowl, believed to have followed the system of road reserves from the north, was first seen on the property. Later a new, but abandoned, mound was found in regenerating habitat on the eastern side of the property. A pair of birds is now regularly seen feeding across the property. It is suspected they have established a mound within the adjoining bushland reserve.

Other species, including the Desert Silky-mouse, Mitchell's Hopping-mouse and many reptiles have also re-established themselves across the whole of Mali Dunes.

Habitat restoration continues on Mali Dunes ….

Private Landscape Restoration for Malleefowl at Mali Dunes, Victoria

Short Facts

1552 acres of mallee in the Yanac area in western Victoria, 10km south of the Big Desert Wilderness Park & 25 km east of the SA border.

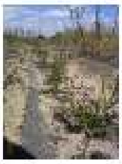
Owned by Sue Hayman-Fox & Bernie Fox since May 2003.

Community Land Management (CLM) project site.

Fully covenanted with the Trust for Nature.

Restoration work

Direct seeding in eroding central area by Greening Australia in May 2003 using bitumen mulch.



Extensive plantings & direct seeding across northerly pastures by Project Hindmarsh in 2004, 2009 & 2010.

Continued habitat enhancement with small private community plantings each year.

Direct seeding with polymer film by Greening Australia in July 2011.

Opportunity, Challenges & Aspirations

Mali Dunes provided an opportunity to link a remnant Bushland Reserve of 600 acres with an uncleared private remnant of 800 acres linked to the Big Desert Wilderness by good quality road reservations.

The challenge was to restore a landscape that had been 'chained & rolled' as recent as 1995.

The aspiration was to reintroduce the Malleefowl once the habitat had been improved to 'suitable quality'.

Re-growth vegetation included large amounts of *Acacia calamifolia* and all plantings have supplemented this.

Malleefowl appear

The bird had been reported in the area over many years but was seen occasionally. In December 2006 the first Malleefowl was sighted at Mali Dunes to everyone's excitement ....

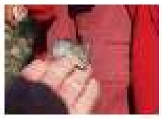
.... And they have remained ....

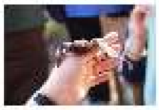
.... along with Bernie and Sue.

1997 aerial photo of Mali Dunes showing Bushland Reserve top right and private remnant below.

Fauna & Reptile Monitoring

Annual pitfall and cage trapping has been undertaken courtesy of ecologists Clive Crouch and Ann Williamson. It is showing an improving diversity and as the habitat improves.





Visitors and Helpers

It was always planned to have visitors come and see what is happening and their help is always welcome. We have hosted Landcare Groups, Victorian National Parks Association, Field Nats groups, BOCA, Victorian Mammal Survey Group, Wettenhall Foundation members, Wimmera CMA and the Victorian Malleefowl Recovery Group.

Our thanks to our supporters including Clive Crouch, Ann Williamson, Richard Morphett, Ian Pratchett and many other volunteers.

2. Using Remote Sensor Cameras to gather data on Malleefowl

Graeme Tonkin, SA volunteer; Member Victorian Malleefowl Recovery Group

Monitoring Malleefowl Mounds using Remote Infrared Cameras

Graeme Tonkin - Malleefowl Volunteer

Introduction

Malleefowl are shy and elusive birds, making them difficult to observe up close in their natural habitat. Remote Passive Infrared (PIR) triggered cameras allow such observation with minimal disturbance to the birds or the environment in which they live.

This trial occurred over a 12 months period and looks at the suitability of remote PIR triggered cameras in monitoring activity that occurs at Malleefowl nest mounds, including mound maintenance, temperature control, egg laying, predator visitation, other animal visitation and interactions.

Method

Camera Types
Two different camera types were trialed during this project.

1. Bushnell
The first being a Bushnell TrophyCam, a commercially available PIR camera. These cameras are easy to operate and have a long battery life of around 6 months, depending on the number of images taken.

2. Home Brew
The second was a home built camera, assembled from readily available components on the "Home Brew" market. The home brew cameras use older model Sony digital cameras that have been modified to provide external wiring for the On/Off function, the shutter release and external batteries to enable longer field life between service visits.

Both of these cameras types are triggered by PIR sensors that detect infrared motion, i.e. the movement of a heat source across the field of view.

Power Source
Each camera used internal batteries as well as a heavy duty external battery pack using D cell batteries to extend the interval between battery changes.

Number of Cameras
Three cameras were set up at three different mounds to take JPEG images whilst another mound had one camera taking JPEG images and another taking MPEG videos.

Camera Mounted on Pole — Camera Positioned at Mound

Camera Position
The cameras were positioned on poles between 1 and 2 meters above the ground and around 1 meter back from the edge of the mound, looking down toward the centre of the mound. They faced either south or north to avoid looking directly into a rising or setting sun. It is important to minimise the amount of vegetation in the cameras field of view because windy conditions will cause the vegetation to move and that will cause false triggering.

Camera Programming
The cameras were programmed to take one image per trigger event and trigger as often as possible whilst detecting further infrared motion. The speed of triggering is limited by the cameras ability to recharge its self, but is around 5 to 10 seconds.

Field Visits
Field visits were kept to a minimum, but the limiting factor on extending the interval between field visits is the size of the memory cards used. The cameras were fitted with 8GB memory cards which could hold in excess of 3,000 images. 16GB cards caused the cameras to slow down and reduced their reliability.

Results

The five cameras together produced in excess of 88,000 images & videos since the first camera was deployed in July 2010.

1. Bushnell
The two Bushnell TrophyCams trialed produced disappointing results. Camera 1 was withdrawn from service on 11th January due to an internal fault and Camera 2 on 16th April after the nest mound ceased being worked. They produced a total of 39,470 images:

15% of the images being target species
85% false triggers.

2. Home Brew
The three home brew cameras performed with much better results and minimal false triggers. They remain in service in the field and have produced a total of 49,218 images of the following content:

85% - Malleefowl
10% - Other species
5% - False triggers

Conclusion

Useful Data
There is much to be learned from monitoring Malleefowl nest mound activity using remote cameras. A few areas for further study could be:

1. The identification of individual Malleefowl
2. Malleefowl pair behaviour
3. Malleefowl interaction with other animals species including echidnas, lizards and foxes.

Much of the data collected during this trial might be useful to honours and PHD students studying Malleefowl and is available for such purposes.

False Triggers
Moving vegetation, passing shadows, or heated ground can cause false triggers. This can be particularly problematic in open areas or when the PIR camera is set very close to the ground.

Reliability
PIR cameras do not operate effectively in hot climates as the difference between background temperatures and those of moving animals may not be large enough to trigger the camera. During the hotter months, night time operation of PIR cameras is much more reliable as the background temperatures are much cooler. During night time operation the PIR sensor is capable of detecting the heat source emitted by a field mouse.

Mouse triggered camera at night

Due to the fact that much of the nest mound activity occurs in the hottest summer months, PIR triggered cameras may not be the most reliable means of monitoring all activity that occurs at malleefowl nest mounds. Activity that occurs during the heat of the day may not be captured.

Future Trials

PIR
Other PIR types may produce more reliable results during hot weather and should be trailed.

Other Detection Systems
Movement detection systems other than PIR are available and would likely provide more reliable triggering results during hot weather, although they are prone to a much higher percentage of "false" and non target triggers.

Other Data
The data collected using remote cameras could be further enhanced by collecting weather data in the same locality.

3. Landscape scale surveying by the Lachlan Catchment Management Authority for Malleefowl nest sites in western NSW

Milton Lewis, Project Officer, Sustainable Ecosystems & Advisory Services, Lachlan Catchment Management Authority, NSW

Authors: Milton Lewis, Kevin Solomon, Ted Davenport, Kerry Davenport, Angus Arnott and Jasmine Wells

The use of helicopter surveying has proven to be the most cost effective method available to accurately survey large areas of Mallee woodland for the presence of nesting Malleefowl. The aim was to rapidly assess the vast tracts of Mallee woodland in the western sections of the Lachlan catchment for the presence of Malleefowl.

In April 2009 aerial surveys were conducted using grid based techniques on privately owned and leasehold properties in western New South Wales. Transects were flown in north south directions as recommended by the NHT National Malleefowl Survey protocol (Victorian Malleefowl Recovery Group 2007) to avoid difficulties caused by the sun at low angles to the horizon. Pathways for the survey were coordinated and plotted using Garmin Mapsource 2.58 and supplied to the helicopter pilot prior to departure. All coordinates were recorded in GDA, in accordance to Lachlan CMA GIS protocols, using three handheld Garmin eTrex Summit HC GPS units. Flight speeds during the survey were about 106 km/h (n=500 flight legs, mean = 106.21 km/h, std = 34.20 km/h) at an altitude of 178 m (n = 500 flight legs, mean = 177.81 m, std = 9.41 m). Distances between transects were 100 m (n = 50, mean = 97.74 m, std = 12.98 m) to allow a surveyor-viewing envelope of 50 m either side of the helicopter. When nesting mounds were located the helicopter would circle back to the site and hover over the mound while three waypoints were recorded and a photograph was captured. As a comparison a ground crew of 10 volunteers were coordinated to walk transects with a 10m gap between each person and search for nest mounds.

Staff of the Lachlan Catchment Management Authority surveyed a total of 51,000 ha over a period of 8 working weeks (48 days or 384 hours) at a cost of $97,184.00. This cost included all flying time, helicopter hire and ground-truthing as well as on-ground costs such as vehicles and insurance. To survey the same area using ground staff at $20.00 per hour (8 hour day for 3 staff = $480.00 per day) would cost about $1.5 million over a period of 638 weeks.

Dealing with the decline of threatened species and the processes that lead to the decline of these species often requires immediate action but the initial cost is difficult to justify to funding authorities. The Lachlan Catchment Management Authority was required to manage a threatened species that was distributed within widespread habitat across the catchment and difficult to traverse. Cost-benefit analysis revealed that although the use of helicopter surveying was initially expensive, large areas could be covered quickly and accurately. When this was tested against the monetary cost and time expenditure in surveying with ground crews there were clear advantages to aerial surveying.

4. Conservation activity in the northern Murray Mallee – where do Malleefowl fit in?

Chris Grant, Bush Management Advisor, SA Dept of Environment & Natural Resources

Authors: Nigel Willoughby[1] and Chris Grant[1]

[1]Department of Environment and Natural Resources, Government of South Australia

Biodiversity conservation requires two key strategies:

1. Addressing key components of a system that are inadequate to meet the common ecological requirements of large groups of species (often called a 'coarse filter'); and;

2. Addressing the specific requirements of other components of the system not covered by the coarse filter issue (often called 'fine filter').

In the northern Murray Mallee of South Australia, available information indicates that the coarse filter issue is inadequate vegetation on areas of deep sand. These areas of sand are now the focus of conservation activity. A landscape recovery team oversees restoration efforts on the sandy components of the landscape by working towards significant long-term goals. But, does the coarse filter issue address Malleefowl conservation or does this species have other specific issues that also need addressing?

While that question is hard to answer, there is evidence that in the northern Murray Mallee the requirements of Malleefowl are provided for by the coarse filter work and that, therefore, no further conservation activities are needed to specifically target Malleefowl (provided that the coarse filter work continues and monitoring indicates it is successful).

5. Wedderburn Conservation Management Network: Malleefowl Conservation Activities

Wendy Murphy, CMN Facilitator, Department of Sustainability & the Environment, Victoria

Authors: WD Murphy and P Watts, Parks Victoria

The Wedderburn Conservation Management Network is made up of community volunteers, landholders, Government agencies and non Government organisations working together to protect and restore public and private native vegetation patches and all the species within these patches. The group is primarily focussed on the preservation of the south-eastern most population of Malleefowl of which there are 4 known breeding pairs remaining in and around the Wychitella Nature Conservation Reserve. The group participates in a range of activities to conserve the Malleefowl population including mound line searches, collection of DNA material for analysis, revegetation works for habitat extension and improvement, vegetation structure and quality surveys and pest plant and animal works.

This season, the group set up two motion activated cameras on an active mound in the Wychitella NCR gathering footage 24 hours a day on all aspects of Malleefowl breeding. Images captured included breeding displays, mating, egg laying, chick emergence and visitors to the mound. Data was recorded on a range of activities including time of day and length of the activity, weather conditions, (wind, temperature, rainfall, humidity) and what the activity was. It is hoped this exercise will be repeated next season and extended to other active mounds in the area. The Wedderburn CMN hopes to produce an educational DVD using video footage and some of the 5000+ pictures taken during the monitoring period.


Photo: © S Gillam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