final report

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Mentor for postdoctoral fellow

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Abstract

Industry's ability to reduce the impacts of vertebrate pest animals such as wild dogs and rabbits is dependent on continual innovation in pest management tools and approaches, which in turn is dependent on the development and retention of research capability. This project sought to develop and retain vertebrate pest research capability by providing support for a postdoctoral fellow to work with one of Australia's leading pest researchers. The postdoctoral fellow gained important skills and experience by participating in a wide range of research projects, undertaking formal training, and receiving expert mentorship. This also strengthened the postdoctoral fellow's ability to create and secure ongoing employment in the field to ensure that this investment in research capability is not lost.

Executive summary

Research to develop industry capability to reduce the impacts of vertebrate pests has been, and will continue to be, an important contributor to profitability. However, the field of vertebrate pest research is characterized by high researcher turnover, and many researchers who start their careers in the field move on to other areas before they can become established. Consequently, existing research knowledge and future research potential is lost to the field. The purpose of this project was to support a postdoctoral fellow to build and retain capacity in vertebrate pest management and research.

The project provided three year's support for a postdoctoral fellow under the supervision and mentorship of one of Australia's lead vertebrate pest researchers. During the project, the postdoctoral fellow participated in a range of different research projects to improve the management of vertebrate pests and their impacts, and undertook formal training to improve his research, management and leadership skills. An important outcome of this project was the creation of an ongoing employment opportunity that will ensure that the investment of this project is not lost, and that ongoing projects can be carried through to completion.

By investing in the development of an early career researcher, this project has retained and developed vertebrate pest research capability and contributed greatly to the retention of this capability for the foreseeable future. This will benefit industry by contributing to the production of effective pest management research outputs in the future.

Table of contents

Background

In June 2011, MLA agreed to fund project B.STU.0245 “Mentor for Postdoctoral Fellow”, a three year research agreement to support a postdoctoral fellow under Dr Glen Saunders’ supervision at NSW DPI, to build and maintain capacity in vertebrate pest management. The position commenced in January 2012 with the appointment of Andrew Bengsen to the role. This final report will detail how the project’s objectives were met and highlight some key achievements.

Project objectives

The following objectives are adapted from the Research Project Agreement. By 30 December 2014 Dr Saunders will:

1. Ensure that the postdoctoral fellow has opportunity for development of leadership skills by acting as a mentor and by enabling the postdoctoral fellow to receive formal leadership training on an annual basis.
2. Develop the research capability of the postdoctoral fellow to a point where he/she will be successful in competitive grant applications.

The Postdoctoral Fellow will:

3. Investigate the feasibility and risk profiles of using PAPP for aerial baiting programs for foxes as compared to 1080 and develop appropriate control strategies.
4. Conduct field trials if appropriate.
5. Apply this knowledge to wild dog control and develop appropriate control strategies.
6. Collaborate with other researchers and their projects to gain the full set of skills appropriate to a career in vertebrate pest research.
7. Participate in training courses and mentoring appropriate to the career.
8. Publish three scientific publications in high impact journals, as lead author.

Methodology

Upon commencement in January 2012, the Postdoctoral Fellow (hereafter, PF) continued working on an existing MLA funded research project: “B.AHE.0064 Aerial/ground baiting of canids to enhance red meat production”. A research program was prepared annually and submitted to MLA’s nominated Project Manager for approval, along with a summary of the outcomes of the previous year’s program (where applicable). Each annual research program included specific objectives that aimed to:

1. Develop the PF’s experience, knowledge and skills in research and research management through a combination of training and research project work, and
2. Strengthen the PF’s ability to secure funding for ongoing work in the field at the completion of the contract.

The specific objectives in each annual research program could be classified into at least one of four types:

1. Management, conduct or participation in/of specific research projects;
2. Collaboration with other researchers and end-users;
3. Formal training programs to strengthen research and research management skills;

4. Development of professional profile and reputation.

Results

All proposed annual research programs were accepted by MLA's Project Manager (initially Johann Schroder, subsequently Cameron Allan) and all objectives in each program have been completed. Details of how project objectives were met are presented below.

1. Ensure that the postdoctoral fellow has opportunity for development of leadership skills by acting as a mentor and by enabling the postdoctoral fellow to receive formal leadership training on an annual basis.

Dr Saunders provided consistent mentoring services throughout the project, including identifying and suggesting opportunities for:

- Leadership training
- Funding
- Research projects
- Non-research projects, e.g. consulting on pest management projects

Dr Saunders enabled the PF to attend five formal leadership or management courses throughout the project (further details provided at point 7, below).

2. Develop the research capability of the postdoctoral fellow to a point where he/she will be successful in competitive grant applications.

With Dr Saunders guidance, the PF participated in a wide range of research projects and in a variety of roles that have helped develop his research and research management capability (Table 1). His capability was further enhanced with formal training for specific research or management skills (Table 2) and informal mentoring from Dr Saunders and other senior researchers.

The PF was awarded a competitive research grant from the Australian Pest Animal Research Program in 2012. This grant allowed him to complete a research project to evaluate the effectiveness of coordinated fox control programs to enhance lamb production.

The PF also contributed to a successful proposal for a $1.125 million, three year research project to evaluate the value of recreational hunting as a pest control tool and to provide guidance on how it might be used more effectively. The PF has been temporarily appointed to the role with responsibility for establishing and leading the project, and has submitted an application for enduring appointment under a competitive, externally advertised employment application process. If this application is successful, it will see the PF continue working at the Vertebrate Pest Research Unit and further strengthening his research and research leadership capacity as research project manager.

Table 1: Collaborative research projects undertaken by the PF during the course of the fellowship.

Project	Number of additional collaborators	Number of collaborating organisations	Postdoctoral Fellow's role	Physical outputs	Status
Coordinated fox baiting	2	2	lead researcher	peer-reviewed paper	complete
Feral cat control	2	2	lead researcher	peer-reviewed paper	complete
Feral pig review	4	4	lead researcher	peer-reviewed paper	complete
Fox monitoring	6	3	lead researcher	peer-reviewed paper	complete
Feral cat movements	10	7	lead researcher	MS under review	ongoing
Aerial fox baiting	2	2	lead researcher	industry report	ongoing
Herbivore control for carbon abatement	2	2	lead researcher	industry discussion paper	complete
Animal management behaviour change	3	2	advisor	nil	ongoing
Feral cat space use	2	2	co-researcher	peer-reviewed paper	complete
Herbivore repellents	3	2	co-researcher	peer-reviewed paper	complete
Predator monitoring 1	3	3	co-researcher	MS under review	ongoing
Predator monitoring 2	2	2	co-researcher	nil	ongoing
Rabbit fumigator	3	3	co-researcher	nil	ongoing

Table 2: Formal training courses completed during the project

Course	Provider	Year
Project Management Fundamentals	Australian Institute of Management	2012
Crew Resource Management & Work Safely Around Aircraft	IPAAS & NSW RFS	2013
Fundamentals of Management	NSW Trade & Investment	2013
Applied Mathematics	Open Universities Australia	2014
Fundamentals of Govt. Procurement	NSW Trade & Investment	2014
Managing Team Budgets	Australian Institute of Management	2014
Problem Solving & decision making	Australian Institute of Management	2014
Project Management Essentials	NSW Trade & Investment	2014

3. Investigate the feasibility and risk profiles of using PAPP for aerial baiting programs for foxes as compared to 1080 and develop appropriate control strategies.

The PF completed a detailed assessment of the risks and opportunities of aerial baiting using PAPP in New South Wales. The results were presented to MLA in a confidential report in 2012 which identified a limited range of conditions under which aerial baiting might be useful and provided recommendations for further research.

Subsequent trials to estimate the rates at which PAPP fox baits degrade when exposed to prevailing environmental conditions, combined with small scale surveys of producers' attitudes and risk profiles, indicated that PAPP fox baits would not be suitable for aerial baiting on to enhance lamb production.

4. Conduct field trials if appropriate.

Given the results of the studies described above, it was agreed that further field trials were not appropriate.

5. Apply this knowledge to wild dog control and develop appropriate control strategies.

Further work to facilitate the adoption of PAPP baits for wild canid control is being conducted under project B.AHE.0064.

6. Collaborate with other researchers and their projects to gain the full set of skills appropriate to a career in vertebrate pest research.

During the course of the project, the PF collaborated with at least 43 different researchers or practitioners, representing 23 organisations on 12 research projects (Table 1). Some of these projects are ongoing. By taking different roles in these projects, the PF gained substantial experience in different aspects of managing and participating in collaborative research and in different types of research projects.

The PF gained further relevant experience by providing non-research services as a subject matter expert or consultant in a further three projects: 1) a book chapter on wild canid management in Australia; 2) a review of the Commonwealth's draft Threat abatement plan

for predation, habitat degradation, competition and disease transmission by feral pigs; and 3) a review of a feral pig management offset strategy for Rio Tinto Australia.

7. Participate in training courses and mentoring appropriate to the career.

The PF completed eight formal training courses during the fellowship (Table 2) and consistently received advice and guidance from Dr Saunders and senior researchers at the Vertebrate Pest Research Unit throughout the project. The training courses aimed to develop specific research or management capabilities necessary for a career in vertebrate pest management research.

8. Publish three scientific publications in high impact journals, as lead author.

The PF published three scientific papers, as lead author, in high impact journals during the fellowship:

1. Bengsen, A. J., Gentle, M. N., Mitchell, J. L., Pearson, H. E. and Saunders, G. R. (2014) Impacts and management of wild pigs in Australia. Mammal Review 44, 135-147.
2. Bengsen, A. J. (2014) Effects of coordinated poison baiting programs on survival and abundance in two red fox populations. Wildlife Research 41, 194-202.
3. Bengsen, A. J., Butler, J. A. and Masters, P. (2012) Applying home range and landscape use data to design effective feral cat control programs. Wildlife Research 39(3), 258-265.

Other peer-reviewed publications include:

- A peer-reviewed paper as lead author in a lesser journal;
- A peer-reviewed book chapter as sole author;
- Two papers as a contributing author in high impact journals;
- A peer-reviewed book chapter as a contributing author;
- A manuscript in submission in a high impact journal, as lead author; and
- A manuscript in submission in a high impact journal, as a contributing author.

Details of all published or accepted papers are provided in Appendix 1.

Discussion / Conclusion

The purpose of this project was to support a postdoctoral fellow under Dr Glen Saunders' supervision to build and maintain capacity in vertebrate pest management and research. All of the specified project objectives were met or surpassed and, provided the PF successfully retains his current position, the project will have achieved its broader aim of building and maintaining capacity. Additionally, by focusing the development of an early career researcher in vertebrate pest research with a requirement for seeking ongoing research opportunities, the project has greatly increased the likelihood that that capacity will be retained and further developed in future.

Appendix 1: Publication details

Lead author publications in high impact journals

1. Bengsen, A. J., Gentle, M. N., Mitchell, J. L., Pearson, H. E. and Saunders, G. R. (2014) Impacts and management of wild pigs in Australia. Mammal Review 44, 135-147.

> Globally, wild or feral pigs *Sus scrofa* are a widespread and important pest. Mitigation of their impacts requires a sound understanding of those impacts and the benefits and limitations of different management approaches. Here, we review published and unpublished studies to provide a synopsis of contemporary understanding of wild pig impacts and management in Australia, and to identify important shortcomings. Wild pigs can have important impacts on biodiversity values, ecosystem functioning, and agricultural production. However, many of these impacts remain poorly described, and therefore, difficult to manage effectively. Many impacts are highly variable, and innovative experimental and analytical approaches may be necessary to elucidate them. Most contemporary management programmes use lethal techniques to attempt to reduce pig densities, but it is often unclear how effective they are at reducing damage. We conclude that greater integration of experimental approaches into wild pig management programmes is necessary to improve our understanding of wild pig impacts, and our ability to manage those impacts effectively and efficiently.

2. Bengsen, A. J. (2014) Effects of coordinated poison baiting programs on survival and abundance in two red fox populations. Wildlife Research 41, 194-202.

> Poison baiting programs coordinated among neighbouring landholders should provide the most effective and efficient tool for controlling fox (*Vulpes vulpes*) populations and impacts in mixed agricultural landscapes, but the effects of such programs on fox mortality and abundance have not been well described. This study aimed to describe the effects of coordinated fox control programs conducted by landholders on fox mortality and abundance, and to evaluate the likely impacts of reduced landholder participation rates on the proportion of the fox population exposed to baits. Methods: The effects of two baiting programs on fox abundance were evaluated using camera trap surveys and abundance-induced heterogeneity models (Royle and Nichols 2003). The proportion of foxes surviving baiting was estimated by tracking the fate of 19 GPS-collared individuals. The benefits of coordinated baiting were examined using simulated scenarios based on local fox movements and bait distribution patterns. Examination of actual and simulated fox home ranges demonstrated that coordinated baiting increases exposure of the target population to baits. However, 69% of foxes captured on properties that later baited were estimated to have survived the baiting period. Camera trap surveys across baited and unbaited properties showed no detectable decline in average fox abundance after baiting. Coordinated baiting increases the proportion of the fox population encountering baited properties. However, high fox survival and the absence of detectable declines in abundance after baiting show that even well-coordinated baiting programs can produce sub-optimal results if many of the foxes using baited properties fail to locate and ingest lethal baits. Baiting programs aiming to reduce the density and impacts of foxes in agricultural landscapes should strive to maximise participation among neighbours. Programs may also benefit from taking steps to improve bait encounter and consumption rates within properties, for example by

deploying baits at sufficient intensity to provide all foxes with access to at least one bait within their short term home range. Future research should aim to identify optimal baiting intensities within properties and conditions to maximise bait uptake.

3. Bengsen, A. J., Butler, J. A. and Masters, P. (2012) Applying home range and landscape use data to design effective feral cat control programs. Wildlife Research 39(3), 258-265.

Effective feral-cat (*Felis silvestris catus*) management requires a sound understanding of the ways cats use their environment. Key characteristics of landscape use by cats vary widely among different regions and different conditions. The present study aimed to describe the most important characteristics of landscape use by feral cats on a large, human-populated island, and to use this information to guide the development of feral-cat management programs. We used GPS tracking collars to record the movements of 13 feral cats at two sites on Kangaroo Island, South Australia, for between 20 and 106 days. We described home-range extents by using local convex hulls, and derived management suggestions from examination of home-range and movement data. Median feral-cat home range was 5.11 km2, and this did not differ between sexes or sites. Cats at a fragmented pastoral site tended to favour woody vegetation over open paddocks, but habitat preferences were less clear at a bushland site. Cats that preferentially used treelines at the pastoral site were almost twice as likely to be recorded close to a tree-line junction as expected. Control programs for feral cats on Kangaroo Island should deploy control devices at a density no less than 1.7 devices km–2. Spatial coverage should be as large as practicable or repeated frequently. Infrequent programs covering small areas can be expected only to provide short-term reductions in cat abundance. The information gained from the present study will contribute to the development of strategic sustained management plans for feral cats on Kangaroo Island. The principles from which we inferred management guidelines are applicable to other regions and species.

Other publications

4. Bengsen, A. J., Robinson, R., Chaffey, C., Gavenlock, J., Hornsby, V., Hurst, R. and Fosdick, M. (2014) Camera trap surveys to evaluate pest animal control operations. Ecological Management & Restoration 15(1), 97-100.

Many camera trap surveys aiming to detect the effects of management actions on pest animal populations are not as useful as they could be, because they do not produce informative results. We used mixed effects models, signed ranks tests and occupancy models to examine changes in the activity and occurrence of European red fox (*Vulpes vulpes* L.) in areas subjected to repeated fox management operations. In agricultural land, mixed effects models identified a decline in fox activity after baiting in 1 year, but not the next. Occupancy models revealed a decrease in fox occurrence in a National Park following control operations. These methods, combined with appropriate survey designs, could greatly enhance the value of many pest animal surveys conducted by management agencies.

5. Bengsen, A. J. (2014) Analysis of camera trap surveys to detect effects of population management. In 'Camera Trapping in Wildlife Research and Management.' (Eds P. D. Meek, A. G. Ballard, P. B. Banks, A. W. Claridge, P. J. S. Fleming, J. G. Sanderson and D. E. Swann). (CSIRO Publishing: Melbourne.)

Camera trap surveys can provide an efficient and effective method for quantifying responses of animal populations to management activities. However, many surveys are not as effective as they could be because they produce only simple indices that are not amenable to statistical interpretation. Here, we use camera trap survey data to demonstrate methods for examining responses of pest animal populations to management programs. Using simple tests of count data, we detected decreases in observations of feral pig *Sus scrofa*, cat *Felis catus* and red fox *Vulpes vulpes* populations following poison baiting or trapping programs. Generalised linear mixed effects models were also effective, and provided additional information. Finally, dynamic occupancy models applied to the fox dataset indicated that poisoning had no detectable impact on fox occurrence. Use of statistical procedures that are appropriate to the subject population and monitoring objectives can provide greater benefits than are currently realised in many studies.

6. Cox, T. E., Murray, P. J., Bengsen, A. J., Hall, G. P. and Li, X. (in press) Do fecal odors from native and non-native predators cause a habitat shift among macropods? Wildlife Society Bulletin.

Predator-odor based repellents have benefits as humane, non-lethal management tools which may reduce the need for lethal control in some areas. Macropods (such as kangaroos and wallabies) are iconic Australian native marsupials, however some are considered significant rangeland pests, and their presence in the urban and peri-urban environment often results in conflict. The management of these macropods is a contentious and volatile issue. We evaluated lion (*Panthera leo*), Sumatran tiger (*P. tigris sumatrae*) and dingo (*Canis lupus dingo*) fecal odors as short-term odor-based repellents for wild eastern grey kangaroos (*Macropus giganteus*) and red-necked wallabies (*M. rufrogriseus*). These odors were used to 'protect' highly palatable food sources; with any food not consumed (residue) collected and weighed each day. Both eastern grey kangaroos and red-necked wallabies relocated a minimum of 100 m away from predator odors during the trial. During the study period more food was consumed at the control food station than at any other food station ($P < 0.001$). Eastern grey kangaroos never fed from a predator odor food station. An increase in vigilance behaviors was observed for both macropod species and red-necked wallabies were more likely to exhibit vigilance behaviors than feeding behaviors at predator odor food stations ($P < 0.001$). There was no difference in food residue between any predator odors and these food stations were only visited on the first day of the study. We report that predator fecal odors may offer protection to highly palatable food sources from macropods and that they may have a use as a macropod relocation tool.

7. Doherty, T. S., Bengsen, A. J. and Davis, R. A. (in press) A critical review of feral cat habitat use and key directions for future research and management. Wildlife Research.

Feral cats (*Felis catus*) have a wide global distribution and cause significant damage to native fauna. Reducing their impacts requires an understanding of how they use habitat and which parts of the landscape should be the focus of management. We reviewed 27 experimental and observational studies conducted around the world over the last 35 years that aimed to examine habitat use by feral and unowned cats. Our aims were to: (1) summarise the current body of literature on habitat use by feral cats, in the context of existing ecological theory (i.e. habitat selection, foraging theory); (2) develop testable

hypotheses to help fill important knowledge gaps in the current body of knowledge on this topic; and (3) build a conceptual framework that will guide the activities of researchers and managers in reducing feral cat impacts. We found that feral cats exploit a diverse range of habitats including arid deserts, shrublands and grasslands, fragmented agricultural landscapes, urban areas, glacial valleys, equatorial to sub-Antarctic islands and a range of forest and woodland types. Factors invoked to explain cat habitat use included prey availability, predation/competition, shelter availability and human resource subsidies, but the strength of evidence used to support these assertions was low, with most studies being observational or correlative. We therefore provide a list of key directions that will assist conservation managers and researchers in better understanding and ameliorating the impact of feral cats at a scale appropriate for useful management and research. Future studies will benefit from employing an experimental approach and collecting data on the relative abundance and activity of prey and other predators. This might include landscape-scale experiments where the densities of predators, prey or competitors are manipulated and then the response in cat habitat use is measured. Effective management of feral cat populations could target high-use areas, such as linear features and structurally complex habitat. Since our review shows often-divergent outcomes in the use of the same habitat components and vegetation types worldwide, local knowledge and active monitoring of management actions is essential when deciding on control programs.

8. Fleming, P. J. S., Allen, B. L., Allen, L. R., Ballard, G. A., Bengsen, A. J., Gentle, M. N., McLeod, L. J., Meek, P. D. and Saunders, G. R. (2014) Management of wild canids in Australia: free-ranging dogs and red foxes. In Carnivores in Australia: Past, Present and Future.' (Eds A. Glen and C. Dickman). CSIRO Publishing: Collingwood.

Wild canids are widespread across most of mainland Australia. They can have major impacts on livestock production and biodiversity values and often necessitate active management. The impacts of free-ranging dogs and foxes should be managed concurrently, as there is often substantial overlap in their impacts and because most available control methods do not discriminate between the two species. Effective management of the impacts of wild canids requires a strategic approach that is driven by participants and based on specific local issues and available knowledge. Strategic management programs, as undertaken, are a form of adaptive management, in which participants gain knowledge about the problems they are addressing by conducting quasi-experiments. These examine the effects of management actions on clearly defined objectives. Importantly, it is the specific local impacts of wild canids that define the management objectives in these approaches, not simply the numbers of animals. Adaptive management can be used to suppress or enhance populations of wild canids depending on the management objectives, that is, the mitigation of damage to livestock and biodiversity values or conservation of dingoes. This chapter outlines and discusses the application of the strategic approach to managing the impacts of wild canids. The nature of those impacts, including new density: damage functions, and the specific tools and methods that are available to counter them are also discussed.