Australian Pest Animal Management Program

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Bureau of Rural Sciences

FINAL REPORT TO THE BUREAU OF RURAL SCIENCES,
DEPARTMENT OF AGRICULTURE, FISHERIES AND FORESTRY

IMPROVED IMPLEMENTATION OF REGIONAL FOX MANAGEMENT PROGRAMS

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NSW GOVERNMENT | Industry & Investment

TABLE OF CONTENTS

PART A: PROJECT OUTLINE

1. PROJECT INFORMATION

1.1 Project Name

Improved implementation of regional fox management programs

1.2 Details of Applicant

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1.3 Collaborators / Third Parties

Collaboration with NSW Livestock Health and Pest Authority (LHPA) State Council and the Vertebrate Pest Management Unit, Emerging Weed and Pest Animal Branch, Industry and Investment (I&I) NSW was required to secure the appropriate legislative changes. Collection of data for this project involved constant involvement with private individuals and organisations responsible for land management and in particular vertebrate pest control (such as NSW LHPA, NSW National Parks and Wildlife Service and Forests NSW) from within the boundaries of the two participating LHPA's of New England, and Central West.

1.4 Period of Project

Commencement date: 01/01/09 Completion Date: 28/02/10

1.5 Project Objectives

The objectives of this project are to:

- Improve and refine the effectiveness of existing best practice fox management particularly where group programs are promoted.
- Determine if it is appropriate to expand fox control orders across the state. As such it has the potential to dramatically affect NSW policy and strategic actions in relation to the control of foxes on agricultural lands.
- Further improve our understanding of cost benefits and population dynamics associated with regional fox control programs.
- Based on outcomes further refine best practice methods for foxes
- Ensure adoption of modified strategies by all land managers and agencies through participatory learning and education programs.

1.6 Acknowledgements

Thanks to all the landholders who took the time to fill in and return their questionnaires. Sincere thanks to the rangers and office staff from the participating Livestock Health and Pest Authorities – especially Lisa Thomas, Rhett Robinson, Peter Frizell, Bob Davidson, Brian Ferris, Bruce Floyd, Rob Munro, Melissa McLeod, and Bec Ballard from Southern New England Landcare - for their cooperation, assistance with collection of questionnaire data and identification of properties for the spatial mapping.

1.7 Conclusions from this study

- The introduction of a fox pest control order (PCO) had no impact on either participation in fox control activities or on lamb production during the first two years of operation.
- The failure of the PCO to bring about any measurable difference in fox impact is thought to be due to the low compliance rates to the new legislation.
- To be successful this change in legislation would require that the regulatory body receives adequate funding and resources for administration, enforcement and education.
- Obstructions to successful implementation and enforcement of this legislation included: cost; education of the changing rural population structure; availability of an adequate selection of effective control options; legislative restrictions on current control options; and the increasing presence of urban and semi-urban fox populations.
- Partnerships between stakeholders and government agencies, guiding operations through local social networks can be an effective alternative to locally promote best practice fox management.
- Education has a key role in fox management programs and should be targeted at all levels. Increasing public awareness of the detrimental effects of fox impacts can ultimately influence attitudinal changes, and shift priorities and actions.
- Positive incentives such as bait and rate subsidies to landholders may be more effective than a heavy-handed regulatory approach to improve stakeholder cooperation and participation.
- Baiting with 1080 remains the most cost effective method for fox control across the rural landscape, however shooting provides an important alternative in areas where baits cannot be effectively applied.
- To further improve fox management programs in Australia future work should investigate:

- Positive incentives – what are the most appropriate and effective incentives to encourage all stakeholders to participate in pest management programs?
- The development of social rural networks and how their use can be optimised for pest management programs.
- A further investigation of enforceable regulations to promote effective pest control, and the use of external coordinators to manage pest programs.
- Improve knowledge on the effects of control methods on fox populations to work towards a better understanding of density / damage relationships and more robust bio-economic decision making.

2. PROJECT DESCRIPTION

2.1 Background

The European red fox (*Vulpes vulpes*) has been identified by the Australian Vertebrate Pests Committee as a national priority invasive species, and fox predation has being identified as a key threatening process by the Commonwealth and NSW State Governments. It has been estimated to cost the Australian agricultural industries and the environment more than $227 million (McLeod 2004), topping the list of introduced vertebrate pest species. This project focuses on the strategic control actions for foxes to obtain long term benefits, and is consistent with the Australian Pest Animal Strategy.

Current best practice management of foxes in Australia, for both agricultural and conservation purposes promotes broad-scale, cooperative management programs, with community involvement and collaboration from government agencies and private landholders. These regional-scaled, integrative programs give more effective long-term respite from fox predation damage, while maximising the cost-effectiveness, as they have a greater impact on this invasive species' migratory and population compensatory abilities (Saunders and McLeod 2007). There are many examples from the conservation literature where such programs have significantly reduced the fox impact on threatened species although such programs are generally more intensive, heavily subsidised by the government and conducted over longer periods than conventional agricultural programs.

Since fox control currently in NSW is a voluntary activity, it is still mainly sheep producers who actively participate in agricultural control programs. This patchiness in spatial coverage and frequency of baiting has been shown to be inadequate to prevent fox reinvasion (Gentle *et al.* 2007), and has been proposed as the reason why still most agricultural fox control programs only provide very short-term, local protection (Saunders and McLeod 2007). This project, by using the legislative powers provided by Part 11 of the *Rural Lands Protection Act (1998)* in the form of a Pest Control Order (PCO) for foxes, can impose fox control uniformly across an entire region and thus the efficacy in terms of local production values and cost effectiveness can be monitored and evaluated. Such an evaluation of truly collaborative fox control in agricultural systems has never previously been possible, and the results have implications on improving best practice management of this invasive pest.

Effective fox management decisions require consideration not only of the costs of control but also the wide-ranging benefits that ensue. Understanding the impact of control programs on fox population dynamics plays an important role in this process. Until recently the economic analysis of fox control programs has been restricted to measuring the cost-effectiveness of fox management strategies and techniques (i.e. the cost to achieve some pre-determined threshold) due to the difficulties in quantifying the benefits of control in the same units (i.e. dollars) as the costs. In an economic study of the regional fox control campaign 'Outfox the fox' (Jones *et al.* 2005) the authors were able to develop economic surplus and benefit-cost models, however they identified the paucity of data of control effects, particularly shooting, on fox populations as a weakness which needed to be addressed. The data from this project would strengthen the fox population model, as well as the ensuing economic models, and assist in identifying the optimal combination of control measures to maximise benefits and effectiveness whilst minimising costs.

This project, commenced in 2007 with funding received from the National Feral Animal Control Program (NFACP). As the gazetting of the PCO was delayed due to administrative problems, the opportunity to monitor the 2007 lambing period was missed and there was not enough time to collect the required full data set of annual lamb production and fox management data before the funding ceased in June 2008. However, with this initial investment all experimental treatments were put in place, historical records back to 2004 were collected, and the first complete data set from the 'treated' site was available for analysis by the end of 2008. All stakeholders are keen to continue their participation in this project, and this project will collect a second year of data in 2009 to strengthen the results and add value to the outcomes.

2.2 Project Outcomes

- The information gathered from this project will be used to improve the effectiveness of existing and ongoing fox management programs particularly where group control is promoted.
- This demonstration project will be used by the LHPA State Council to determine if it is appropriate to expand fox control orders across the state. As such it has the potential to dramatically affect NSW policy and strategic actions in relation to the control of foxes on agricultural lands.
- The project will provide further improvements to our understanding of cost benefits and population dynamics associated with regional fox control programs
- These outcomes will in turn value add to the outcomes from the previously funded BRS fox project.

2.3 Methodology

- **Site selection** – This project was continuing from the work conducted in the previous NFACP funded project 'Improved Implementation of Regional Fox Management Programs'. The three study sites were selected in consultation with the former NSW Rural Lands Protection Board (RLPB) State Council and RLPB Managers and their Boards (now known as the Livestock Health and Pest Authority - LHPA). All are involved in coordinating fox management programs for their ratepayers and landholders, the recent history of fox management in these areas has been documented and there is room for improvement (i.e. landholder participation can be realistically increased).

- **Continuation of steering committee** – consultation with the steering committee formed in the previous NFACP funded project 'Demonstration and evaluation of a truly collaborative regional fox control program' was continued. Due to the formation of the New England LHPA from the amalgamation of the former Northern New England and Armidale RLPBs in January 2009, additional rangers and a representative from Southern New England Landcare were also invited to participate in the steering committee.

- **Implementation of monitoring programs** - the monitoring of the fox management programs at all sites (treatments) involved monitoring operational factors (efficiency - what was done where, and at what cost) and performance factors (effectiveness - did the control meet the objectives).

  - **Operational monitoring** - operational variables monitored included methods currently used in agricultural programs such as participation rates, awareness levels, type of methods used, control activities undertaken and their timing, area under control, and costs involved in these control activities (equipment used, labour and materials).

  - **Monitoring of fox impacts** - to monitor the effectiveness (performance) of the fox management programs, the changes in the impact of foxes was measured. Fox predation has been reported on a variety of livestock animals. Agricultural production figures, such as lambing percentages, as well as observations and perceptions were collected from participants using questionnaires. This technique has been successfully used in the previous NFACP projects. The validity of data collected in this manner can be affected by the participants' competency in record-keeping, as well as by the number of records returned (response rate) and who actually responds (sample bias) (White *et al.* 2005). These problems can be minimised by using a well-designed survey, and timely collection of the data.

- **Spatial mapping techniques** – The spatial scale of the different fox management programs at each site was analysed using GIS mapping. This technique, used in the previous NFACP project, allows for the examination of the relationship between the spatial scale and agricultural production impacts between the experimental sites.

- **Fox population modelling** – The collection of data throughout the project allowed modification of the dynamic fox population model of McLeod *et al.* (2004). Shooting data was collected using a survey distributed to all shooters at the start of the project. This technique was successfully used for collecting information from shooters in the current NFACP project. Baiting data was also obtained from participants in a similar manner, as well as from the NSW 1080 Register and operational staff.

- **Economic analysis –** The data collected from this project was insufficient to allow a re-evaluation of the stochastic economic surplus and benefit-cost models developed by Jones *et al.* (2005). However the additional data collected, particularly the shooting data could strengthen the calculations of McLeod *et al.* (2007), enabling the economic analysis of ongoing fox management to be compared to the current group baiting practice.

PART B: REGIONAL FOX CONTROL PROGRAMS

1. INTRODUCTION

The fox is not a declared pest in NSW, hence fox control on private lands is a voluntary action by land managers. Historically, fox control strategies used for agricultural protection have been reactionary and on a relatively small scale and short-term basis, being determined by the biology of the livestock protected, rather than that of the fox. Most research agrees that the culling of foxes can reduce the impact of predation at a local level, however the effects are temporary owing to immigration and possible compensatory potential in breeding and juvenile survival (Saunders *et al.* 1995, Heydon and Reynolds 2000, Thomson *et al.* 2000, Harding *et al.* 2001, Baker and Harris 2006, Rushton *et al.* 2006, Gentle *et al.* 2007). Therefore with no long-term strategic planning, land managers readdress the same problem year after year, with seemingly no respite.

During the late 1990s, larger-scale, cooperative management programs were promoted for both conservation and agricultural purposes to provide more effective long-term respite from predation damage, while maximising the cost-effectiveness of the control program (Saunders *et al.* 1995), although little experimental evidence was available to support these claims. Since that time there have been several studies investigating the effectiveness of large scale fox control programs, for both conservation and agricultural based programs. Results from conservation based programs have been mixed with some native populations responding positively to fox culling while other species have shown either no effect or a negative response (e.g. Banks 1999, Banks *et al.* 2000, Risbey *et al.* 2000, Olsson *et al.* 2005, Dexter and Murray 2009).

Results from agricultural programs have also been mixed. In a small scale property based study Greentree *et al.* (2000) found no effect of fox control on gross lamb production, however the number of lambs predated by foxes was significantly reduced as the frequency of fox control activities increased. Linton (2002), studying a large scale regional fox management program across agricultural regions in South Australia, found that some sheep producers (particularly those with low production figures) could benefit greatly (up to 35%) from group fox control and that fox control was having an effect at a scale larger than a single property. Gentle *et al.* (2007) modelled the potential for fox immigration after a typical group baiting program in central NSW and found that the spatial coverage and frequency of baiting was inadequate to prevent fox reinvasion. In a previous NFACP funded project McLeod *et al.* (2007) found that it was not just the fox control efforts that were conducted on an individual property that impacted on it's lambing event, but the fox control efforts of the neighbouring properties (within a 2.5 km radius) were also important. The results of the study by McLeod *et al.* (2007) also highlighted the importance of the frequency and timing of fox control efforts on the effectiveness of the program. Landholders that baited twice a year (approximately autumn and late winter/spring) could significantly enhance their lamb production, even without neighbour support in the control program.

In NSW, agricultural focussed group fox control programs are commonly coordinated by the Livestock Health and Pest Authority (LHPA) (formerly the Rural Lands Protection Board (RLPB)) with support from other government agencies. NSW National Parks and Wildlife Services (NPWS) are the primary organisers of conservation based programs, but usually work closely with the LHPA and local landholders. Despite widespread publicity campaigns, the effectiveness of these group programs is markedly constrained by the reluctance of some land managers to become involved, and in most regions where mixed farming occurs, it is only sheep producers, who perceive a direct benefit to their immediate lamb production, that are active participants (McLeod *et al.* 2007). The reluctance of many landholders stems mainly from the lack of recognition of the ubiquitous distribution of foxes and the varying perceptions of its economic, environmental and social impacts. With the majority of group programs using poison baits containing the Compound 1080, reluctance of land managers can also arise from the perceived risks of accidently poisoning their working dogs and other non-target animals with 1080, the lack of confidence in the effectiveness of baits and the increase in legislative requirements required to purchase and lay these baits (Fitzgerald 2004, McGeary 2005, McLeod *et al.* 2007).

Fox management can be classified as a collective action problem. Effective long term control of this pest requires a critical mass of landowners in an area to participate but there is little incentive for an individual landowner to control foxes, particularly when there is no direct economic benefit, unless all the neighbours do. Potential remedies for such collective action problems include economic incentives or external legislation by government authorities (Olson 1965, Singleton 1998). By using the legislative powers provided by Part 11 of the *Rural Lands Protection Act (1998)* in the form of a Pest Control Order (PCO) for foxes, landholders are obligated to participate in some form of fox control program. Thus fox control can uniformly be imposed across an entire region and the efficacy in terms of local production values and cost effectiveness can be monitored and evaluated. The relevant PCO was gazetted in December 2007, which empowered the Northern New England RLPB to publish an order requiring all occupiers of land within Division D to practice some form of fox control. Fox control programs instigated under this new PCO commenced in autumn 2008. This project followed the second year of operation of this PCO.

2. OBJECTIVES

- Improve and refine the effectiveness of existing best practice fox management particularly where group programs are promoted.
- Determine if it is appropriate to expand fox control orders across the state. As such it has the potential to dramatically affect NSW policy and strategic actions in relation to the control of foxes on agricultural lands

3. METHODS

3.1 Study Sites

The same study sites were used that had been selected for the previous NFACP funded project ‘Improved Implementation of Regional Fox Management Programs’, in consultation with the former NSW Rural Land Protection Board (RLPB) State Council and RLPB Managers and their Boards. At the commencement of 2009 the RLPB was replaced by the Livestock Health and Pest Authority (LHPA) with 14 new districts formed across the state. Two of the study sites, Division D in Northern New England (NNE) RLPB (the area covered by the PCO) and Division A in the Armidale RLPB fell with the newly formed New England LHPA, while the site within Dubbo RLPB was included in the Central West LHPA (Figure B3.1). Despite the change in administrative areas, the pest management within each study site remained unchanged during 2009.

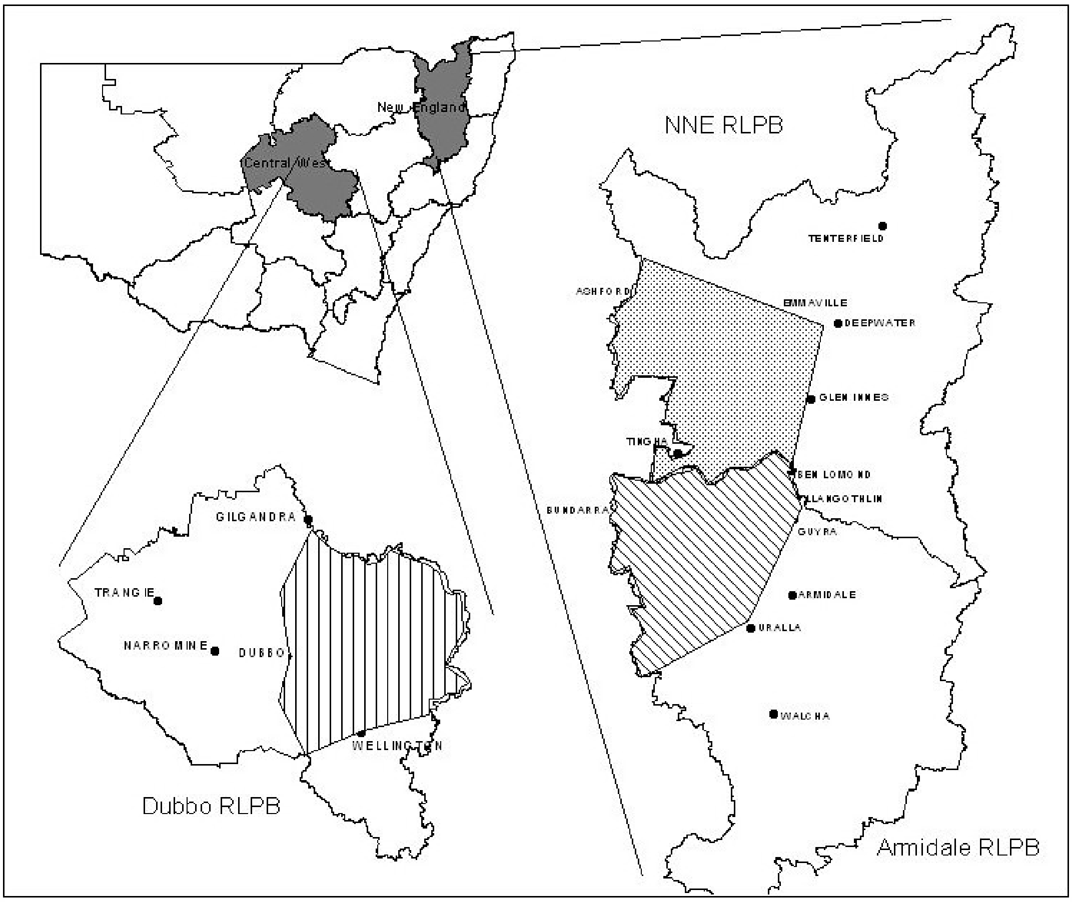


Figure B3.1: The new Livestock Health and Pest Authority (LHPA) districts of NSW showing the three study sites (shaded) within the New England LHPA (amalgamation of old Armidale and Northern New England Rural Lands Protection Boards) and the Central West LHPA (containing the old Dubbo Rural Lands Protection Board) .

All of the study sites fall within the 'Uniform Rainfall- Temperate Climatic Zone' (Bureau of Meteorology 1986), which is characterised by mainly reliable rain and warm to hot weather in summers, and mainly reliable rain and cool to cold temperatures in winter. The Australian Great Dividing Range is in the east and extends into lower plains in the west. Median annual rainfall increases heading west to east and is generally between 400-800 mm but higher in some areas in the east. Elevation ranges from about 200–1000 m above sea level with a few higher peaks up to 1370 m. The main agricultural enterprises across these regions are merino wool, prime lamb, beef cattle production, and cropping. Vegetation consists of open improved pastures with remnant vegetation mainly consisting of dry sclerophyll forest and woodland.

3.1.1 Current Fox Management Programs

The original three boards chosen to participate in this project were all involved in coordinating fox management programs for their ratepayers, however each had a different method of organisation.

Armidale RLPB was a participant in the 'Southern New England Landcare Coordinated Fox Control' program which commenced in 1994. This program began with a group effort between a small number of Landcare groups and over the years developed into a joint venture between the RLPB, Landcare, and NPWS which was overseen by the Southern New England Landcare Coordinating Committee (SNELCC) (Pollard 2000, SNELCC 2002, Boyd 2007). Funds and in-kind contributions (staff time, office facilities) were provided by each participating agency to cover the employment of a project officer to manage the program and associated costs, which included promotional activities and subsidised baits for group involvement (Boyd 2007).

Dubbo RLPB had two dedicated 'Pest Animal' rangers who organised and coordinated the fox group baiting programs. This Board was a participant in the 'Outfox the Fox' promotional campaign since its commencement in 1999, using the associated media coverage and awareness/ education to assist in promotion of their group baiting efforts. The Board supplied funds for subsidising group baiting activities. The RLPB rangers were integral in the development and running of the community driven Goonoo Fox Baiting Program, aimed to protect the threatened Mallee fowl and reduce the negative impact on agricultural area around the Goonoo State Forest. This program recently won a national award for excellence in pest animal management.

Northern New England RLPB promoted its group baiting activities through its newsletters and other organisations such as Landcare, Bushfire brigades and Wild dog associations. There were no dedicated 'Pest Animal' RLPB rangers as such, each ranger took care of pest control activities in their designated area, along with their other duties. The rangers encouraged keen landholders to coordinate activities in their own local area where possible. The Board offered some funding towards group baiting programs, particularly dog baiting programs. Other government agencies such as NPWS participated in coordinated group activities where possible.

3.2 Legislation

This project is reliant on using legislative powers to enforce the mandatory fox control programs at the main treatment site. Part 11 of the *Rural Lands Protection Act (1998)* allows the Minister for Primary Industries to make Pest Control Orders (PCO) declaring certain species of animals and insects, which are not protected fauna or threatened species, to be pests on designated public and private land. Even though there are currently three mammal species declared as pests in NSW (wild rabbits, feral pigs and wild dogs), there has never been such an order made for foxes under this Act (foxes, along with mice, are classed as nuisance animals). Also an order of this type has never been declared in similar circumstances as this one.

The relevant PCO (Number 15) was gazetted in December 2007 which empowered the NNE RLPB to publish an order requiring all occupiers within "the controlled land", defined in the Schedule as Division D of the board, to eradicate the fox by either baiting, shooting or trapping. The time period for this PCO was set at three years from the date of Gazettal.

3.3 Steering Committee

Consultation with all stakeholder groups is an integral part of this project, and the steering committee is an important component of this process. The steering committee set up in the previous project 'Improved Implementation of Regional Fox Management Programs' was successful in its guidance and assistance in the development and implementation of the study, so it was decided to continue this positive collaboration with the stakeholders. It was planned this committee will meet at least once a year, with regular correspondence across the time of the project.

3.4 Experimental Design

This project relied on the introduction of new legislation, and a consequence of this change in landholder responsibilities required a certain amount of education and promotion. It has been established that awareness and education campaigns are important factors contributing to the success of pest management programs (e.g. Bremner and Park 2007), and as such could lead to confounded results. Thus three sites were chosen; the treatment site with the mandatory fox management incorporating the declaration of foxes and the associated education / awareness component (the old Division D – NNE RLPB), a second treatment site with current fox management and the additional education / awareness component (the old Division A – Armidale RLPB) and a control site which employs only their current fox management practices (Division B – Dubbo RLPB).

3.5 Data Collection

This project was an observational study of LHPA fox management programs. No direct manipulation or experimental field work was involved. Data were collected from participants using 1080 bait registers and postal questionnaires.

3.5.1 Landholder Questionnaires and Focus Groups

Postal questionnaires are a cost effective way of reaching a large number of participants however they are susceptible to low response rates and sampling bias (White *et al.* 2005). To reduce the sampling errors inherent in the use of these types of questionnaires the design process was rigorous, being first piloted on a sub-sample of participants to determine any problems. As most of the information required was factual, the questionnaire contained mainly closed-format questions to eliminate uncertainty. The collection of factual type data can be susceptible to respondent biases so the accuracy of data collected was assessed against data collected by alternate means where possible (e.g. responses on1080 baiting compared to that collected on the 1080 register).

As reported in McLeod and Saunders (2008) the 'pre-treatment' questionnaires were posted to all landholders within the study sites and handed out at field days and group baiting meetings from March 2007. Lamb production questionnaires were also distributed in this manner in 2007, 2008 and 2009. To increase response rates in 2008 and 2009, many landholders were first personally contacted by phone or email before the questionnaire was sent. This was followed by a reminder call if the questionnaire was not returned in a timely manner. The questionnaire was also promoted through the RLPB / LHPA Newsletters and media campaigns that stressed the importance of the study while making the participants feel their contribution was valued. Because of the low return in the 'pre-treatment' questionnaires and the need for timely returns, all consenting participants were contacted by telephone to complete the 'post-treatment', in a three week period of December 2009.

In addition to these questionnaires, two focus groups were conducted in November 2009 to allow more in-depth discussion of fox issues by interested landholders and stakeholders. Focus groups are a form of group interview that can not only quickly collect data from several people simultaneously, but can take advantage of group interaction to encourage and enhance discussion, and to better explore people's perspectives, knowledge and experiences (Kitzinger 1995). Invitations were mailed to a subsample of landholders, regardless of enterprise or fox control history, in the NNE and Armidale study sites. Invitations were also sent to representatives of other stakeholder groups such as NSW NPWS, Landcare, I&I NSW, LHPA board members and employees and NSW State Council. An independent facilitator conducted the focus groups using open ended questions to encourage discussion on a range of fox-related issues and pursue priorities that were of importance to the participants.

3.5.2 1080 Poisons Register

In NSW, 1080 is tightly controlled under the *Pesticides Act 1999*, as well as by Commonwealth legislation. Only Authorised control officers, usually employees of LHPAs or other government agencies are allowed to obtain, handle, prepare and supply 1080 prepared baits. A 1080 Poisons Register must be kept by each agency that handles 1080. This register contains the names and property identifier of all landholders or agencies who have collected 1080 baits for use on their land. It also records the bait type, quantity of baits, target species and date collected. With the cooperation of each of the participating boards, all of this data from the NSW poison register of 1080 use was collated for the experimental period 2007 to 2009, with additional records going back to 2004 for NNE and Dubbo. The property identifier supplied by the LHPAs was then matched to cadastral information, so the location of each property could be mapped using a GIS mapping program. As information was unavailable as to what sections of each individual property was actually baited, it was assumed that baits were laid evenly across the entire property.

3.5.3 Shooting Data

Data was collected from a sample of fox shooters throughout 2009 using a questionnaire containing mainly closed-format questions. This questionnaire was based on a similar one successfully used by McLeod *et al.* (2007) of state-wide shooters, and which had been designed following the recommendations for best practice in questionnaire-based studies by White *et al.* (2005).

Volunteer sampling in questionnaires have many inherent problems, the main one being that you have no way of knowing how representative the respondents are of the larger population (List 2002). There are several methods to check or reduce this uncertainty including random questionnaires or ensuring the response rate is high from all sections of the fox shooting community. Stressing the importance of the study, making the shooters feel their contribution was valued and gaining the trust of the participants are all important to ensure a high response rate. An incentive scheme was offered to enhance the return of questionnaires in a timely manner.

3.5.4 Lamb Production Data

A standard measurement of lamb production that is recorded by producers is the lamb marking percentage (LMP); defined as the number of lambs that survive to lamb-marking, as a proportion of the number of ewes joined (Cottle 1991). At the large regional scale that this study was operating, this figure was the only repeatable variable of lamb production that was able to be collected across the three study sites. The most economical method to collect the required data (i.e. the number of ewes joined, ewe body condition, ewe and lamb breed and the number of lambs marked) from lamb producers was by means of a postal questionnaire as explained in section 3.5.1.

3.6 Statistical Analysis

3.6.1 Landholder Questionnaires

A Fisher's test was used to compare the ratios of the landholder's comparisons of control methods and the importance of the fox as a pest, fox control, and group control in their area.

3.6.2 1080 Poisons Register

To test the hypotheses that the declaration of the fox as a pest animal had an effect on landholder involvement in fox control (total number of landholders, proportion of landholders baiting with a group, and total number of baits used) data was modelled using a linear mixed model.

3.6.3 Shooting Data

For comparisons between shooters and day / night shooting forays, data was first checked for normality and differences in variances. A one-way Anova was used to compare number of forays, time spent, foxes spotted, foxes shot and success of shooting. A Fisher's test was used to compare the ratios of juveniles and adults shot.

3.6.4 Lamb Production Data

There are many variables, other than fox predation, that influence lamb survival (Holst *et al.* 2002). Before any analyses of the collected lamb production figures, these covariates were adjusted for using the LambAlive component of the GRAZPLAN decision support system (Donnelly *et al.* 1997). LambAlive contains a predictive model that estimates the level of mortality of new born lambs in relation to chill index, ewe breed, ewe condition and percent of lambs that are twins. It requires the start date of the lambing period and averages the mortality risk over a lambing period of 17 days (length of oestrous). Chilling factor, CH (kJ m^{-2} h^{-1}) is related to mean daily wind velocity, v (m s^{-1}), mean daily temperature, T_{mean} (°C), and total daily rainfall, R (mm) by the equation (Donnelly *et al.* 1997):

$$CH = 481 + (11.7 + 3.1v^{1/2})(40 - T_{mean}) + 418(1 - \exp(-0.04R)).$$

The proportion of young that die in the first three days after birth from exposure, XR, can be predicted from the functions below given relative body condition of the ewe at lambing *BC*, chill index, *CH*, and litter size, *Y*, as explanatory variables (Donnelly *et al.* 1997):

$$XR = \frac{\exp(XO)}{1+\exp(XO)}$$

where

$$XO = C_{D8} - C_{D9}BC + C_{D10}CH + C_{D11,Y}$$

A higher proportion of lambs from Merino ewes die than lambs from crossbred ewes; the parameter values for the two genotypes are listed in Table B3.1.

Table B3.1: Parameters used for predicting mortality rates in newborn lambs from merino and crossbred Ewes in LambAlive (after Donnelly et al. 1997).

Parameter	Description	Units	Merino Ewes	Crossbred ewes
C_{D8}	Constant term	–	-9.95	-8.90
C_{D9}	Effect of body condition	–	1.71	1.49
C_{D10}	Effect of chill index	$kJm^{-2}h^{-1}$	0.0098	0.0081
$C_{D11,Y}$	Effect of lamb number (*Y*)	–		
	1	–	0.0	0.0
	2, 3	–	1.10	0.82

Sheep data such as the number of ewes joined, ewe body condition, ewe and lamb breed and the number of lambs marked, was collected using the questionnaire. The proportion of twin data was obtained from experimental and demonstration flocks from within the study area (McLeod *et al.* 2007). Two breed categories, merino and crossbred (which included all other breeds and crosses) were used. Ewes with missing body condition scores were allocated the average score of '2'. The start date of the lambing period was calculated from 150 days (average gestation length) from the given joining date (Cottle 1991). Historical district weather records were obtained from the Australian Bureau of Meteorology. Daily temperature and rain data was downloaded from the SILO website (http://www.bom.gov.au/silo), and monthly average wind speed from the Bureau's own web site (http://www.bom.gov.au).

These adjusted lamb production figures were then used in the analysis to test the hypothesis that the declaration of the fox as a pest animal had an effect on lamb production. This was analysed using a generalised linear mixed model taking as the dependent variable the number of lambs marked.

4. RESULTS

4.1 Fox Programs

At the beginning of 2009, two of the study sites (Armidale and NNE) were amalgamated under the same administrative authority (NE LHPA). Despite this amalgamation the fox programs were organised and conducted in a similar manner to previous years (see 3.1.1). The Armidale site still participated in the joint venture with Landcare, and NPWS. A new coordinator was employed for the 2008 and 2009 group programs. A new incentive scheme was introduced in these years, where all participants were entered in a draw, with local businesses donating many prizes. The same ranger remained in charge of the NNE site, however he was on personal leave throughout July 2009. One of the rangers at the Dubbo site was promoted to a management position, and her pest management duties were covered by an additional ranger. This site was also involved in the trialling of a new fox toxin para-aminopropiophenone (PAPP), delivered in the manufactured bait Foxoff® throughout winter 2009.

Posters and educational handouts that had been developed with consultation between the participating stakeholders and the project officer at the commencement of this project in 2007 (McLeod and Saunders 2008) were continued to be used over the course of the study in 2008 and 2009. This material was used in displays and handouts at field days, information evenings, attended by the group fox baiting coordinators (in Armidale) and other promotional activities, as well as distributed through LHPA newsletters and flyers.

4.2 Legislation

The PCO having been gazetted in December 2007 was in force throughout 2008. Although the time period for this PCO was set at three years from the date of Gazettal, the formation of the new LHPAs in 2009 saw the dissolution of the old RLPB boundaries, and thus “the controlled lands” were no longer defined, and the PCO lost its validity. Despite this technical hitch, the rangers proceeded with fox control activities in this designated area throughout 2009 as if the PCO was still in place.

There are currently three PCOs in place across all of NSW for vertebrate pests; those for wild dogs, wild rabbits, and feral pigs. As part of their duties rangers from the LHPAs can inspect properties and if they find evidence that landholders are not carrying out their obligations under these PCOs (i.e. not conducting suitable control programs against these pests) the rangers, in the first instance can warn the landholder and usually offer assistance where applicable. A notice under section 169 of the *Rural Lands Protection Act (1998)* may also be issued. If the landholder still refuses to co-operate, rangers can then issue an eradication order, which can lead to fines and court action for noncompliance. The LHPA rangers use these orders as a last resort, preferring to assist landholders develop appropriate pest control programs, providing advice and assistance in all aspects of pest management. The number of notices and eradication orders issued by RLPBs / LHPAs across NSW is given in Table B4.1.

No fox notices or eradication orders were issued to landholders during this trial. The LHPA management and rangers at the NNE study site preferred to take a more positive attitude and assist landholders develop appropriate fox control programs, particularly group programs, rather than enforce compliance.

Table B4.1: Notices and Eradication orders issued by the Rural Lands Protection Boards / Livestock Health and Pest Authorities across NSW from 2005 until 2009.

Year	Notices under section 169	Eradication Orders
2005	22	
2006	14	
2007	12	
2008	23 (21 rabbits, 2 pigs)	4 (rabbits)

In October 2008, a new Pesticide Control Order (1080 Liquid Concentrate and Bait Products) was enacted in NSW. Under this new Pesticide Control Order 1080 was listed as a restricted chemical product, limiting its supply to only landholders who hold a current AQF3 chemical accreditation. To gain initial accreditation landholders were required to attend a 2 day workshop at a personal cost of approximately $250. This accreditation requires renewal every five years, which involves attending a refresher workshop of at least one day duration. From 2010 these requirements have been reduced to a half day workshop at a reduced cost.

4.3 Steering Committee

Membership of the steering committee was extended from that established in 2007/08 to incorporate the formation of the LHPA. In addition to the original committee membership (Manager Melissa McLeod and Rangers Bob Davidson, Brent Petrie / Rob Munro, State Council Pest Manager Tim Seears, NSW I&I Program Development Officer Phil Gardner, Pest Management Officer from the NPWS Stuart Boyd-Law, GlenRac Landcare officer Kylie Falconer, and two local landholders Graham Moore and Jim Coleman), the senior ranger for the new NE LHPA Peter Frizell, and the coordinator for the Armidale fox program and SNELCC Landcare officer Bec Ballard were invited to attend.

The first meeting of this new steering committee was held on January 28th at the Glen Innes office of the NE LHPA. The minutes for this meeting are attached in Appendix 1. All members of this committee also took part in the focus group workshops conducted in November 2009 (see section 4.5 for results).

4.4 ‘Pre-treatment’ and ‘Post-treatment’ Landholder Questionnaires

The questionnaire to collect ‘pre-treatment’ perceptions of fox management was posted to all participating landholders in February and March 2007 and finalised by the end of June 2007. Responses to this questionnaire were poor, particularly in the Dubbo site (2%) where no promotion took place. At the NNE site 19% of the questionnaires were returned and 16% at the Armidale site. All sites showed a similar mixture of enterprises; overall 47% ran sheep/goats and cattle, 28% just cattle, 15% just sheep/ goats and 10% other (including no livestock, hobby farms, pigs and horses).

These returned questionnaires were biased towards landholders who had an interest in fox issues and / or who actively controlled foxes on their properties (Overall 82% participated in fox control programs with 59% shooting and 56% using 1080 baiting at least once a year). Of all the landholders who baited, 32% always baited with a group, 55% only baited with a group occasionally or when it was convenient, and the remaining 13% never baited with a group. These ratios differed between sites (see Figure B4.1), with Armidale having the highest percentage that baited with a group. NNE had the highest percentage that never participated in group baiting. Of all the landholders who responded that they shot, 57% also baited.

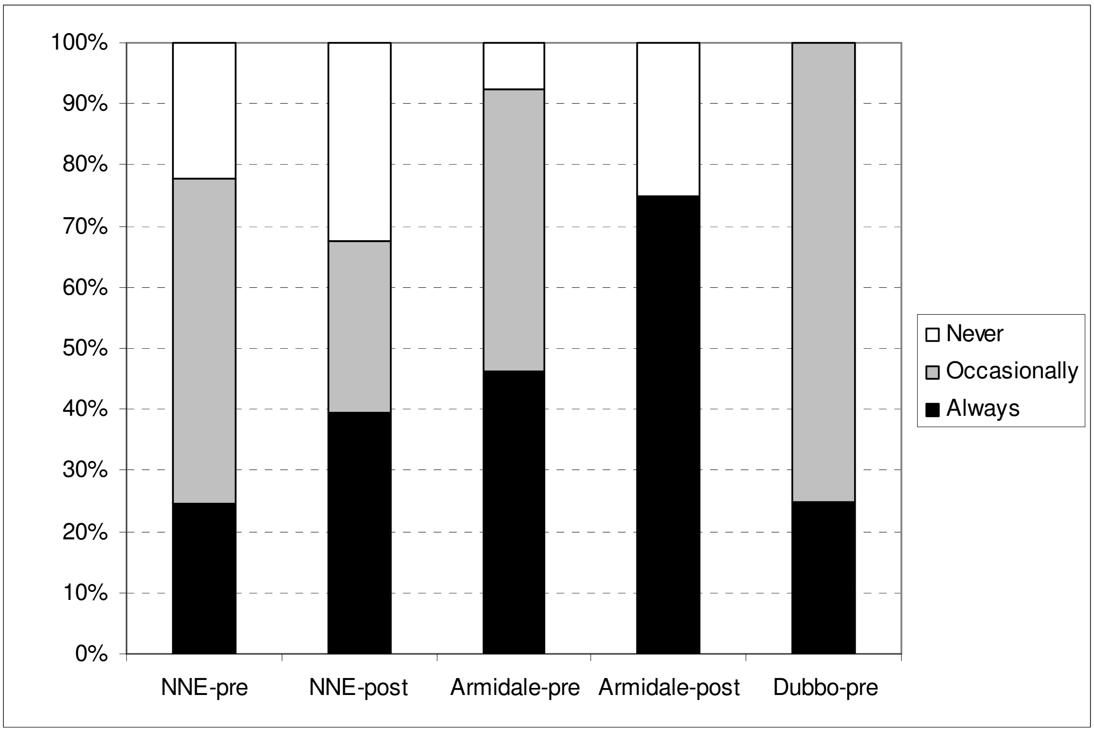


Figure B4.1: Landholder participation in group 1080 baiting programs pre- (2007) and post-treatment (2009) questionnaires.

Three quarters of all responding landholders agreed that the fox should be a declared pest in NSW. This proportion was similar across the three sites (range 73.3 – 76%). Most commented that the impacts to native wildlife as well as agricultural production were important reasons for this declaration, and that it would encourage group effort, regardless of enterprise and interests. Some landholders were sceptical, with the cost of mandatory control the main concern.

The ‘post-treatment’ questionnaire was conducted at the end of data collection in December 2009, using a phone survey. All the respondents to the pre-treatment questionnaire from within the Armidale and NNE study sites were approached. Since the initial response to the ‘pre-treatment’ questionnaire was poor from the Dubbo site the landholders from this site were not included in the ‘post-treatment’ questionnaire.

Of the 178 landholders who participated in the initial questionnaire (158 NNE, 20 Armidale), 37% could not be contacted by phone, and a further 13% were either unavailable, not interested or too busy to reply. From the 88 landholders who did respond, 26 had made changes to their enterprises since the ‘pre-treatment’ questionnaire with the majority reducing their cropping (8) or livestock (cattle (7) and sheep (7)). One landholder had moved from sheep to cattle, two had added cattle and only one landholder had added sheep. In total 51% ran sheep/goats and cattle, 24% just cattle, 18% just sheep/ goats and 7% other (including no livestock, hobby farms, pigs and horses).

These responses were still biased towards landholders who had an interest in fox issues and actively controlled foxes on their properties (Overall 86% participated in fox control programs). Shooting had increased as a control method with 81% respondents reporting its use at least once a year, with 63% using 1080 baiting at least once a year. Of all the landholders who baited, 43% always baited with a group, 26% only baited with a group occasionally or when it was convenient, and the remaining 32% never baited with a group. These ratios differed between sites (see Figure B4.1), with Armidale still having the highest percentage that baited with a group and NNE still with the highest percentage that never participated in group baiting. Of all the landholders who used shooting, 60% also baited.

In both the pre- and post-treatment questionnaires landholders were asked to rate the effectiveness of the fox control methods of baiting and shooting. Baiting was considered the most effective method, and there was no change in significances between the pre- and post-treatment questionnaires (p=0.30, Fisher's Test). Eighty five percent of landholders rated baiting as excellent or good in the pre-treatment questionnaire and 92% in the post-treatment questionnaire, providing it was done correctly ("baiting good if done OK", "need a strategy and plan", "must spread baits out so one fox doesn't take them all", "won't use anything other than 1080, it's the best. It comes back to application"). Those landholders who did not rate baiting highly expressed a lack of confidence in this method ("too broad acting", "1080 baits too weak", "not as potent so not killing the foxes", "(the baits are) pulled out of the ground but not eaten", "unsure as don't see dead foxes". "don't like baiting").

As a stand alone method, shooting was not rated as highly as baiting by the majority of landholders, although its effectiveness improved slightly (although not significantly) in the post-treatment questionnaire. In the pre-treatment questionnaire 16% of landholders rated it as excellent, 29% good, 42% fair and 13% poor, while in the post-treatment questionnaire 16% rating it as excellent, 41% good, 29% fair and 14% poor (p=0.22, Fisher's Test). Many landholders commented that shooting was an opportunistic method, which was less consistent than baiting, and the effectiveness depended largely on the shooter's ability and accuracy. It was seen as a good compliment to baiting though. Shooting was regarded as more target specific, although it was difficult to do, time-consuming, introduced licensing problems and tended to make other foxes more wary and difficult to spot.

In both the pre- and post-treatment questionnaires landholders were asked to rate the importance of a) the fox as a pest b) fox control on the land and c) group control programs in their area. In the pre-treatment questionnaire at least 85% of respondents thought that foxes were a very or moderately important pest in their area, which was similar across all sites. The landholders from the Armidale board considered group control programs more important than landholders from the other sites (Figure B4.2).

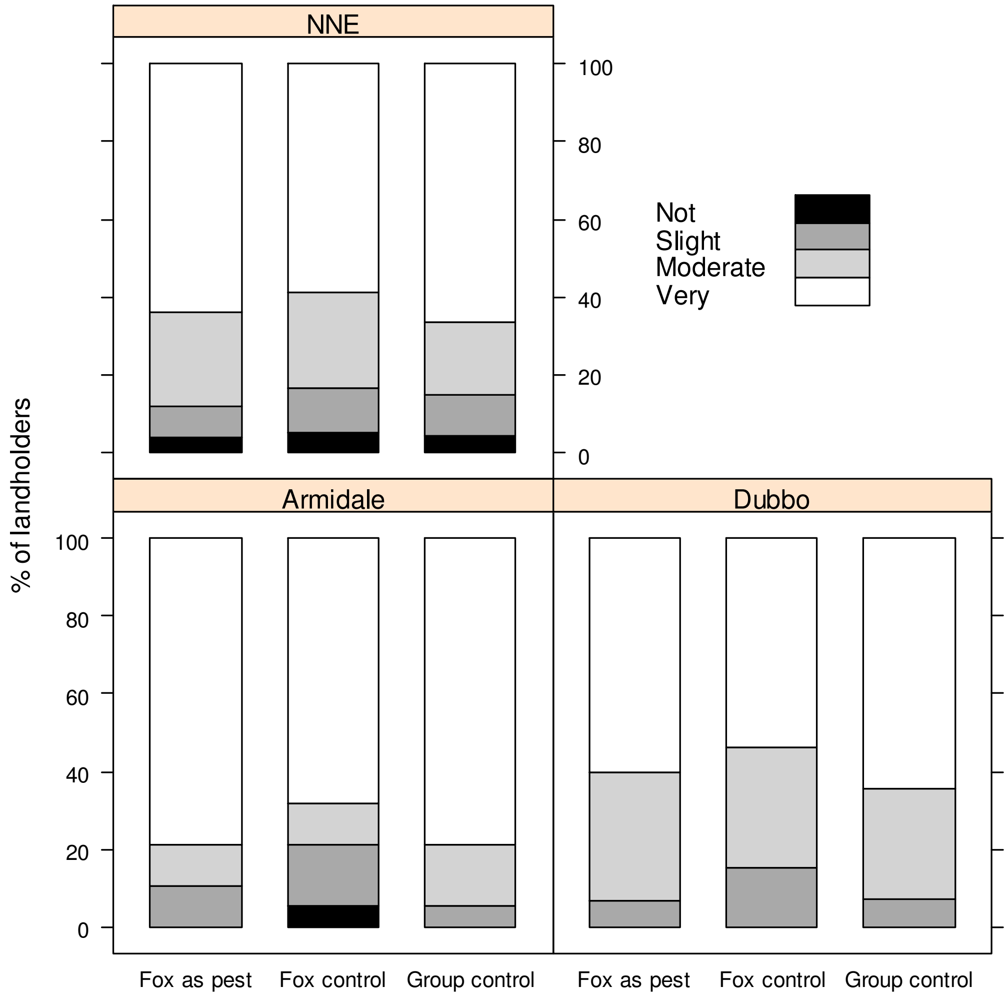


Figure B4.2: Pre-treatment responses to the questions asking landholders to rate the importance of a) the fox as a pest b) fox control on the land and c) group control programs in their area, for each of the participating study sites..

The responses to these same questions in the post-treatment questionnaire remained unchanged for landholders from the Armidale study site, but changed significantly for the landholders from the NNE study site (where the fox had been declared a pest) (Figure B4.3). At least 79% of NNE respondents thought that foxes were a very important pest in their area compared with 64% in the pre-treatment survey (p=0.034, Fisher's Test), 77% listed fox control as a very important issue compared to 59% pre-treatment (p=0.037, Fisher's Test), and 85% thought group control was important compared to 66% pre-treatment (p=0.002, Fisher's Test).

Comments on group programs from the NNE site ranged from "group programs definitely work" to "group programs are a waste of time". Non-participation in group programs, especially by landholders without sheep, was seen as a major problem across all sites ("more cattle – less groups", very difficult to control when surrounding properties don't", "reduction in sheep numbers so not as much control going on"). One landholder reported an attack on young born calves by foxes, and thought this should be a stimulus for cattle producers to become involved.

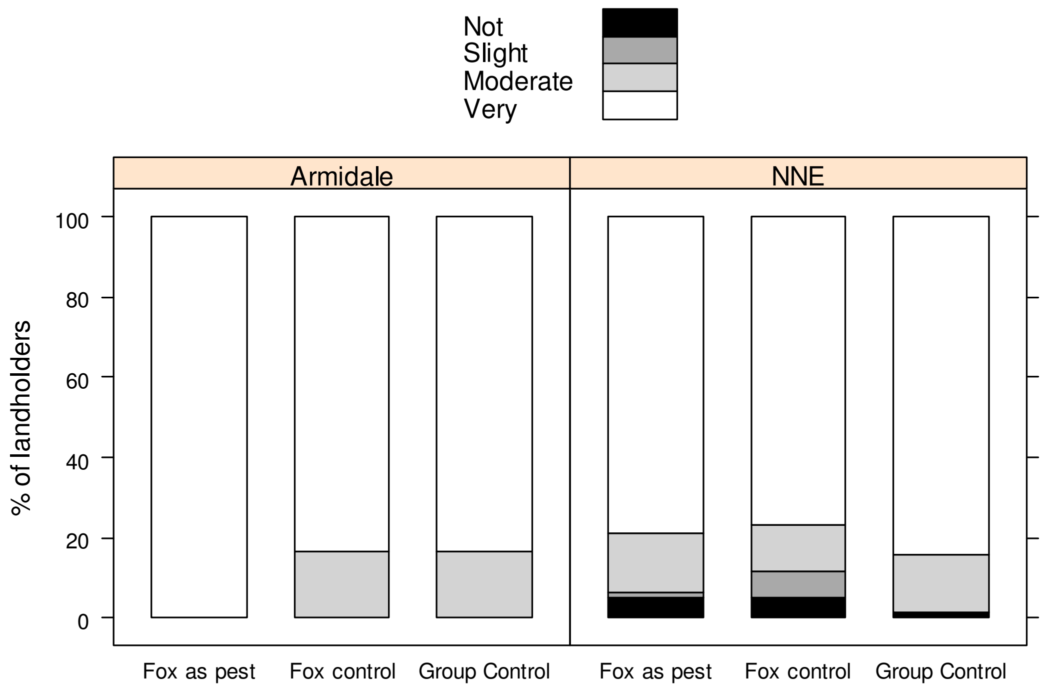


Figure B4.3: Post-treatment responses to the questions asking landholders to rate the importance of a) the fox as a pest b) fox control on the land and c) group control programs in their area, for Armidale and NNE study sites.

Eighty two percent of the landholders questioned from the NNE study site knew that the fox was a declared pest in their area ("knew because of information sent out"). There was no influence of the declaration on 74% of the landholders questioned, who continued to be involved in fox control activities regardless of the legal status of the pest ("it is not optional for us to control, we would do it anyway"). The declaration did persuade 6% of the landholders to commence fox control on their properties, but had no influence on a further 9% who refrained from any form of fox control ("I'm retired, what's the point", "Don't have sheep", "Don't see many"), with11% not commenting on this question.

Landholders were asked to comment on any issues they saw relevant to fox control in their area. The new chemical certification legislation introduced in October 2008 drew many negative comments from landholders, with a small number indicating that it had prevented them from baiting in 2009 ("too expensive and time consuming", "chem. cert. stopping control", "new chem. cert. legislation is stupid"). Incentive schemes and bounties were another popular topic, with many landholders calling for a return of fox bounties ("need an incentive, i.e. bounty", "Bounty might make a big difference"). One landholder suggested a LHPA rate-based incentive system. Two landholders expressed concern with the lack of control conducted by other authorities such as councils and railways.

4.5 Focus Groups

Eighty invitations were mailed / emailed to a subsample of landholders, regardless of enterprise or fox control history, in the NNE and Armidale study sites as well as representatives of other stakeholder groups such as NSW NPWS, Landcare, Industry and Investment NSW, LHPA board members and employees and NSW State Council. Two focus groups were conducted, the first at Ben Lomond within the NNE study site, and the second at Uralla within the Armidale study site. The first workshop was attended by 19 people with five apologies given. The second workshop was only attended by 9 people with 2 apologies (see Appendix 2 for minutes).

The topic for the focus group was 'Should foxes be a declared pest species' (i.e should fox control be mandatory for all landholders)? The independent facilitator initiated the discussion using open ended questions such as what are the pros for declaring the fox, what are the cons, what management options are available, and what are the alternatives. Due to the different sizes and structure of the groups, the progress of each discussion varied, however the main points raised by both groups were very similar.

Table B4.2: A summary of the main points for and against a declaration of the fox as a pest animal from the focus group discussion.

Should foxes be declared (i.e. should fox control be mandatory)?	
Pros	• Landholder legal obligation to control foxes, able to pressure landholders to control foxes that might not do so voluntarily • Educating community about reasons to control foxes, mechanism to increase education via media, field days etc • Defines a target level of control – continually suppress and destroy • Access to other control options, ways to assist and encourage • Increase effectiveness of control, encourage group participation • Increase sheep production, improve dung beetle survival • Decrease weed spread, parasites and lower threat of rabies spread • Highlight biodiversity outcomes as well as production • Prevent use of fox as a means to control rabbits • More property inspections by rangers
Cons	• Cost – will there be extra funding available? • Policing – enforcing Act, staff workload • Feasibility – will it be more effective? • Increased requirement to educate public, new landholders • Limitations of current control methods, TAPS limit some options • Chemical certification AQF3 requirements • What about urban foxes? Would only apply to rural landholders • Big stick approach – prevent people from seeking assistance • Misinformation, misuse of control methods, illegal use of chemicals • Coordination key to success- getting people to co-operate • Imposing changes to farm management • State division – consistency between states

The main arguments for and against a declaration are summarised in Table B4.2. Although there were many predicted benefits in forcing every landholder to participate in fox control, the cost, both in resources and time was the main concern. Who was to pay for the fox control programs and the additional education required? Would there be extra funding available to the LHPA and / or landholders? How much fox control was enough and how would rangers enforce the Act? Would other control options become available? How would the new Chemical accreditation requirements affect landholder's choice of methods? Would fox control under a declaration be more effective in reducing impacts?

The focus groups discussed current management options, what was working and what needed improving. The main points are summarised in Table B4.3. Many participants expressed their frustration at the limitations of current control options. Baiting using the toxin 1080 is the most widespread method for fox control, however with the new chemical accreditation rules and the reluctance of many people to use this toxin, effective alternatives also need to be available. How group baiting is organised should take into account the community demographics and local 'politics', with farmer run community groups usually more effective. Partnerships between organisations such as Landcare and the LHPA were seen as important, and there is a need for other local government agencies to become involved. Education was seen as an ongoing

Table B4.3: A summary of the discussion on current fox management options.

Current fox management options:	
Good points	• Coordinated group baiting • Farmer run community groups successful because of peer pressure, knowledge of local politics, word of mouth • Partnerships between organisations e.g. Landcare, LHPA, NPWS • Number of bait types available • Baiting strategies – bait replacement, follow up baiting, mound baiting / bait stations, use of attractants. • Shooting / Trapping – alternatives available to get bait shy foxes • Hiring of traps from LHPA • Education of techniques from LHPA rangers when required
Improvements	• Change in attitude – landholders responsibility • Timing – neighbouring groups baiting at same time • Business support incentives – free or discounted baits, reduction in rates, free additional baits for adjoining TSR's, railways etc (similar to NPWS system). Offer a bounty. • Contract baiters • Reduce training for chemical certification for minimum 1080 use • Education – target some groups • Coordination with dog programs to involve cattle producers • Research into biological control and new technology e.g. PAPP • Encourage alternative methods - ripping of dens, shooting, trapping • Find out why people do not bait and work on solutions • Involvement of other local government agencies

requirement, with some targeting of particular groups (e.g. cattle producers, school children). Research into new technology and options was seen as mandatory.

The final question posed to the focus groups was ‘what are the alternatives to fox declaration’? This discussion largely overlapped with the previous discussion on ways to improve current management options, with the themes of education, attitude changes, incentives and research into new technologies being repeated (see Table B4.4). It was agreed that landscape approaches, incorporating all tenures (partnerships) should be the aim of future fox management programs.

Table B4.4: A summary of the discussion on alternatives to declaring the fox a pest animal in NSW.

Alternate fox management options:	
1. Landscape approach, all tenures - partnerships with LHPA assistance	
2. Develop groups with common interests - high sense of community, peer pressure	
3. Incentive to do fox control e.g. rate subsidy, government agencies supply some baits to adjoining landholders, business support incentives, market for fox pelts	
4. Research - into new technologies and improvements on current techniques	
5. Education	• A long term requirement • Bring about an attitude change - unacceptable not to control foxes • Broad approach - use of a celebrity to push fox control in media • In schools - children pressuring parents • To landholders – information on strategies & techniques delivered in variety of modes e.g. mini field days, handouts • Promote fox control as part of commonsense overall land management not only biodiversity outcomes • Incorporate with nocturnal field trips, biodiversity field activities, identification of tracks and scats

4.6 1080 Registers

1080 baiting data from the 1080 registers was collected from all study sites from 2004 through to 2009. At both the Dubbo and NNE study site, every landholder who collected 1080 fox baits was entered on the 1080 register sheets as a separate entry, regardless of whether they baited with a group or not. At the Armidale site when group baiting programs occurred only the group details were entered on the 1080 registers and landholders details were recorded separately. Only landholders who did not bait with a group were individually entered on the 1080 register. This method of recording made it difficult to collect all the necessary data from 2004 to 2006, as the group baiting records from this period were unavailable.

The types of baits issued varied between the study sites with Red meat being the main bait type at the Dubbo site (53%), followed by Foxoff® (34%), Liver (9%) and Chicken heads (8%), with DeFox™, Kidney and Foxoff containing PAPP (2009 only) making up the remainder (Figure 4.4). Foxoff® baits were the main bait type issued at both the Armidale and NNE sites (58% and 54% respectively). Armidale then favoured Liver baits (31%), Chicken wings (9%) with Heart and Red meat making up the remainder. Chicken heads were the next favoured bait at the NNE site (21%), followed by Red meat (16%), DeFox™ (5%), Chicken wings (3%) and Liver (1%) (Figure B4.4). These percentages were reasonably uniform across years at the Armidale site. Chicken wings became increasingly popular at the NNE site to the detriment of Foxoff™ and Red meat. Red meat also declined in Dubbo, with an increase in Liver, Defox™ and the trial PAPP bait.

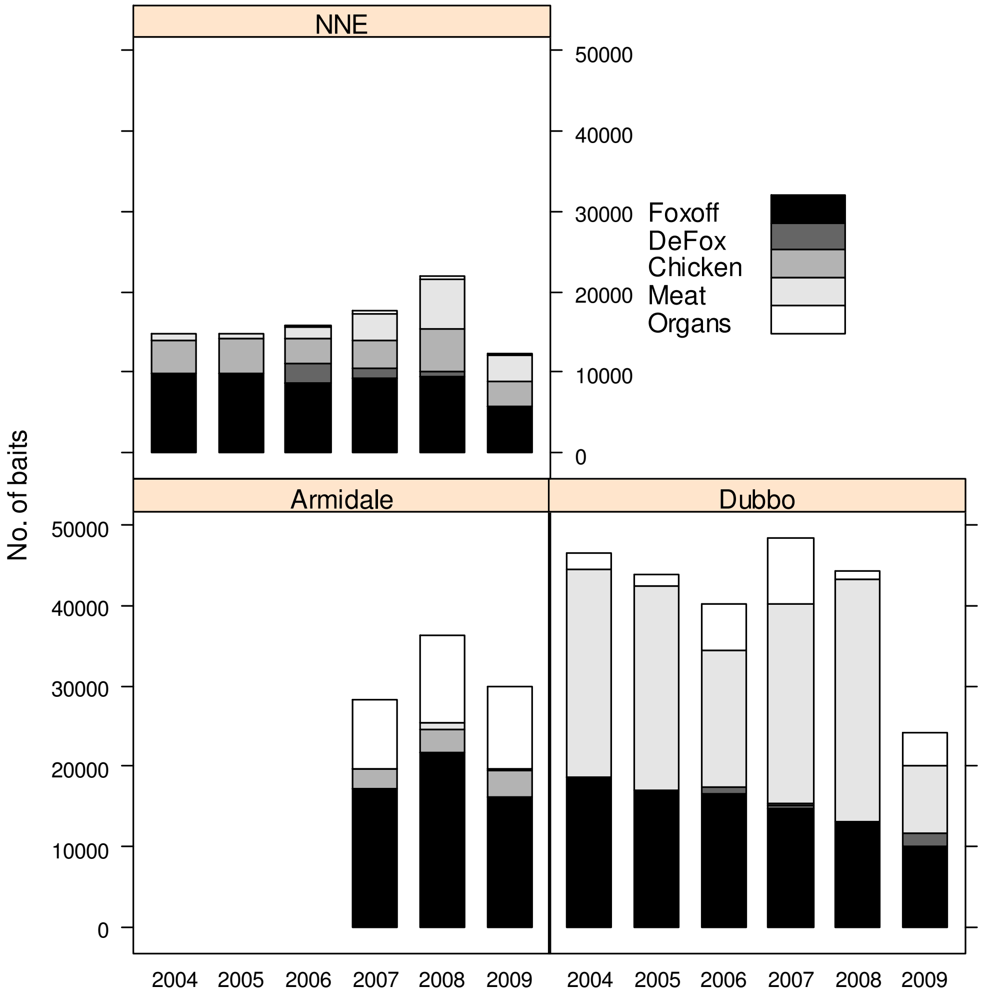


Figure B4.4: Bait types issued across the study sites from 2004 until 2009 . The 'organs' category includes mainly Liver baits, but also Kidney and Heart baits. The trial Foxoff baits containing PAPP used ay Dubbo in 2009 are included in the 'Foxoff' category.

The breakdown of 1080 fox bait distribution across the three study sites is given in Table B4.5. The 'Register entry' category gives the number of individual instances where 1080 baits were handed out (and subsequently recorded on the 1080 sheets). This category includes individual participants in group programs for the Armidale site. The 'Individual properties' category gives the number of separate properties that were issued with 1080 fox baits. The 'Group participation' category specifies the percentage of properties that participated in a group program. The percentage of properties that performed two or more baiting programs in any year is given under the 'Properties baiting 2x' category. Baits that were collected within a month of each other were considered to be part of the same bait program and were not included in this category.

Table B4.5: Fox 1080 bait distribution across the three study sites. Description of each category is given in the text.

Site	Category	2004	2005	2006	2007	2008	2009
Armidale	Register entry				548	730	654
	Individual Properties				431	525	461
	Group participation				77%	74%	79%
	Properties baiting 2x				8%	19%	14%
Dubbo	Register entry	691	588	593	710	613	339
	Individual Properties	460	429	402	473	419	251
	Group participation	73%	63%	67%	76%	77%	78%
	Properties baiting 2x	39%	29%	37%	38%	38%	30%
NNE	Register entry	274	273	319	306	316	164
	Individual Properties	197	185	206	209	226	133
	Group participation	46%	43%	43%	49%	52%	19%
	Properties baiting 2x	31%	37%	38%	36%	28%	17%

Participation in group programs at the Dubbo and Armidale sites was consistently high throughout the sample period, with around three-quarters of all landholders in any given year baiting with a group. Participation was lower at the NNE site, with just under half of landholders baiting with a group in most years except 2009 where the figure dropped to 19%. Around a third of landholders at the Dubbo and NNE sites conducted at two or more baiting programs a year. Only small numbers of landholders at the Armidale site conducted more than one baiting program a year. Dubbo and NNE sites showed a dramatic decline in landholder baiting in 2009. There was also a small decline at the Armidale site, however because of the small data set it is difficult to comment on this aspect.

From the property cadastral information supplied by the corresponding authorities an average of 95% of individual properties listed in the 1080 register at the Armidale site could be identified and linked to the GIS mapping program (Figure B4.5), 94% at the Dubbo site (Figure B4.6) and 89% at the NNE site (Figure B4.7). Reasons why the remaining 5-11% could not be linked include incomplete cadastral information available, incomplete information recorded on the register, or change in circumstances (ownership, name of property, subdivision). This last reason become extremely relevant for records collected in 2004 to 2006. In NNE for instance only 86% of properties using 1080 fox baits in 2004 could be linked, whereas 91% of properties in 2009 were linked.

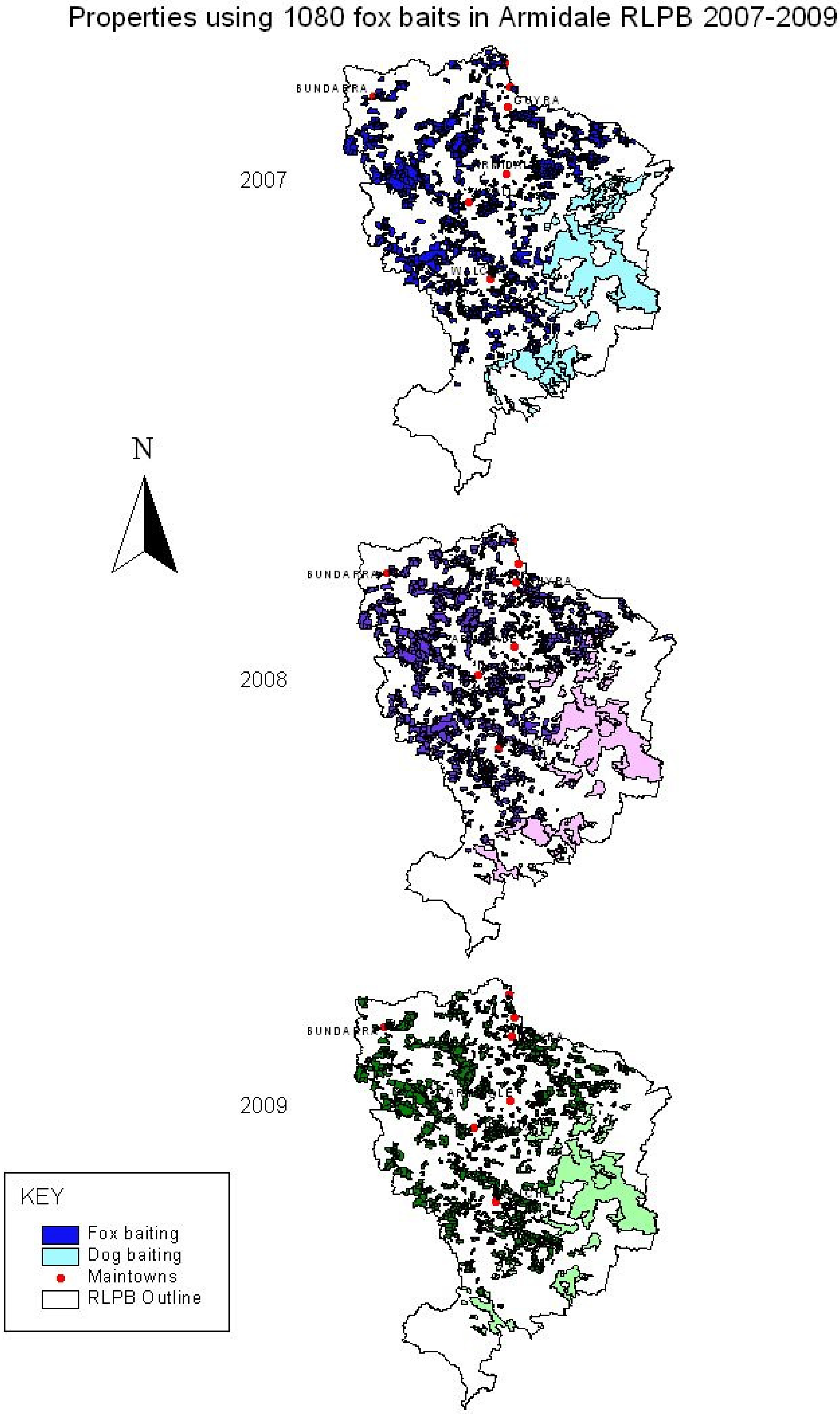


Figure B4.5: Properties that used 1080 fox baits and dog baits at the Armidale study site in the years 2007 to 2009.

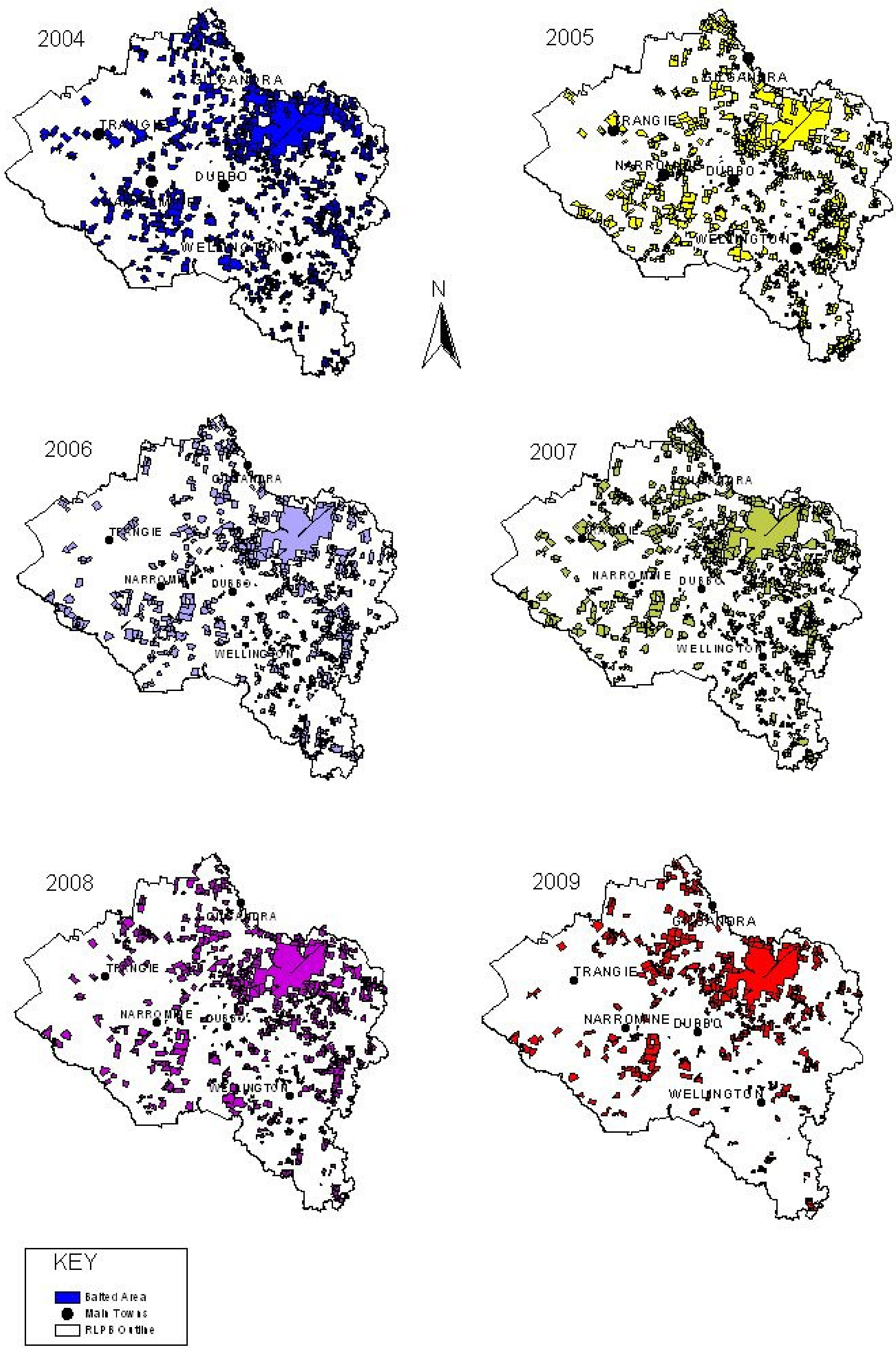


Figure B4.6: Properties that used 1080 fox baits at the Dubbo study site in the years 2004 to 2009.

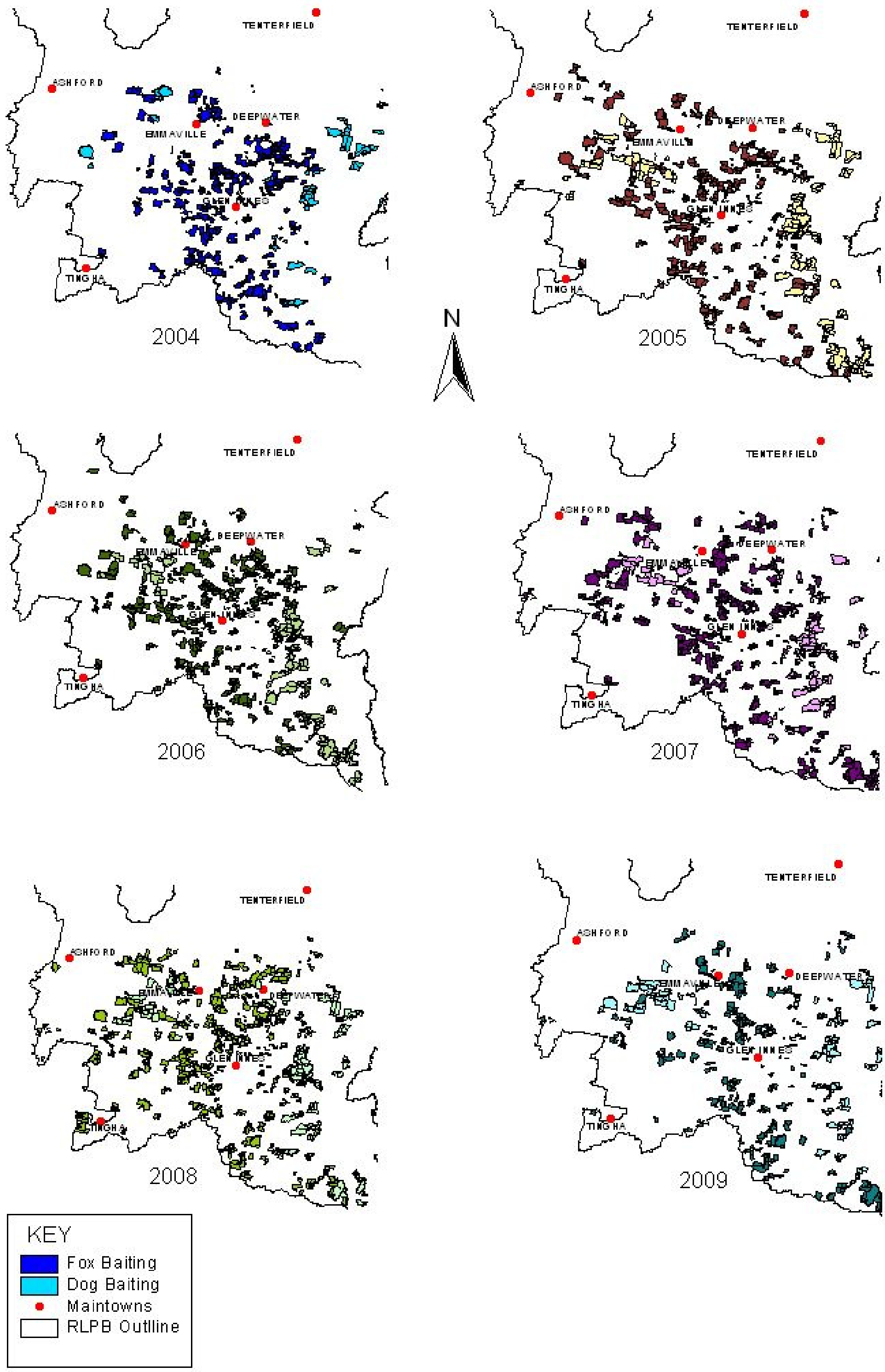


Figure B4.7: Properties that used 1080 fox and dog baits at the NNE study site in the years 2004 to 2009.

To analyse if the declaration of the fox as a pest animal at the NNE site effected landholder involvement in fox control, three hypotheses were tested:

1. The number of landholders participating in fox control activities (1080 baiting) in the NNE site increased after the declaration.
2. The proportion of landholders participating in group fox control in the NNE site increased after the declaration.
3. The total number of 1080 fox baits increased at the NNE site after the declaration.

These hypotheses were tested by fitting linear mixed models to the data. For hypothesis 1 and 3 the model fitted included a linear trend in *Time* with a sinusoidal trend within each year, which differed across sites. Smooth deviations from these trends within each *Site* across *Time* were modelled using a common spline model with *Time* plus separate spline models with *Time* for each *Site*. A *Drought* effect, and an interaction between *Site* and *Drought* effect were included as a fixed effects. Finally, as fixed effects, a post *Intervention* effect was included for the NNE site with this effect modelled as a linear deviation from the underlying trend. Also included in the model were individual year effects, effects for Sites within *Years* and finally a random error component. The model to test hypothesis 2 was similar, but with the dependent variable (proportion of landholders baiting in a group) assumed to have a quasi-binomial distribution.

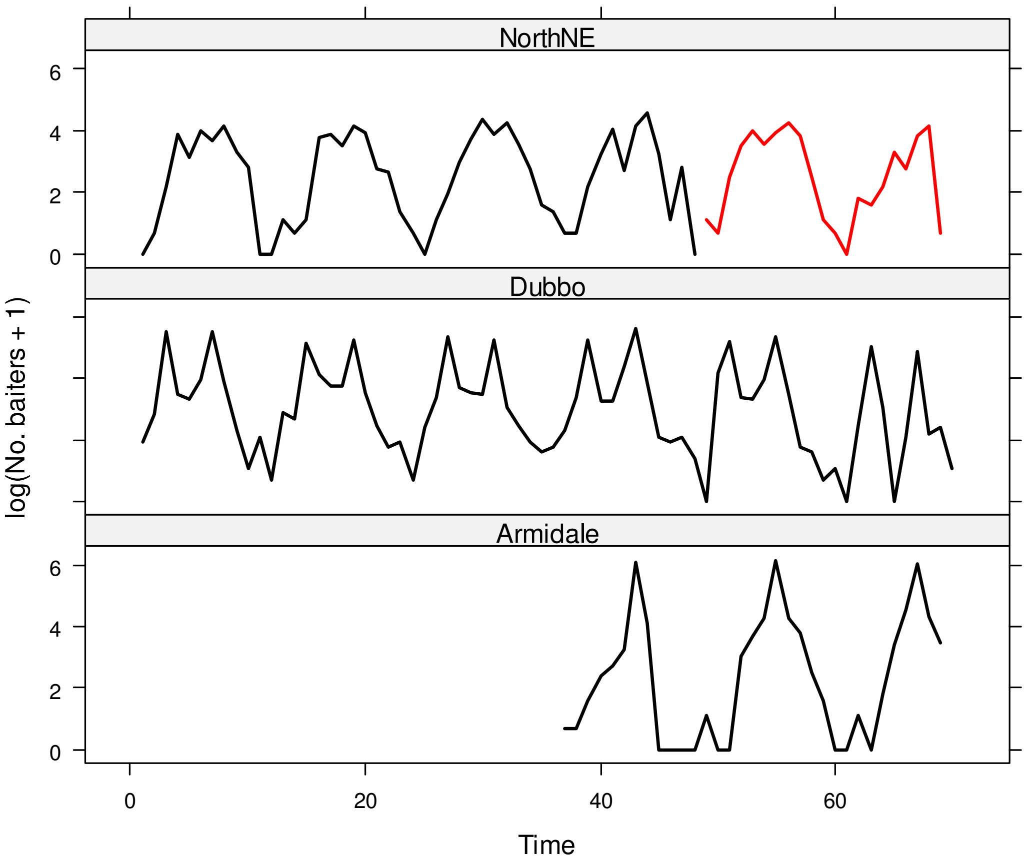


Figure B4.8: Plot of the log (No. baiters + 1) versus time for each site, where time is in months since beginning of 2004. Red corresponds to the data following the declaration of the fox as a pest animal (Month 47 – December 2007).

Figure B4.8 shows the plot of the log (No. baiters + 1) versus time, separately for each site, where time is *Months* since beginning of 2004. This plot indicates that Intervention had no effect on the number of landholders participating in baiting. This conclusion was confirmed by the results of the modelling where no significant ($P < 0.05$) deviations from trend post Intervention was found for the NNE Site.

Group baiting participation varied between the study sites, with Armidale and Dubbo recording the highest participation rates, and NNE the lowest. This result corresponded with the questionnaire data discussed earlier. Group participation at the Dubbo site peaked consistently during March and July of each year, coinciding with the two main lambing periods in this district (Figure B4.9). The patterns of group participation were not as consistent at the other two sites, but also peaked around the main lambing periods (slightly later than those of Dubbo - April/May and August). Figure 4.9 gives the plot of the proportion of landholders baiting in a group versus time. Analysis of this data indicates again that there is no significant ($P < 0.05$) deviations from trend post Intervention at the NNE Site.

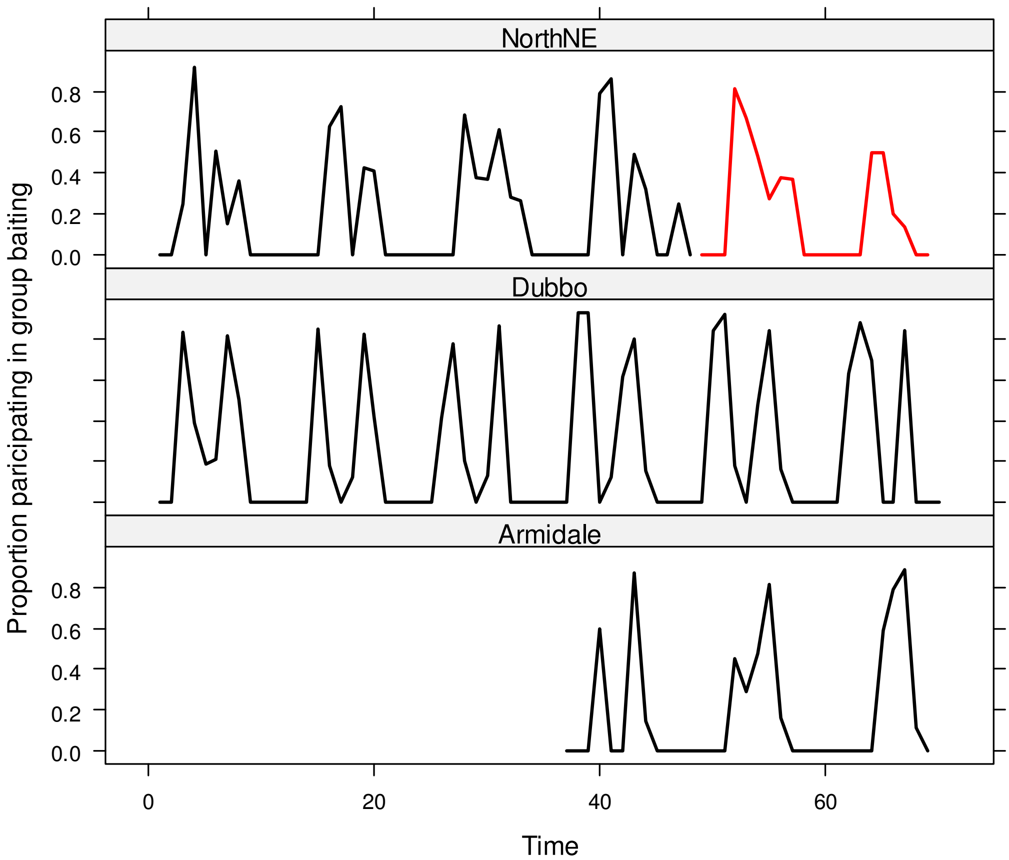


Figure B4.9: Plot of the 'Proportion of landholders participating in group baiting' versus time for each site, where time is in months since beginning of 2004. Red corresponds to the data following the declaration of the fox as a pest animal (Month 47 – December 2007).

The total number of 1080 fox baits laid over the experimental period at each site is show in Figure B4.10. Again the analysis of this data indicates no significant (P > 0.05) deviations from trend post *Intervention* at the NNE *Site*, after adjusting for the other effects in the model.

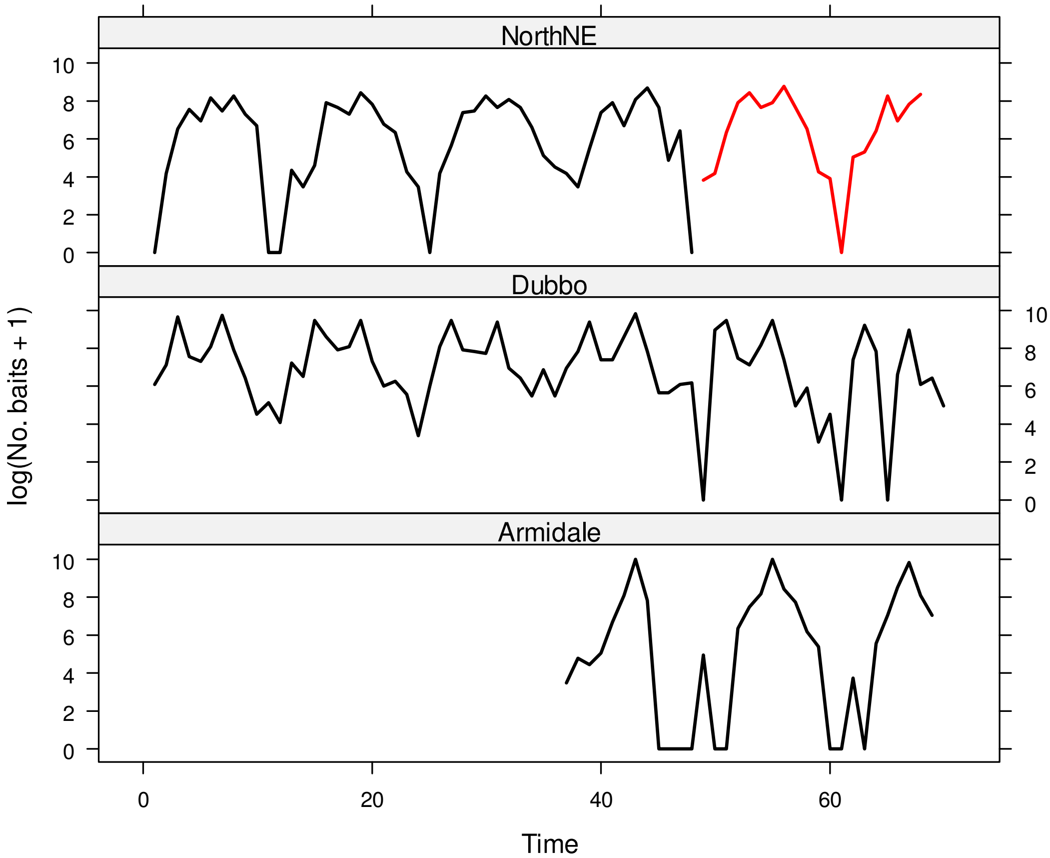


Figure B4.10: Plot of the log (No. baits laid + 1) versus time for each site, where time is in months since beginning of 2004. Red corresponds to the data following the declaration of the fox as a pest animal (Month 47 – December 2007).

4.7 Shooting Data

Information was received from 33 fox shooters from across the Armidale study site (32 rural occupiers and 1 recreational), documenting 115 separate forays between May and August 2009. Thirty of the shooters who were classified as rural occupiers shot at their home location (property), with two shooting on multiple owned properties and one also shooting on the neighbouring property. The remaining two ‘rural’ shooters shot on properties other than that given as their home location. The one recreational shooter shot on two properties owned by different landholders.

The number of forays reported by each shooter ranged from just one through to 15 separate events across the four months of the sampling. All shooters who shot on properties other than their own, regardless of that property’s enterprises, only reported one foray per property. Shooters that shot on their own properties reported a varying number of forays, which seemed to be dependent on the type of enterprise of that property (i.e. if they ran sheep or not) and if other control techniques were also used (of all the properties where shooting occurred, 59% also baited). All the shooters that shot on properties with no sheep reported only one foray. On properties that did ran sheep, those that relied solely on shooting to control foxes reported the most number of forays. There was a significant difference between the number of shooting forays and the use of other fox control techniques (the average number of forays on a property which used shooting as the only form of fox control was 7.7 compared to 2.8 forays on those properties that also used other techniques: F=8.36, df=1, p<0.01). Table B4.6 provides a summary of these details.

Table B4.6: The relationship between the number of shooting forays reported by shooters, the property's enterprises and other fox control techniques used.

Location	Enterprise	Fox Control Techniques	Average No. Forays
Own property	Sheep	Shooting only	7.7
		Other techniques used	2.9
		Unknown	1.5
	No sheep	Shooting only	1
		Other techniques used	1
	Unknown	Shooting only	1
Other property	Sheep	Shooting only	1
	No sheep	Shooting only	1
		Other techniques used	1

Fox shooting was conducted both during the day and at night (43 day, 70 night, 2 both day and night). The time spent shooting ranged between 0.1 to 3 hrs for daytime forays, and 0.2 to 4 hours for night time forays, with a significant difference between the average time spent shooting (1.4 hours for daytime. 2.2 hours at night: F=13.43, df=1, p<0.001). The majority of forays reported taking less than half an hour were cases of opportunistic spotting i.e. the foxes were seen in the course of doing other activities.

There was a significant difference in the number of foxes spotted per hour during day compared to night time (1.0 per hour during the day compared to 2.0 per hour at night: F=10.79, df=1, p<0.001), and the number of foxes shot per hour (0.6 per hour during the day compared to 1.0 per hour at night). There was no difference in the success between day and night (the proportion of foxes shot to those seen was 67% during the day and 59% at night: F=1.25, df=1, p=0.27). Only 66 of the forays provided information on the age of the foxes shot. There was no difference between the ratio of adults and juveniles (<1 year old) shot at night compared to the day (p=0.10, Fisher's Test). Table B4.7 gives the details for these analyses.

The majority of night shooters used a spotlight, with only one using a red filter. Whistles and predator calls were used in 36 of the forays, spread evenly across day and night time. Two shooters reported using dogs to locate foxes during the day.

Table B4.7: Comparison of day and night fox shooting forays

	Day		Night		P value
	n	mean	n	mean	
Time spent (hrs)	43[1]	1.4	70[1]	2.2	$p<0.001$*
Foxes spotted	29[2]	1.0/hr	57[2]	2.0/hr	$p<0.001$*
Foxes shot	29[2]	0.62/hr	57[2]	0.97/hr	$p<0.01$*
Success - foxes shot/spotted	43	67%	70	59%	$p=0.27$
	n	ratio	n	ratio	
Adult / juveniles	28	22/13	38	58/15	$p=0.10$

[1] The 2 forays that were both day and night are not included
[2] Opportunistic sightings (14 day, 10 night) and missing data (3 night) not included
* significant difference at 0.05 level

Unlike the study of McLeod *et al.* (2007) which reported results collected from mainly recreational shooters, this study was biased towards shooters who were primary producers or rural occupiers. Despite this difference, there were many similarities including the number of foxes spotted and shot per hour and the success rate for both day and night forays (Table B4.8). The major difference was in the time spent on each foray. The recreational shooters reported by McLeod *et al.* (2007) spent longer for both day and night forays than their primary producer counterparts. This could be due to the fact that many of the recreational shooters were based in the larger metropolitan areas so tended to travel further to reach their shooting locations, and actually spent longer on each foray compared to those recreational hunters with rural postcodes.

Table B4.8: Comparison of shooting results between this study and that of McLeod et al. (2007).

	This study		McLeod *et al.* 2007	
	Day	Night	Day	Night
Time spent (hrs)	1.4	2.2	3.2	3.9
Foxes spotted (/hr)	1.0	2.0	0.9	1.9
Foxes shot (/hr)	0.6	1.0	0.5	1.0
Success (%)	67	59	63	60

4.8 Lamb Production Data

Lamb production data for the 2007 - 2009 (autumn and winter), as well as historical records were collected from landholders at all study sites. This information was collected using postal questionnaires which were distributed by the rangers at various field days and when baits were collected, commencing in autumn 2007. The responses for 2007 were lower than expected, especially in the Armidale and Dubbo sites, so a more personal approach was trialled at the Dubbo site in 2008 and continuing in 2009. During the autumn months landholders were encouraged to participate, firstly by presentations at group baiting functions, followed by a phone call or email to organise a convenient time to either collect the required data or send out the postal questionnaire. Reminders were also sent out later in the year once lamb marking was completed. The method of distribution of questionnaires to new landholders in 2008 and 2009 at the NNE and Armidale sites remained the same as for 2007. Those landholders that had replied in 2007 at these sites were contacted (by either email or post) at an appropriate time to collect their 2008 and 2009 data.

Lamb production questionnaires were received from 104 producers (4 Armidale, 32 Dubbo and 68 NNE), detailing lambing information from 301 flocks from 2006 to 2009 (10 Armidale, 92 Dubbo and 199 NNE). Forty six of these contained incomplete data, leaving a total of 255 flocks for analysis (10 Armidale, 88 Dubbo and 157 NNE). A further 38 questionnaires were received from landholders who were not lamb producers. An accurate count of the number of questionnaires handed out was not kept, however the response was low for all years across all sites. Armidale was the worst site, where despite over fifty questionnaires being personally handed out, only four were returned.

An analysis of this lamb production data was undertaken using a Generalised Linear Mixed Model, taking as the dependent variable the number of lambs marked (Marked). This response variable is assumed to have a quasi-Poisson distribution, having variance proportional to the number of ewes Joined times the expected number Marked per joining. The log of the expected number Marked per joining is fitted as a linear combination of fixed and random effects. Fixed effects include a linear trend with *Time* with this allowed to differ across *Sites*, with the possibility of smooth deviation about the trend with *Time*, common across *Site* and fitted as a spline. Finally as fixed effects was included a linear deviation from trend post *Intervention* at the NNE Site. Random effects included effects for *Month*, *Year*, *Month* x *Year*, *Site* x *Month*, *Site* x *Year*, *Site* x *Month* x *Year*, *PKey*, *PKey* x *Month* and *Site* x *Year* (with *Month* and *Year* taken as factors with a level for each unique value).

There was no significant ($P > 0.05$) deviation from trend post *Intervention* at the NNE Site, after adjusting for the other effects in the model. Here the deviation from trend with *Time* post *Intervention* was not significant, nor was there a constant *Intervention* effect ignoring a post *Intervention* linear trend. Figure B4.11 shows a trellis-plot of LMP versus *Time* (Months since July 2006) for each site.

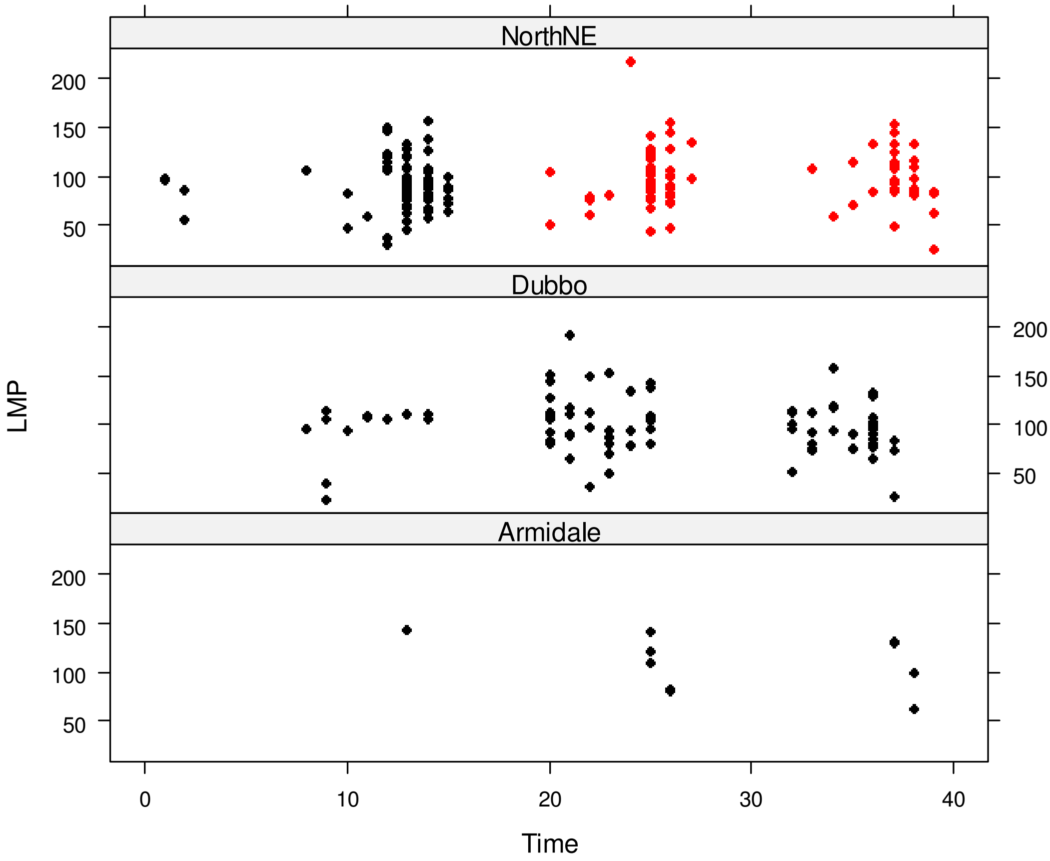


Figure B4.11: A trellis-plot of Lamb marking percentages (LMP) versus Time (Months since July 2006) for each site is given below. Points given in red correspond to observations post Intervention (at NNE site only).

5. DISCUSSION

From our results the introduction of a fox control order (declaration of the fox as a pest species) had no effect on either participation in fox control activities (baiting) or on the resulting lamb production at the NNE site over the first two years of operation. Although a controlled replicated experiment was not feasible for this study, as the Minister only used his powers under Part 11 of the *Rural Lands Protection Act (1998)* to declare a Pest Control Order (PCO) for foxes at one site, the design of this study as an observational study of uncontrolled events (before and after an intervention i.e. the declaration), with both spatial (three different sites) and temporal (six consecutive years) controls was still a valid one (Kuehl 1994, Krebs 1999). Unfortunately the important assumption made that the declaration of the fox as a pest animal would equal mandatory control was not the case. Although the increased education in NNE study site that took place as part of the declaration process increased the awareness of the fox problem, participation rates remained low. The failure of the fox control order to result in any measurable difference in fox impact may be due to the low compliance rates to the legislation rather than a flaw in the legislation itself.

An important aspect of compliance to legislation is enforcement. The deterrence theory of imposing a law or regulation assumes that the regulated entity will choose compliance levels based on factors affecting the cost of compliance and the likelihood that violations will be detected by the enforcement authority (Scholz and Wang 2006). Laws and regulations introduced without effective enforcement mechanisms rely on voluntary compliance, something which is unlikely to occur if there is less benefit in compliance than noncompliance (Rowcliffe *et al.* 2004). Hence compliance by landholders to the fox PCO would be determined by not only the cost of compliance but by their perceptions of any direct benefit and effectiveness of enforcement actions.

The enforcement of the PCOs in NSW is the duty of the LHPA. Rangers have the power to inspect properties and if they find evidence that landholders are not carrying out their obligations (i.e. not conducting suitable control programs against these pests) they can issue a notice under section 169 of the *Rural Lands Protection Act (1998)*. If the landholder still refuses to co-operate, rangers can then issue an eradication order, which can lead to fines and court action for noncompliance. Time and resources are limited, so the LHPA management and rangers tend to use these orders as a last resort, preferring to take a more positive approach and assist landholders develop appropriate pest control programs, particularly group programs, rather than enforce compliance. This 'light-handed' regulatory approach can reduce hostility towards the regulatory authority (Oliver 1980), fostering public goodwill and actually increase participation in some control activities (e.g. Hershdorfer *et al.* 2007).

Punishments or negative incentives are the most effective method for motivating unanimous cooperation, although for maximum effectiveness they need to be consistently enforced (Oliver 1980). On the other hand rewards and positive incentives are found to change people's behaviour more effectively than punishments and negative incentives (Oliver 1980). To induce the collective action that is required for the effective fox management the type of incentive, the patterns of cost and the different context in which they are most efficient need to be considered. Selective positive incentives tend to be most effective for motivating a small number of people, as those who join or contribute to the collective action can be treated differently from those who do not (Oliver 1980). The incentive supplier must be prepared to potentially give the incentive to an entire group, thus care must be taken when selecting the incentive to avoid a cost 'blowout' if large numbers comply. If the cooperation of a large number is required a better choice may be a positive incentive that has a jointness of supply (i.e. the total cost is not dependent on the number of participants, e.g. a raffle). However such incentives have a relatively low value to participants and run the risk of failing to achieve the desired increase the participation levels (Oliver 1980).

The most frequent example of an incentive offered for fox control in Australia is that of a bounty offered to hunters (Hassall and Associates 1998, VIASVPRD 2003, Saunders and McLeod 2007). This type of incentive, which is paid to a third party (hunters) who does not suffer directly from the impact of foxes, has been proven to be both ecologically and socially flawed, and is usually introduced because of political pressures with little evaluation of the pest problem, success criteria or cost effectiveness (Oogjes 1995, Hassall and Associates 1998, VIASVPRD 2003). The supply of baits at either a reduced cost or for free is a more selective and effective incentive that is regularly offered to increase participation in group baiting programs (Boyd 2007, Saunders and McLeod 2007, this report). This type of incentive has proved popular with many stakeholders, however its ability to attract new participants is questionable. An example of a 'jointness of supply' type incentive is the inclusion of participants in a prize draw as trialled by the Armidale site. Other incentive suggestions discussed in the focus groups include LHPA rate subsidies for ratepayers involved in pest control programs, business support incentives and subsidised bait contractors.

Over three quarters of landholders surveyed across the three sites supported a PCO for foxes, although it is possible many did not understand the full implications of such a declaration. A main concern from many stakeholders was the cost, not only for the regulatory authority but for individual landholders as well. To be successful legislation requires adequate funding and resources for administration, enforcement and education (Oliver 1980, Rowcliffe *et al.* 2004, Hershdorfer *et al.* 2007). Thus if a fox PCO were to be introduced in NSW consideration would need to be made for adequate resources and financial support for the LHPA. Adequate funding for landholder programs would also be required as incentives for compliance and participation.

As previously discussed to be effective legislation needs to be consistently enforced. As part of this requirement the legislation must be enforceable, with clearly defined requirements and boundaries. The fox is an elusive, secretive animal that is ubiquitous, highly mobile and not easy to monitor. From an LHPA ranger's perspective it would be difficult to find evidence that landholders are not carrying out their obligations under a PCO. Also foxes are not just a rural problem, with increasing numbers being found in urban and semi-urban areas (Marks and Bloomfield 1999, O'Keeffe and Walton 2001, Olsen *et al.* 2005, Marks and Bloomfield 2006, White *et al.* 2006). The control of these urban foxes is not covered by the PCO, which only focuses on rural lands. These uncontrolled urban populations could provide a continuous source of animals for the rural areas.

As part of the legislative requirement there must be a selection of effective control tools that landholders can use. Poison baiting with 1080 is the most effective and popular fox control method used in Australia (Saunders *et al.* 1995, West & Saunders 2003, Saunders and McLeod 2007) however many landholders dislike using this technique because of its inhumanness (Sharp and Saunders 2005). The results from our questionnaire show that baiting with 1080 was perceived by landholders as the most effective, however this technique is not available to all landholders owing to locality restrictions and the increase in legislative requirements for bait purchase and use.

Fox baiting activities showed a decline at all sites in the last year of this study albeit at different levels. One factor identified as influencing this outcome was the introduction of new chemical regulations across NSW. Under this new legislation 1080 became a restricted chemical thereby limiting its distribution at the point of supply. Landholders wishing to use 1080 fox baits had to possess the appropriate chemical-user accreditation, otherwise they were refused permission. To gain the appropriate chemical user qualifications landholders had to participate in a two-day training course at a personal cost of several hundred dollars. Landholders' frustration over these new requirements are being addressed by the LHPA and an announcement should be made in 2010 (Peter Frizell, Senior Ranger New England LHPA, pers. comm.).

Shooting is the only other widespread fox control techniques available. Although shooting is a popular technique used by many landholders it is not perceived to be as effective and consistent as baiting. It is a humane method when conducted correctly (Sharp and Saunders 2005), but is time consuming and less cost effective than baiting (McLeod *et al.* 2007, Section D). Also there are legislative restrictions on gun ownership and use. Data collected on shooting practices of primary producers in this study was similar to that reported by Saunders *et al.* (1995) and by McLeod *et al.* (2007) on recreational shooters. No difference was found in the ratio of adults and juveniles shot, however there was not enough information to comment on the age bias of this method as reported by Coman (1988).

With the limitations of the two main available fox control techniques, research into new options and the improvement of existing techniques is urgently required, especially if landholders will be forced to comply with the PCO regulations. A bait containing the toxin, para-aminopropiophenone (PAPP), which has a faster, more humane action than 1080, improved target specificity, and an antidote readily available, is currently being developed by the Invasive Animal Cooperative Research Centre, however it is not due to be released for several more years. This new formulation will provide an additional option for landholders but will still suffer from the same supply restrictions as 1080, and will unlikely be of assistance with the urban fox problem.

Aside from the changes in chemical legislation in the last year of this study, another confounding factor was the restructure of the existing RLPB system and the formation of the LHPA organisation. This restructure brought with it new management ideas, job descriptions and priorities. The Armidale fox baiting program seemed least effected by this restructure probably owing to the employment of an external coordinator who could carry on their work with minimal disruption. Participation in the fox control activities (baiting) at the NNE and Dubbo sites which both relied on the rangers to organise and coordinate programs, decreased significantly from previous years. To be successful, group programs require constant promotion and organisation (Boyd 2007, Hershdorfer *et al.* 2007, McLeod *et al.* 2007), a commitment which could not be maintained in the short term with the change in priorities and work loads of the new LHPA rangers.

In recent years there has been a widespread adoption of participatory approaches in decision making and management processes. These approaches encourage ongoing engagement by incorporating the interest and needs of all stakeholders, and to develop economically feasible programs, based on local experiences making them more relevant and therefore sustainable (Kothari 2001, Keogh and Blahna 2006, Reed 2008). These partnerships between stakeholders and government agencies, operating through local networks, can provide an arena for interaction which encourages broader participation, offering increased stakeholder satisfaction (Scholz and Wang 2006) and under the current financial climate, a greater chance to attain funding to assist with operational costs (Bodin and Crona 2009).

Local social networks have been found to effectively increase enforcement and compliance, especially with environmental regulations (Scholz and Wang 2006, Bodin and Crona 2009). Programs organised through existing local networks can increase participation through local knowledge, 'word of mouth' information transfer and peer pressure. However all social networks are not created equal with the structural relationships within these networks having significant impact on participants' behaviour, and hence the effectiveness of the network (Bodin and Crona 2009, Klepeis *et al.* 2009). This problem was highlighted in the focus group discussions on the effectiveness of particular fox control groups. They felt fox groups formed within local networks that shared common interests and a high sense of community were the most effective, and the types of local networks depended on the structure and local politics of a particular area.

The structure of rural Australia has been changing to a more heterogeneous mix of landholders and land uses. There has been a move away from full time commercial ventures, and an increase in 'amenity migrants' (non-economic residents), part-time or absentee landholders who tend have a poor understanding of rural pest problems and different values that lead them to be less concerned, as well as time and financial constraints (Bunker and Houston 2003, Burnley and Murphy 2003, Argent *et al.* 2007). This new rural structure has led to a reduced capacity to coordinate regional-scale responses to pest problems as these strategies assume landholders are commercial operators with skills, motivation and equipment to implement the appropriate control measures (Klepeis *et al.* 2009).

Education has a key role in fox management programs and should be targeted at all levels of the public. These education programs should not be limited to the operational procedures (the 'how') of fox control but should have an emphasis on the 'why' as well. Increasing public awareness of the detrimental effects of fox impacts can ultimately influence attitudinal changes and policy, increasing pressure on land managers and policy makers to shift priorities and take action (Schneider and Ingram 1990, Hershdorfer *et al.* 2007). Education should be viewed as a long term commitment with the aim of changing attitudes towards fox management and thus reducing the need for incentives to motivate collective fox management programs (Oliver 1980).

Fox control programs at all three sites were based on best practice fox management as recommended by NSW I&I and BRS (Saunders and McLeod 2007). Best practice fox management addresses issues related to choice of techniques, frequency and spatial coverage of programs and operational aspects such as bait delivery and equipment choice. All sites promoted and encouraged group programs, aiming to maximise the area covered at any one time, with different levels of success (70-80% of landholders who baited were involved in group programs in the Dubbo and Armidale sites, with 40-50% at the NNE site). Increasing the frequency of control activities of landholders to at least twice a year was more difficult with only 30-40% of landholders baiting twice a year at the Dubbo and NNE sites and less than 20% at the Armidale site, although these figure may be higher if shooting forays could be taken into account. Results from both the landholder and shooter questionnaires suggest around 50% of properties tend to conduct both baiting and shooting programs in the same year.

In summary:

- Our results indicated that the introduction of a fox pest control order (PCO) had no impact on either participation in fox control activities or on lamb production during the first two years of its operation.
- The failure of this PCO to bring about any measurable difference in fox impact is thought to be due to the low compliance rates to the new legislation.
- To be successful a change in legislation would require that the regulatory body (LHPA) receives adequate funding and resources for administration, enforcement and education.
- Obstructions to successful implementation and enforcement of this legislation include: cost; education of the changing rural population structure; availability of an adequate selection of effective control options; other legislative restrictions on current control options; and the increasing presence of urban and semi-urban fox populations.
- Partnerships between stakeholders and government agencies, guiding operations through local social networks can be an effective alternative to locally promote best practice fox management.
- Education has a key role in fox management programs and should be targeted at all levels. Increasing public awareness of the detrimental effects of fox impacts can ultimately influence attitudinal changes, and shift priorities and actions.
- Positive incentives such as bait and rate subsidies to landholders may be more effective than a heavy-handed regulatory approach to improve stakeholder cooperation and participation.

We recommend that future work should address the following issues to further improve fox management programs in Australia.

- Positive incentives – what are the most appropriate and effective incentives to encourage all stakeholders to participate in pest management programs?
- The development of social rural networks and how their use can be optimised for pest management programs.
- A further investigation of enforceable regulations to promote effective pest control, and the use of external coordinators to manage pest programs.

PART C: BIOECONOMICS OF FOX MANAGEMENT

1. Introduction

It has been challenging to conduct accurate cost- benefit analyses of fox management programs (Saunders *et al.* 2010). The collection of reliable economic estimates of damage caused by this pest has been hampered by the lack of monitoring of the outcomes from management programs, for either the pest or the resource(s) being protected (Reddiex and Forsyth 2006). This is further impeded by the difficulties in quantifying the benefits, particularly environmental ones, of fox management in the same units (i.e. dollars) as the costs. Thus economic analysis of fox control programs has usually been restricted to measuring the cost-effectiveness of these activities (i.e. the cost to achieve some pre-determined threshold) (e.g. Hone 2004, McLeod *et al*. 2004, Moberly *et al*. 2004, Gentle 2005, McLeod *et al.* 2007).

The economic study of Jones *et al.* (2005) was the first attempt to evaluate a large scale fox baiting program ('Outfox the Fox'), using economic surplus and benefit–cost analysis. The main beneficiary of the program was identified as the lamb industry (it was assumed that lamb production would increase between one and five percent as a result of the fox control program). The change in annual economic surplus due to this program was calculated to be $3.4 million. The benefit–cost analysis showed that the project provided a significant return on public investment with a mean net present value of $9.8 million and a mean benefit–cost ratio of 13:1. Probability analysis indicated there was a very low probability that this group fox control program would provide a negative economic return.

Environmental impacts of foxes are far more difficult to value than agricultural losses. What is a realistic value for wildlife? Pimentel *et al.* (2002) valued wild birds by incorporating generated income from bird watching and hunting, and the costs of species recovery programs and regulatory activities. McLeod (2004) calculated a total number of native birds eaten annually by foxes based on assumptions of density estimates, dietary studies and energy requirements, then allocated an estimated worth of $1 per bird to arrive at a total value for fox impact of $190 million.

Calculating the costs of fox control activities are more straightforward. Obtaining cost estimates for the labour and resources used is reasonably easy to achieve. Most gross cost estimates are based on 1080 baiting, as this is the most popular control technique (West and Saunders 2003, Saunders and McLeod 2007), and the easiest information to collect. Examples include Bomford and Hart (2002), McLeod (2004), Reddiex *et al*. (2006), Gong *et al.* (2009) and Saunders *et al.* (2010). Saunders and McLeod (2007) published a cost structure for determining the cost of an agricultural 1080 ground baiting program using various strategies of bait checking and replacement with a typical program (with baits checked and replaced twice) costing approximately $20 per square kilometre.

An alternative is to compare the cost effectiveness of a different range of strategies, so management decisions may be made on the basis of whether a particular strategy, or combination, would satisfy the management objective. In Australia, such cost effectiveness analyses has been conducted on baiting operations. McLeod *et al.* (2004) examined the cost effectiveness of different combinations of sterilisation and lethal baiting campaigns. Gentle (2005) used cost effectiveness analysis to compare different 1080 baiting strategies on the basis of longevity, palatability, and the handling/ replacement costs associated with three different bait types. Both these studies compared the effectiveness of a range of bait delivery decisions (such as when to bait, bait type, frequency and density of distribution).

McLeod *et al*. (2007) investigated the cost of shooting as a control technique. This study conducted a survey of recreational shooters, using the resulting data collected on time spent by shooters on each forays, along with vehicle and equipment costs to estimate a cost of $40 per fox killed by this technique. Analysis of programs that hired professional shooters resulted in values ranging from $70-$80 per fox killed. This study attempted to compare the cost effectiveness of shooting with that of 1080 baiting, using the cost per fox killed as the measurable outcome. Using assumptions from the literature on the efficiency of 1080 baiting programs and fox density, the cost of a typical 1080 baiting program was estimated to around $5.00 per fox killed. Only in cases where baiting efficiency dropped to below 10% (i.e. less than one in ten foxes killed) would shooting become more cost effective.

As lamb turnoff rate (number of lambs surviving until weaning) is the major profit driver for lambing enterprises (Fogarty *et al.* 2006), the effectiveness of a fox control program can be measured by the total number of lambs weaned. Gross margins are commonly used to compare similar resourced enterprises and estimate the profitability of particular management operations undertaken in different enterprises. A ‘gross margin’ is the gross income from a particular enterprise less the variable costs incurred in achieving the particular enterprise (NSW Industry and Investment 2007). Using their data on lamb production increases McLeod *et al.* (2007) were able to model the outcome of different baiting strategies. The strategy with the largest increase in lamb weaning was two baiting programs six months apart along with at least one neighbour baiting program. Following this strategy, a producer with a typical crossbred ewe enterprise (joined to terminal rams) was calculated to return a gross margin of $16.00 per ewe, for the outlay of the two baiting programs and some neighbourly cooperation.

Effective fox management decisions require understanding of the impact of control programs on fox damage and fox population dynamics (Hone 1994). The construction of dynamic models allows for the examination of complex relationships that could not otherwise be done using purely experimental methods. However the construction of successful models is constrained by the quality of the available data that has been measured to either estimate the parameters used in the models formulation, or to validate its predictions (Ellner and Guckenheimer 2006).

In their work to examine the efficacy of immunocontraceptive agents as an alternative method of control for fox populations McLeod *et al.* (2004) developed a fox population model to simulate the dynamics of an age and sex structured fox population. To construct this model, the authors used fox population data collected from both Australian and overseas literature. The data used for the lethal control effects had to be confined to 1080 poisoning due to the unavailability of shooting data in the literature. The authors identified this paucity of shooting data as a weakness which they felt needed to be addressed in future research.

The shooting and baiting data collected for this project and a previous BRS funded project (McLeod *et al.* 2007) offered an opportunity to strengthen the fox population model developed by McLeod *et al*. (2004), and hence to assist in identifying the optimal combination of control measures to maximise benefits and effectiveness whilst minimising costs.

2. Objectives

- Further improve our understanding of fox population dynamics associated with regional control programs.
- Further improve our understanding of the costs and payoffs associated with regional fox control programs.

3. Methods

The data collected from this project was insufficient to allow any cost benefit analyses or the re-evaluation of the stochastic economic surplus and benefit-cost models developed by Jones *et al.* (2005). However the additional data collected, particularly the shooting data was used to strengthen the gross margins and cost effectiveness calculations of McLeod *et al.* (2007). This data in turn could then be added to the model developed by McLeod *et al*. (2004) to compare the costs and payoffs (in terms of reduced population size) of regional shooting and baiting programs.

3.1 Cost Calculations

Calculating the cost of both baiting and shooting programs involves estimating the costs of the labour used as well as vehicle and equipment costs. The minimum labour wage paid over this time was $14.31 per hour (source from the Australian federal Government Fairpay website: http://www.fairpay.gov.au).

Vehicle operating costs were based on figures collected from the NRMA web site (NRMA 2010). This site had calculated the whole of life (WOL) operating costs for a range of vehicles, which included capital (including depreciation and interest), standing (registration and insurance), and running costs (fuel and maintenance). A typical 4WD vehicle as used by shooters and farmers ranged from $0.90 to $1.30 per kilometre (average $1.20). Farmers and shooters were assumed to own their vehicles for private use other than just fox control activities so it was decided not to include the capital costs for this study. Capital costs made up around 50% of the WOL cost, so if excluded, running and standing costs averaged $0.60 per kilometre

Saunders and McLeod (2007) published a cost structure for determining the cost of a 1080 ground baiting program using various strategies of bait checking and replacement on an average 2000 hectare property on the tablelands in NSW. A typical program with baits checked and replaced twice was costed at $373.70 in total.
The cost of shooting was calculated followed the method used by McLeod *et al.* (2007) by estimating labour, vehicle and equipment costs. Labour and vehicle operating costs were similar to the ones already calculated for baiting programs. The only equipment to be included was the cost of bullets. Capital cost of equipment such as a rifle, scope and spotlight were not considered. Most fox shooters use a .222 or

.223 calibre bullet which cost on average $1.25 per bullet. From the success data collected from the shooter questionnaire it was calculated the just over half of the number of foxes spotted were shot. Fleming (1997) also reported a similar figure, although notes that not all foxes that are spotted are within range for shooting. Since distance of spotted foxes was not collected it is assumed that all spotted foxes reported in the questionnaire were within range. Therefore if it is assumed one bullet is fired at every fox spotted, two bullets are needed for every fox killed.

Other required shooting data was collected from shooters who participated in the survey described in Part B. Information collected included the time spent shooting and the number of foxes spotted and killed. As no data was collected on the number of people involved and the number of kilometres travelled, these were estimated using the shooting data from McLeod *et al.* (2007). Data on the efficiency of shooting was estimated from the Milton case study described in McLeod *et al.* (2007). Data on the cost and efficiency of baiting programs was collected from the literature for comparison with the shooting data.

3.2 Cost Effectiveness Comparisons

There are no reliable methods for detecting thresholds that could be used to trigger a control campaign for foxes, therefore control strategies rely on regular campaigns that are targeted when livestock is vulnerable, not on the status of current fox abundance. Thus for this cost effectiveness analysis a range of current baiting and shooting scenarios were compared to determine their effect on i) fox density, ii) payoff in terms of reducing density, iii) the accrued cost of control (measured as present value) and iv) the cost-effectiveness of alternative combinations (measured by the payoff/cost ratio). To achieve this analysis the relationship between the cost per fox controlled (by either method) and the density (population size) of foxes needed to be developed, then incorporated into the population model of McLeod *et al.* (2004).

3.3 Gross Margins

Industry and Investment NSW has developed a range of typical Merino and first cross enterprise gross margins based on a theoretical flock of 1000 ewes or wethers. Included in these figures are sensitivity tables which can be used to determine the effect of weaning percentage on gross margins (NSW Industry and Investment 2008a and b).

4. Results

4.1 Cost Calculations

The new labour and vehicle running costs as detailed in section 3.1 above were incorporated into the cost structure formulation of Saunders and McLeod (2007) for baiting programs (Table C4.1). The total cost of a ground baiting program on an average 2000 hectare property on the tablelands in NSW, with baits checked and replaced twice was calculated to be $426.08. Table DC.2 tabulates the results from the cost calculations for the average day and night shooting foray for this study. The average cost per fox is calculated to be around $27.00 to $29.00.

Table C4.1: Costs of ground baiting (after Saunders and McLeod (2007)).

Item	No. of units	Unit Price	Cost	Total Cost
Initially laying 60 baits	8h labour	@14.31/h	$114.48	
Initial vehicle use	33km	@$0.66/km	$19.80	
				$134.28
Baits	81 baits	@$1.10/bait	$89.10	
Warning signs	10 signs	@$2.00/sign	$20.00	
				$109.10
Check & replace baits	5h labour	@14.31/h	$71.55	
Vehicle use	33km	@$0.66/km	$19.80	
				$91.35

Table C4.2: Results collected from shooters who responded to questionnaire (Part B) and calculated costs of their fox shooting.

Cost	Averages from questionnaire	Day Shoot	Night Shoot
Labour	No. people	1.5[1]	2.2[1]
	Time spent shooting (hours)	1.4	2.2
	Cost @$14.31 per hour	$20.03	$31.48
Vehicle	Distance travelled (km)	5.2[1]	40.0[1]
	Cost @ $0.60 per km	$3.12	$24.00
Equipment	Time spent shooting (hours)	1.4	2.2
	No. bullets used per hour	1.0	2.0
	Cost @ $1.25 per bullet	$1.75	$5.50
Total	Total cost per foray	$24.90 (0.9 foxes)	$60.98 (2.1 foxes)
	Total cost per fox	$27.67	$29.04

[1]Source: McLeod *et al.* (2007)

4.2 Cost Effectiveness Comparisons

As already calculated a 1080 ground baiting program (with baits checked and replaced twice) on a typical 2000 hectare property on the tablelands in NSW was costed at $426.08 ($21.30 per square kilometre). The average density of foxes in these areas averages five foxes per square kilometre (Saunders and McLeod 2007). The reduction of fox populations to typical ground baiting programs in NSW have been reported by four studies (Table DC.3), ranging from 50 to 97% with an average around 77%. The cost calculation using a range of efficiency values are given in Table C4.4. The cost per fox killed increases with a reduction in efficiency. Using the range of efficiencies reported in the literature, the cost per fox ranges between $4.39 and $8.52, well below the cost associated with shooting. The efficiency of a baiting program would have to drop to below 15% for the cost per fox to be equal to that calculated for shooters.

Table C4.3: Effectiveness of fox baiting programs reported from NSW studies.

Bait density (per km^2)	Initial fox density (per km^2)	Population reduction (%)	Location	Reference
12	7.2	70	tablelands – farmland	Thompson and Fleming 1994
1.7 -3.1*	0.05–0.2*	91	tablelands – forest	Fleming 1996 * pers. comm.
4.4	1.3–1.9	50	tablelands – farmland	Fleming 1997
0.14	?	97	coastal area	Dexter and Meek 1998

Table C4.4: Cost calculations for fox baiting programs at different reduction efficiencies (Cost of laying baits is $21.30 per square kilometre, fox density set at five individuals per square kilometre).

Efficiency	Foxes killed/km^2	Cost per fox
97%	4.85	$4.39
77%	3.85	$5.53
50%	2.5	$8.52
15%	0.75	$28.40

To develop the relationship between the cost of fox control and the population size information was required for control campaigns that had some measure of the fox population density, as well as data on the number of foxes removed, and the effort required so the above cost structure could be applied. For shooting, this data was available from the Milton case study (a sustained and systematic program conducted by a professional shooter over several weeks) described in McLeod *et al.* (2007). Index counts of the fox population were taken before and after each shooting program (two separate areas for five consecutive years), and the number of individuals removed was known, allowing for an estimation of the population size using the Index-manipulation-index formula of Caughley (1977). The results are shown in Figure C4.1. The best fit between cost per fox and population size was determined by Akaike's information criterion as the equation $y= 2709x^{-0.6787}$, with the cost increasing as the population size declined. The average efficiency of a shooting program (60%) was also estimated from this data (no. killed / total population x100).

Obtaining similar information for baiting proved more difficult as most baiting studies in the literature could not give an accurate figure for the number of individuals removed during any given program. Limited data were obtained from the studies of Thompson and Fleming (1994) and Saunders *et al.* (1997) where the number of foxes removed was estimated by the method detailed in Thompson and Fleming (1994), then the population size estimated using the Index-manipulation-index formula of Caughley (1977). Although a slight trend was evident, there was no significant relationship found (Figure C4.2), so the average cost per fox of $28.73 was used instead. The average efficiency of a baiting program used was 70% (see table C4.3).

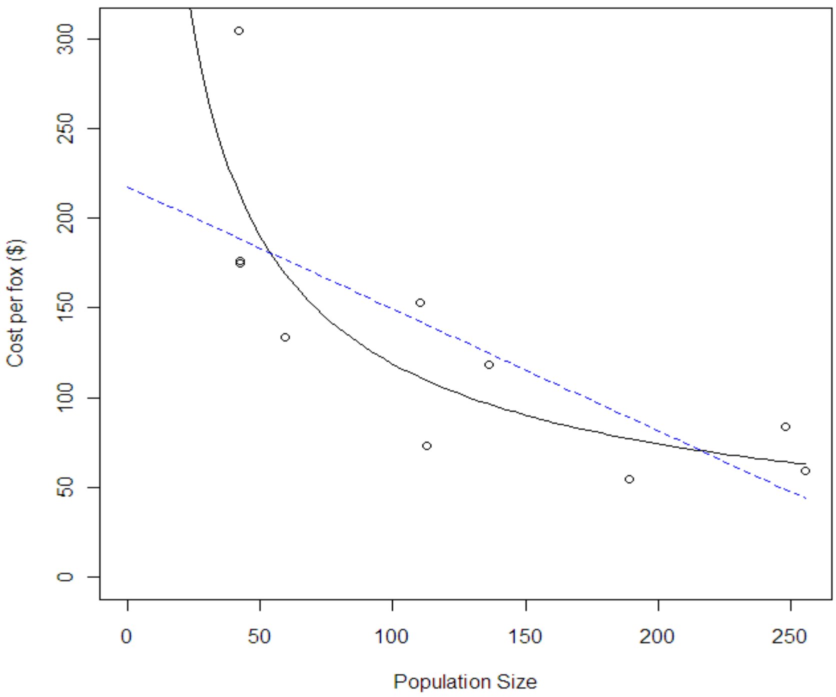


Figure C4.1: The cost per fox removed by shooting vs the fox population size. See text for detail. Data from McLeod et al. (2007).

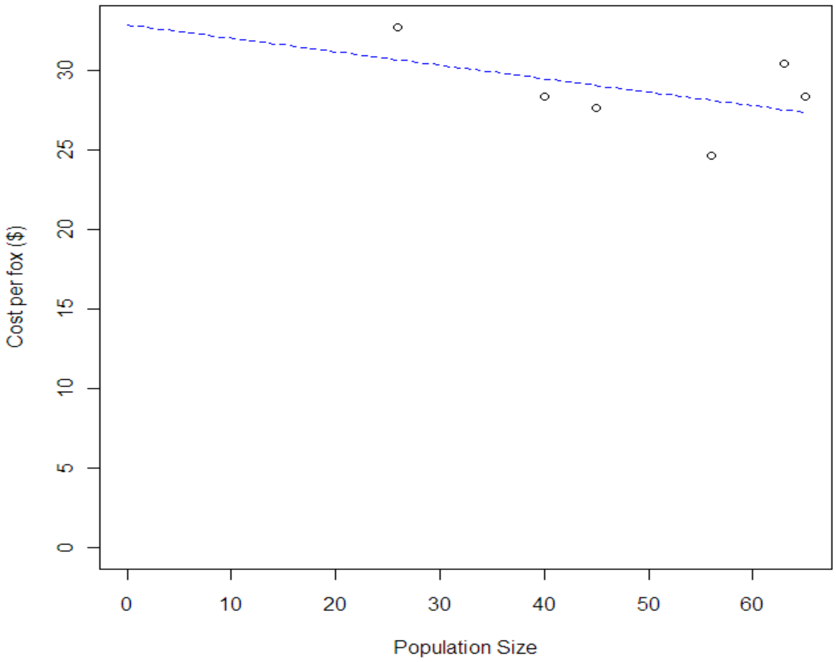


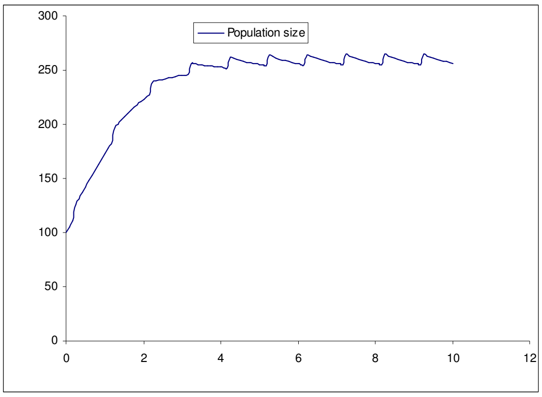
Figure C4.2: The cost per fox removed by baiting vs the fox population size. See text for detail. Data from Thompson and Fleming (1994) and Saunders et al. (2007).

For the cost-effectiveness comparisons six typical scenarios that were common practice at the study sites were used for the comparison; i) no control ii) baiting only in July, iii) shooting only in July, iv) baiting in March and July, v) baiting in March and shooting in July, and vi) baiting and shooting both in July. The results of the model are presented in four parts. Firstly the effect on fox density with the initial population of foxes set at 100 and the carrying capacity limited at 250; secondly the payoff in terms of reduced fox density (i.e payoff = 1- ($n_2 - n_1$) where n_1 is the unmanaged fox population and n_2 is the managed fox population); thirdly the accrued cost of control (over 10 years) which is measured as present value, incorporating a 2% inflation rate; and lastly the cost-effectiveness of alternative combinations measured by the payoff/cost ratio.

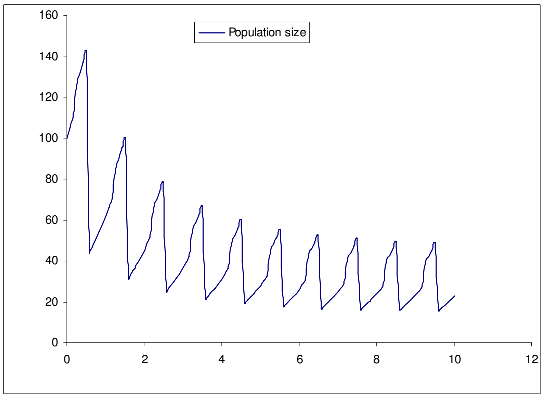
If no fox control is undertaken, the initial fox population increases until it reaches the carry capacity where it remains showing small fluctuations due to the normal breeding cycle of this animal (Figure C4.3i). All the other scenarios tested caused a decline in the fox population to various degrees with the lowest populations occurring when multiple programs / techniques were conducted each year (Figure C4.3ii – vi). Although many of these scenarios showed a similar decline in fox populations, a major difference can be seen between the payoffs, accrued costs and effectiveness of each of the six scenarios (Table C4.5), with those scenarios involving shooting costing more than baiting, and those using multiple programs per year actually costly less over time as fox populations decline to a lower level. The most cost effective scenario is baiting twice a year, once in autumn and once in winter. The least cost effective scenario tested was shooting once a year in winter.

Table C4.5: Payoff, accrued cost of control and cost effectiveness (payoff/cost ratio) of six typical fox control scenarios.

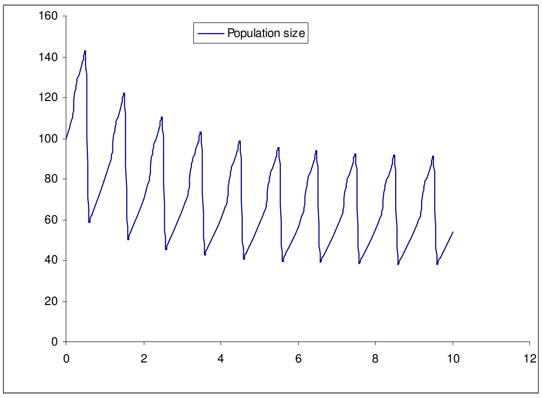
Scenario	Average Payoff	Accrued Cost of Control ($)	Cost effectiveness ($x10^{-5}$)
i) no control	0	0	-
ii) Jul baiting	0.80	16,272	4.9
iii) Jul shooting	0.68	80,876	0.8
iv) Mar & Jul baiting	0.92	10,092	9.2
v) Mar bait, Jul shoot	0.91	56,032	1.6
vi) Jul bait & shoot	0.90	44,699	2.0



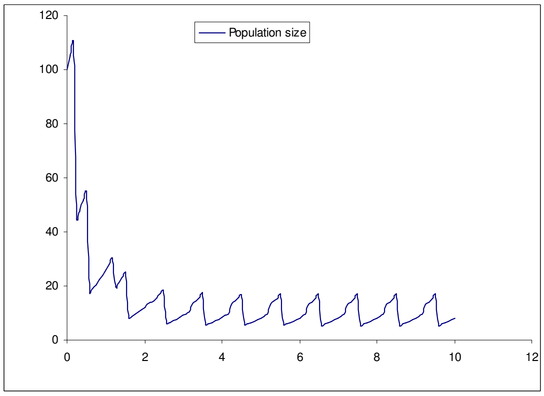
i) no fox control



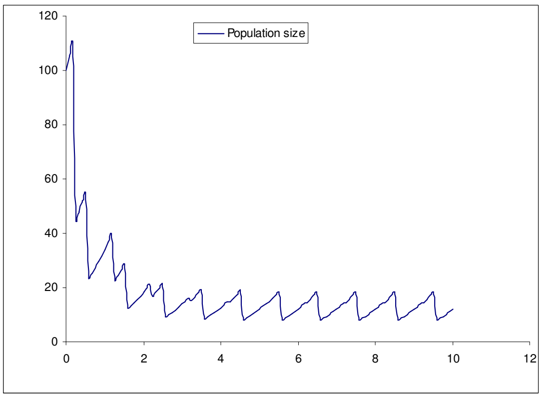
ii) baiting only in July



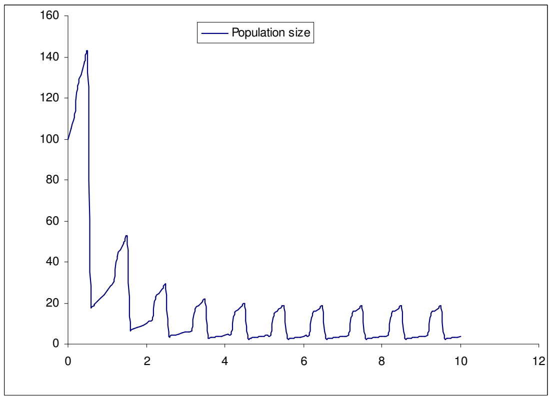
iii) shooting only in July



iv) baiting in March and July



v) baiting in March and shooting in July



vi) baiting and shooting both in July

Figure C4.3: The effect of the indicated fox control scenario on fox density (y axis) over a period of ten years (x axis), starting with a population of 100 foxes. For model details see text.

4.3 Gross Margins

Table C4.6 gives the corresponding increase in gross margins for various increases in lamb marking percentages (LMP) using data calculated by NSW Industry and Investment. Because only LMPs were collected it was assumed that the weaning percentage (WP) was three percent lower than the LMP (NSW Industry and Investment 2008a and b).

Table C4.6: Increases in gross margins (GM) per dry sheep equivalents (DSE) and per ewe associated with corresponding increases in lamb marking percentages (LMP) and weaning percentages (WP).

Breed	LMP	WP	GM/DSE[2]	GM/ewe
Crossbred[1]	99	96	$22.01	$57.23
	123	120	$29.40	$76.44
	147	144	$36.80	$95.68
Merino[1]	73	70	$23.81	$57.14
	91	87	$28.34	$68.02
	107	104	$32.85	$78.84

[1]DSE ratings: crossbred ewe - 2.6 DSE/ewe and merino ewe - 2.4 DSE/ewe.
[2]Sources NSW Industry and Investment (2008a and b), average crossbred lamb price $91.00 per head and merino lamb price $62.00 per head.

These results in table C4.6 show that for a crossbred ewe enterprise (joined to terminal rams) an increase in LMP of 24% returns an increase in gross margin of approximately $19.00 per ewe, and for a merino enterprise (where the wether lambs are sold as trade lambs and the ewe lambs are kept for breeding) an increase in LMP of 16-19% returns an increase in gross margins of approximately $10.85 per ewe.

5. Discussion

5.1 Cost Effectiveness Comparison

The cost per fox killed calculated from the shooting data collected in this study was approximately $28.00. This figure is less than the $40.00 reported by the study of McLeod *et al.* (2007), which was biased towards recreational shooters. All but one shooter in this study were primary producers or rural occupiers. There were many similarities in the data collected from the two classes of shooters, including the number of foxes spotted and shot per hour and the success rate for both day and night forays (see Table B4.8). The major difference was in the time spent on each foray, with the recreational shooters spending around twice as long for both day and night forays than their primary producer counterparts which added towards the cost.

Despite the difference in shooting cost per fox killed between recreational and primary producers / rural occupiers, the amount was still higher than for 1080 baiting, worked out between $4.39 and $8.52 a fox. Supporters of recreational shooting may claim that since their fox control activities are performed by volunteers, the labour cost component should not be incorporated in the any calculations of cost. Simply this would reduce the cost per fox down to a range of $5 to $14, closer to that of baiting. However this simplification does not allow for the incorporation of the factor of ‘time’ in the comparison between the two methods, an important difference which needs to be taken into consideration for any analysis to be valid.

The cost effectiveness of 1080 baiting is largely dependent on the efficiency of this technique to achieve population reductions. Efficiencies of 1080 programs reported in the literature range between 50 to 95%, with and average around 70%. According to our results the efficiency of a baiting program would have to drop to below 15% for the cost per fox to be equal to that calculated for primary producers / rural occupier shooters, and below 10% to be equal for recreational shooters (McLeod *et al.* 2007).

From the most typical fox control scenarios used by producers in the study sites, baiting twice a year, once in autumn and again in winter proved the most cost effective strategy, with any inclusion of shooting increasing the cost, and hence lowering the cost effectiveness significantly. It must be remembered however that our cost effective calculations for shooting were derived from data collected from a professional shooter conducting a sustained and systematic control program. This would significantly add to the cost per fox of our calculations ($75 per fox as opposed to the $40 or $28 reported above for recreational shooters or primary producers), but also is likely to increase the effectiveness (60%) as opposed to that of the adhoc and limited forays reported by most recreational shooters and primary producers.

Although generally not as cost effective as 1080 baiting in terms of the cost per fox killed, shooting is an important fox management tool, and there would be some circumstances when shooting is the more effective method. Each method has its weakness and strengths (see Table C5.1). No one fox control method is one hundred percent effective, so shooting provides a viable alternative in areas where foxes will not succumb to baiting. It can be a successful alternative in areas where 1080 baiting is not feasible, or where baiting may not be preferred option. The two cases studies described by McLeod *et al.* (2007) offer evidence that group shooting programs can be just as successful as group baiting programs. The key to success, as for baiting programs, involves incorporating as large an area as possible and conducting regular (twice a year), systematic control programs to maximise the effectiveness.

Table C5.1: The advantages and disadvantages of 1080 baiting and shooting (after McLeod et al. 2007).

	1080 Baiting	Shooting
Advantages	Large areas covered quickly	Target specific
	Relative inexpensive	Humane
	Not labour intensive	Cover areas where baiting restricted
Disadvantages	Non target risk	Labour intensive
	Humaneness	Relatively costly
	Public perceptions	Targets naïve animals
	Need for notification	Public perceptions
	Bait aversion / shyness	Rogue shooters
	Restricted use	Damage to property
	Disruption to dog use	Public liability / risk

5.2 Gross Margins

Although gross margins are useful for evaluating different management options for an enterprise, it must be remembered they do not represent straight profit as many fixed costs are not included. McLeod *et al*. (2007) calculated the gross margin outcomes of several different baiting strategies with the most efficient one (two baiting programs and some neighbourly cooperation increasing lambing percentages by 20%) producing a gross margin for a producer with a typical crossbred ewe enterprise (joined to terminal rams) of $16.00 per ewe. If this same strategy was followed with data collected from this study, a producer could return a gross margin of $19.00 per ewe.

The predation rate on otherwise viable lambs is subject to controversy with some studies suggesting predation is of only minor significance (e.g. Rowley 1970, Holst *et* *al*. 2002, Greentree *et al*. 2000), while other studies suggesting up to 30% of lambs can be affected (Lugton 1993). In large scale surveys Linton (2002) found that sheep producers with low lamb marking percentages (50-80%) could achieve gains of up to 35% after participating in group fox control programs, and McLeod *et al.* (2007) reported potential gains up to 20% with neighbour cooperation and an increase in baiting frequency (to at least two programs per year). These results suggest that the impact of fox predation in any one area or even on an individual property is quite variable and can be dependent on many factors including sheep flock health, environmental and even individual fox behaviour (Rowley 1970, Holst *et al.* 2002, Saunders and McLeod 2007). Producers need to take their personal instances into account and should apply these gross margins carefully when deciding lamb management options, however there is the potential to improve profits considerably by conducting fox management programs.

In summary:

- Producers have the potential to improve production and profits significantly by conducting strategic fox management programs.
- Our results indicate that currently 1080 baiting is the most cost effective fox control method for rural producers.
- Shooting, although not as cost effective as 1080 baiting, still has a role in fox management as an alternative when baiting is not feasible, or bait-shy foxes are present.

We recommend that future work should address the following issues to allow for more definitive cost- benefit analyses to further improve fox management programs in Australia.

- Accurate estimates of the fox densities and / or the validation of current indexing techniques.
- Accurate estimates of the number of foxes killed during control programs, particularly 1080 baiting programs.
- Improved understanding of the benefits of fox control and the determination of a damage / density relationship for both agricultural and conservation landscapes.

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APPENDICIES

Appendix 1: Steering committee minutes

Appendix 2: Focus group notes

Appendix 1: Steering committee minutes

Fox Demonstration Project - Steering Committee Meeting Minutes

10am 28th January, 2008
Northern New England LHPA Office
1 Greenaway Street, Glen Innes

Present: Kylie Falconer – Glenrac, Stuart Boyd-Law – NPWS, Bob Davidson – New England LHPA, Peter Frizell - New England LHPA, Rob Munro – New England LHPA, Bec Ballard – Southern New England Landcare, Graham Moore – Wellingrove landholder, Phil Gardiner – NSW DPI, Lynette McLeod – NSW DPI

Apologies: Jim Coleman – Ben Lomond landholder, Melissa McLeod – New England LHPA, Tim Seears - State Management Council

Lynette gave a brief presentation to summarise 2008 results. Main points:

- APAMP funding had been secured for further 12 months funding
- Bait data collection relatively smooth for 2008
- More effort required in collecting lamb production data particularly Armidale
- Shooting data collection required
- Need cadastre data from the LHPA's to complete mapping

With the 2009 funding, there is money available for technical assistance and baits. One of the main concerns is the new regulations for chemical use in NSW. All landholders that use 1080 fox baits will require a current AQF3 qualification. Rangers concerned this will reduce the number of land holders participating in group baiting. It was decided to use some of the technical assistance money to subsidise landholder chemical training. Peter / Bec to get back to Lynette with details.

The 2009 programs are expected to run in a similar fashion to the 2008 programs. In 2008 'Armidale' had 32 groups that baited from the end of June through to beginning of August. Each group has an organiser, who faxes bait orders to Bec. She organises drop off days (some become mini field days) with the LHPA rangers. Small number of groups bait twice. Baits are cheaper if bait in a group. National Parks and Shire provide baits 50/50 to landholders adjoining. In 2009 it is hoped to collect shooting data and will offer a prize to landholders who provide data. Lamb production data questionnaire to be distributed with newsletter.

In 2008 'NNE' majority of groups bait in July/August. Three groups bait twice a year – firstly in March / April then winter. Large Dog baiting program in April. In 2008 there was an increase in the number of groups baiting. Data collection questionnaires to advertised in newsletter.

Other Business: Automatic fox bait machine – Stuart and Phil to investigate options and check out current legislation.

Meeting concluded 11am.

Appendix 2: Focus group notes

Fox Demonstration Project
Focus group - Should foxes be declared?

Ben Lomond 26/11/09

Present: Bob Davidson (NE LHPA Ranger), Perry Floyd (NE LHPA Ranger), Bruce Floyd (NE LHPA Ranger), Robyn Jackson (NE LHPA Director), Brian Tomlin (NE LHPA Director), Phil Frizell (NE LHPA Senior Ranger), Bec Ballard (SNELC), Ken Pines (NPWS), Phil Gardner (I&I NSW), Shirley Handy, Jim Coleman, John & Dorothy Every, Roger White, Bob Williamson, Grant Ryan, Richard Mason, Jess Richards (I&I NSW), Lynette McLeod (I&I NSW).

Apologies: Jim Swales (NE LHPA Director), Annabel Sides (NE LHPA Director) Elizabeth Kerry (Landcare), Kylie Falconer (GLENRAC), Guy Ballard (I&I NSW).

Pros:
Legal mechanism to make control happen
Landholder obligation to control – presently voluntary
Access to other control options, ways to assist and encourage landholders
Educating community about reasons to control foxes
Highlighting ecological reasons for control as well as production
Eradication will potentially reduce weed spread
Reduction in predation of dung beetles – lead to increase in soil health
Encourage group baiting
Prevent use of fox as a means to control rabbits

Cons:
Where will funding come from for monitoring etc
Feasibility of success – Will it work?
Enforcing Act – proving landholders aren't controlling foxes, hard due to mobility of foxes
Changing landholders, new people moving into area, educating new owners
Threat abatement plan limits some control options available
Legislation with chemical cards (AQF3 qualification)
Funding sources, what is available
Big stick approach
Fox populations in towns
Educating broader population, control options
Add to workload, additional staff needed
Time involved with landholders to get involved
Pre-conceptions of 1080 use, education
Additional time required by landholders to monitor bait stations, farm management
Coordinating baiting – key to success. Need to coordinate all landholders
Limitations of current control methods
State division – NSW vs Vic
Getting people to co-operate

Management Options:
Coordinated group baiting

Alternative methods – shooting, trapping
Business support incentives
Number of bait types available
Timing – neighbouring groups baiting at the same time
Aim to bait whole authority in 6 week period
Follow up baiting – all year round
Replace baits for at least a month
Use of 'feralmone'
Mound baiting
Education of baiting techniques and management options
Incentives / Bounty?
Authority happy to run more field days
Bait station – pick out active mounds, working mounds will attract other foxes, use same mounds every year
Use a few mounds and check daily
Fox-off good for re-baiting
Use shooting to get bait shy foxes
Modified rabbit traps / soft jaw traps
Poultry a good attractant to traps
Current rules – you can hold fox-off baits for up to a month before you have to re-notify your neighbours
Trapping
Contract baiters
Can hire cage traps
Chemical certification – hopefully next year Authority rangers able to conduct a half day training course for minimum 1080 use (20kg carrots, 50 baits x 3 occasions). Still has to be approved.

Alternatives:
Landscape approach, all tenures
Groups with common interest, high sense of community
Peer pressure, partnerships, LHPA assistance e.g. Malpas Dam approach – Armidale LGA, NPWS supply a proportion of baits to adjoining landholders
TSR adjoining landholders – up for debate
In lieu of multiple baiting need broad approach
New technologies – PAP won't be available for at least 2 years, M44 spring loaded mechanism, trials currently down south
Education – mini field day when dropping baits off
Need to control foxes – foxes made to be unacceptable
Education in schools – children pressuring parents
Education is a long term thing
Education in commonsense management, not only on biodiversity outcomes
Identification of scats and tracks (Guy has been running successful workshops)
Incorporating nocturnal field trips, biodiversity field day activities with why foxes need to be controlled
A face to push fox control media etc, broader approach, cog in the wheel etc
Incentive to do fox control, e.g rate subsidy
Fox skins, market for pelts
Rotation of bait type, wings – foxoff – liver etc

Fox Demonstration Project
Focus group - Should foxes be declared?

Uralla 27/11/09

Present: Brian Ferris (NE LHPA Ranger), Paul Berder (NE LHPA Ranger), Bec Ballard (SNELC), Phil Gardner (I&I NSW), Graeme & Shelley Marchant, Cameron & Judy Lisle, Lynette McLeod (I&I NSW).

Apologies: Tim Seares (State Council), Ken Pines (NPWS)

Pros:
More sheep / lambs / income
More property inspections by rangers
Able to pressure landholders to control foxes that might not otherwise control
Increased effectiveness of control
Easier to audit for foxes, scats, dens etc
Education – mechanism to run field days, media, changes to legislation
Defining a target level of control – continually suppress and destroy
NPWS – biodiversity outcomes
Decrease disease, lower threat of rabies spread if introduced
Decrease parasites
Increase dung beetles
Decrease weed spread

Cons:
Policing
Feasibility
Cost
Legislation
Education – increased requirement to educate people of the need to control, increase cost of time
Illegal use of other chemicals / misuse of control methods
Urban foxes
Limitations of current control methods
Pest control order only applies to rural landholders
Chemical certification, AQF3 requirements
Misinformation, landholder accessing incorrect information eg neighbours vs LHPA
Fear of getting into trouble – big stick approach will prevent people coming forward

Management options:
Farmer run community groups – peer pressure, knowledge of local politics
Partnerships between organisations eg Landcare and LHPA
Different community demographics, some will bait with one group and not others
Word of mouth
Prevision of a % of baits in rates notice
Education
Research into biological control eg sterilisation of foxes
Bounty
Coordinate with dog program to involve cattle producers

Offering free baits to get involved
Encourage ripping of dens, trapping shooting / pushing alternative control options
LGAs to control foxes – push alternative methods and baiting
Control stock routes, railways and other government agencies for foxes
Surveying people as to why they won't bait
Survey people who baited in 2008 and not 2009 as to why they didn't bait
Attitude change – identify that it is the landholders responsibility
PAP
Free additional baits for landholders adjoining TSRs, railways to bait along the boundary fences. Similar to NPWS system
Promote that foxes will take calves, attack cows down with calving difficulties
Push LHPA rather than Landcare in some areas