ECONOMIC EVALUATION OF THE ROLE OF BOUNTIES IN VERTEBRATE PEST MANAGEMENT

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by
HASSALL & ASSOCIATES P/L

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CONTENTS

SUMMARY

Despite nearly 200 years of control effort, vertebrate pests still cause significant damage to Australia's agricultural and environmental resources. Introduced vertebrate pests, such as rabbits, foxes and feral pigs now make up approximately 10% by species of Australia's mammals.

Bounty schemes have been utilised throughout the world as a financial incentive to induce control of pest species and hunting. However, most schemes have been condemned by their implementing agencies as a costly, misguided and ineffective tool for addressing pest problems. Fraud has become synonymous with all bounty systems with well documented evidence of widespread abuse by scheme participants. Such payments are often introduced in the absence of an adequate assessment of alternative solutions to a perceived pest problem and as a response to political pressure.

Other failings of past bounty schemes include:

- the requirement to present evidence of destruction, limiting collection methods to those that allow recovery of the body (ground shooting and trapping). Such financial incentives also impede the implementation of potentially more efficient control tools such as poisoning and harbour destruction;

- the combined effect of an inefficient control tool and the rapid reproduction of many targeted pests quickly diminish the benefits of control;

- until recently there has been little documentation as to the actual level of damage caused by feral pests. When combined with a poor understanding of the long-term consequences to agriculture and environmental resources this has significantly reduced the priority given to pest control in the management decision-making process; and

- the bounty payment is often considered by scheme participants to be an ongoing source of income rather than an incentive to increase control activity.

Despite these failings and with little evidence of the past success or potential of such schemes, pressure to introduce traditional bounty shemes to address certain pest animal problems still occurs.

This study examines several "smart" bounty options incorporating modifications to address past shortcomings. These modifications include restricting the number of participants, altering the duration and eligible areas of a program and limiting the payment to control of individual problem animals.

This desk-top evaluation involved an extensive literature review and consultation with pest management bodies and the commercial use industry. A range of "smart" bounties were then assessed within a framework covering technical, administrative and cost considerations.

The results of the evaluation indicate that although capable of offering positive benefit-cost ratios, bounty schemes remain a clumsy vertebrate pest management tool which require

considerable supervision, are subject to fraud and do not guarantee increased control activity or a significant reduction in pest animal damage.

The review of previous bounty schemes revealed their common introduction for political reasons, justified on equity grounds despite an absence of adequate evaluation of the problem or success criteria, and without consideration of the principle of beneficiary pays. The evaluation shows that "smart" bounty options cannot ensure this will not continue.

In accordance with the principle of beneficiary pays, if the impact of pests on agricultural enterprises in a particular area are known, then the costs of reducing this impact should be covered by the affected land managers rather than the local or national community. As all the benefits are captured by the land manager, the establishment of a third party financed/administered system is considered unjustifiable and a poor use of limited pest control resources.

On the other hand, if the wider community wants to maintain conservation values, it should be prepared to support the management and protection of those values. However, this is more likely to be achieved through funding of government-coordinated regional management programs than through bounty schemes.

Where groups of landholders are affected by similar pest animal problems, they are likely to achieve more by supporting a levy to fund a regional management program coordinator than by supporting bounty schemes.

Notwithstanding the above points, there may be some situations where a bounty scheme has potential. A review of the successful campaign to eradicate the coypu (an aquatic rodent) in eastern England has demonstrated that a strategic control program of an isolated population utilising financial inducements can work. A review of the current pest status in Australia does not justify the introduction of such a payment but this control option should be considered if an unwanted animal became established in a relatively small area.

This study concludes that the use of a financial incentive in the form of a bounty payment as a general tool to reduce vertebrate pest damage is inappropriate. The resources of pest control authorities would be better directed to other areas such as:

- extension of information on better pest management techniques and strategies with an emphasis on the need to define impacts and set performance indicators before any management is undertaken;

- funding regional pest management coordinators;

- overcoming key information deficiencies including density-damage and benefit-cost relationships; and

- developing more effective pest management techniques and strategies.

1. INTRODUCTION

1.1 Reason for the study

'A vertebrate pest is an animal that has a significant

net deleterious impact on a valued resource.'

(Braysher 1993)

Activities supported by Acclimatisation Societies saw more than 60 vertebrate species introduced to Australia between 1840 and 1880. From this base some 26 introduced vertebrates including the fox, feral pig, feral goat and rabbit, have come to form a conspicuous part of Australia's fauna. Introduced vertebrate pests are estimated to comprise some 10% of Australia's mammals (Wilson et al. 1992).

Although difficult to quantify, the combined impact of these animals is estimated to cost hundreds of millions of dollars annually in lost agricultural production and environmental damage (Braysher 1994). It has been estimated that rabbits alone cause a direct annual loss to the Australian economy in the order of $95 million through lost pastoral and agricultural production and reduced land values without even considering the environmental losses (CSIRO 1990; DPIE 1994).

Of growing concern is the impact of feral pests on Australia's wildlife. This country is responsible for approximately half of worldwide mammal extinctions over the last 200 years (O'Brien 1993). Recent studies indicate that, if uncontrolled, the widespread presence of vertebrate pests such as foxes could cause some native species such as the numbat and the brush-tailed rock-wallaby to become extinct (Saunders et al. 1995) and the feral cat is known to have significant impacts on island fauna.

Pest animals could also facilitate the spread of endemic and exotic livestock diseases. Endemic diseases such as leptospirosis, anthrax, footrot and sparganosis are common in some vertebrate pest species and have the potential to cause serious damage to livestock industries and human health.

Pest management authorities and landholders have several options for managing the impact to vertebrate pests. These include:

- *do nothing*: this is common practice in many areas - particularly semi-arid and arid zone production systems where the low value of production and large areas involved often make large-scale pest management uneconomic.

- *eradication*: the permanent removal of the entire pest population. Although not considered feasible in most situations on mainland Australia it is often the objective of control programs on islands, in conservation areas and for group control schemes (Parer and Pech 1988).

- *continuous control*: regular control of the pest species to keep the resident population at a level where the benefit corresponds to the cost of control activities. Such a strategy

accepts that vertebrate pests cannot be eradicated and that ongoing management is required to limit their damage. Implicit in this is the notion that the benefit of control should be greater than the costs.

- *ad hoc control*: measures initiated with no clear objective other than to kill as many pest animals as possible with available resources. Such programs usually result in the rapid return of pest numbers to pre-control levels and considerable resource wastage (Braysher 1993).

- *one-off control*: a single or set of actions directed at the permanent control of a pest population. The most common example of this control strategy is exclusion fencing.

- *biological control*: despite the potential value of biological control agents such as myxomatosis and rabbit calciviris disease, conventional control techniques (e.g. poisoning and harbour destruction) often prove to be more effective. The development of new biological control techniques involves long-term high-risk research which should not be relied upon in the immediate future.

Eradication of Australia's pest animals would appear to be a solution to the threats mentioned above. However this has not been achieved for a single mainland pest, despite decades of consistent suppression efforts. Eradication as a pest management option is largely unrealistic under Australian conditions (Hone and O'Grady 1980; Ericksen 1991; Braysher 1993; ANCA/BRS 1995; Bomford and O'Brien 1995). For this reason management of terrestrial vertebrate pests via an ongoing program of control is often a more appropriate program objective and should generally be the preferred management option (Tyndale-Biscoe 1992). Appendix 1 details BRS' suggested economic framework for determining the optimal strategy for pest animal management.

'Although used throughout Australia for over a century, bounties have generally failed to control pest animal populations and are even attributed to encouraging the spread of some target pests.'

A traditional method of continuous control has been the use of bounty payments whereby a predetermined amount is paid on the presentation of evidence that a nominated pest has been destroyed. Although used throughout Australia for over a century, bounties have generally failed to control pest animal populations and are even attributed to encouraging the spread of some target pests (Rolls 1984). Evidence collected in Australia and overseas suggest that where bounties have been introduced to create an incentive to harvest a pest population, commercial shooters and trappers manage/farm the population to maintain long-term income (Tisdell 1982; Rolls 1984; Smith 1990).

Bounty payments were first used in Australia in 1830 when two shillings was paid for the tail of any unregistered dog found loose in the streets of Sydney, Parramatta, Liverpool and Windsor (Breckwoldt 1988). Since then bounty payments have been made by various states for a large number of native and introduced animals including the now extinct Tasmanian Tiger and Toolache Wallaby. To date there is no documentation of an Australian control program involving bounty payments that has, to the satisfaction of all participants, effectively addressed the problems resulting from introduced pests.

Despite widespread documentation of system abuse by bounty recipients and the general failure of bounties as a control tool, there are continuing calls to expand the bounty system as a widely accessible tool for the management of vertebrate pests. For example, the request for the introduction of bounty payments periodically appears as a motion from the floor at the Annual General Meeting of the NSW Farmers Association.

This study has been undertaken for the BRS to derive possible bounty payment schemes that are able to address and overcome the problems experienced by administrators of previous bounty schemes.

1.2 Study objectives

The study objectives were to:

- evaluate options for encouraging cost-effective damage control through the use of bounty payments;
- explore options for smarter bounty systems;
- determine the cost-effectiveness of bounties when used in conjunction with other pest management options compared to these management options on their own; and
- communicate recommendations on the most promising bounty schemes to vertebrate pest control authorities.

1.3 Methodology

The study was broken up into five principal tasks:

- review the aims and objectives of bounties as a tool for pest control;
- review literature and anecdotal evidence to determine why previous bounty schemes have failed and the requirements for a successful bounty scheme;
- consult with industry participants and authorities to derive bounty schemes with potential to overcome identified failings;
- construct an economic model to evaluate the merit of alternative bounty schemes and a framework to review other technical, administrative and cost components of new bounty options; and
- evaluate traditional and new bounty options used in association with other control measures.

Bounty options have been assessed on the basis of marginal cost analysis. The incremental change in the cost of control activity and the incremental change in the cost of pest damage has been determined with respect to differing levels of control activity. On this basis, the optimal level of control is the point where the plot of the above two lines cross. Further increases in control activity will result in a situation where the cost of control is higher than the saving reflected in reduced damage.

Sensitivity testing of the results has not been undertaken due to the considerable time required to run the model and interpret the results. It is acknowledged this would have been useful, particularly variations to the rate of removal and reproductive rate. Nevertheless, the failure to test the sensitivity of the modelling is not believed to have detracted from the validity of the conclusions.

1.4 Economic model

To determine pest population numbers an interactive grazing model depicting population changes over a base year (Year 0) and twenty years following was derived. The model can accommodate a commercial species and a pest competing for available pasture biomass. The commercial species can be used as a surrogate for all herbivores other than the specified pest, or the model may be run in the absence of competition. The spreadsheet incorporates a series of commands that examine the effect of a pest control action from destruction of the nominated pest species.

Variables of the model include:

- pest and commercial species;
- expected available pasture biomass;
- daily feed requirements as a function of body weight;
- reproductive rate as a function of available pasture biomass;
- population survival rates as a function of natural mortality and available pasture biomass; and
- initial population.

A full description of the model is included at Appendix 2.

1.4.1 Model limitations

In using the model the following limitations must be recognised:

- the only variable that can be modified after the base year (Year 0), is the pest removal rate. The model lacks the flexibility to change the assumed Year 0 variables in subsequent years, for example to reflect seasonal variation, by means other than modification to the annual pest removal rate. If a drought event that kills 80% of the pest population is assumed to occur in Year 12 this can only be incorporated as an 80% cull rate in Year 12. Results have been derived from reasonable assumptions as to long-term average annual available pasture biomass. Such an assumption will understate biomass in good years and in turn, overstate drought conditions;

- the model is designed to examine the competition between two herbivorous species and is not able to include the predation of commercial or "non-examined" species as a source of food. An example of this problem is the predation of lambs by feral pigs; and

- the model has difficulty in coping with high reproductive rates. This problem becomes especially evident when examining pests such as feral pigs and rabbits. Consequently the adopted reproductive and infant mortality rates are lower than would normally be expected in a population dynamics model.

However, these limitations are not considered to detract from the validity of conclusions.

2. WHAT ARE BOUNTIES AND WHY ARE THEY USED?

2.1 Definition of bounties and objectives for implementing a bounty scheme

A bounty payment, as defined in this report, is a sum of money paid to encourage the capture and destruction of a specified introduced pest animal. Traditionally, the presentation of a nominated body part is required as evidence of destruction. This largely limits pest control tools to those that allow recovery of the body, namely shooting and trapping (Tisdell 1982)[1].

'The requirement to present evidence of destruction for bounty payments often promotes the use of relatively ineffective management techniques such as trapping and shooting.'

Justification of a bounty program varies with the intent of the scheme, but is generally to either: (a) induce people to destroy pests that either compete with, or are damaging to, man's interest (Whitehouse 1976); or (b) reduce the financial burden of pest control (or pest damage) facing landholders (Rolls 1984).

Bounty payments are generally introduced to encourage people to seek out and destroy a greater number of pests than they otherwise would. The offering of a financial incentive to destroy vertebrate pests is seen by those lobbying for the introduction or maintenance of a scheme as being necessary for a number of reasons including the following:

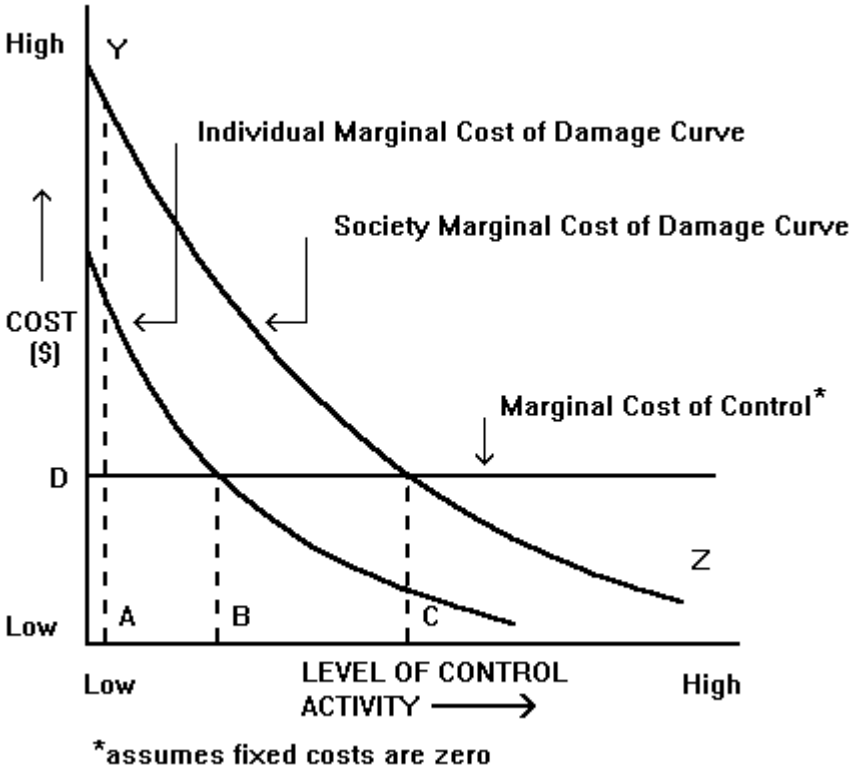
- *To overcome a market failure in the level of control activity being undertaken by landholders*

  A market failure is when the cost as measured by an individual or group of individuals differs from that of society as a whole and is a major reason for intervention in the working of free markets (Lipsey et al. 1982). Figure 2.1 depicts the situation faced by Australian landholders for most vertebrate pests, that is increasing control costs *per pest* taken as the resident population declines.

  From Figure 2.1 it can be concluded that the rational person undertaking pest control activities will reduce the target population from the uncontrolled level at A to B where the marginal cost of control equals the marginal cost of damage inflicted by the pest (that is, the optimal level of control). If it is considered by members of the wider community with a differing assessment of the marginal cost of damage that a more acceptable level of control is at C, those undertaking control activities, in the absence of regulation, will require an inducement to increase their level of control. This amount is the marginal cost (D) multiplied by the increased level of pest reduction (C - B) necessary to achieve the optimal level of control.

Figure 2.1 *Market failure and pest control*

[1] It may be possible in the future to associate proof of destruction for certain pests to an assessed reduction in damage levels rather than the number of animals presented for payment. Such a scheme is likely to be confined to a relatively small area where previous losses and/or damage levels are well documented. At this time the technology necessary to allow widespread application does not exist.



- *To assist landholders reduce the resident pest population by subsidising the cost of certain control activities*

  Such a bounty has been justified when the cost of control is considered to be financially prohibitive even if by the controller's own assessment the damage caused is unacceptable. Using Figure 2.1 and assuming the individual's damage assessment is the same as society's (YZ), this situation arises when financial constraints limit population control activities to B even though at this point the level of control is sub-optimal (marginal damage is greater than marginal cost). With the introduction of a bounty payment the individual has an enhanced ability to increase control activity to a more acceptable level.

- *To assist landholders eliminate both predators and competitors of domestic stock and pests that damage cropping enterprises*

  Such programs are intended to control animals that either compete with, or are injurious to, man's interests (Whitehouse 1976). Although similar to the above two examples, many bounty programs around the world have been introduced on the basis of the number of pest animals present as opposed to the damage they do or may cause. In such schemes the objective is simply the elimination of as many pests as possible (Smith 1990). Today, even where damage is severe, it is difficult to justify socially the widespread destruction of certain animals regardless of their pest status (Environment and Natural Resources Committee 1995).

- *To induce those not directly involved in agriculture or environmental management to assist in pest control*

Such programs are directed to increase the number of participants in the search for pest animals and thereby increase the probability of the resident population being pursued. These are introduced when the landholder faces non-financial constraints that prevent adequate control (such as insufficient time), or when those not directly involved are willing to incur a greater proportion of the control cost than landholders (as is often the case with recreational shooters).

- *To subsidise those areas worst affected by a pest*

  Due to geographic factors and land-use decisions, some landholders are more exposed to pest animals than their neighbours. Locations near National Parks, marshes, vacant Crown Lands, or traditional gathering areas for migratory species are geographic examples. Similarly, the decision to grow a particular crop, such as rice or grapes, may expose a landholder to more damage than neighbours not involved in the enterprise.

- *To provide some form of control in the absence of other measures*

  Such a program is implemented for political expedience, where the aim is for the government to be seen to be doing something about a perceived pest problem. These programs are usually popular, but almost always ineffective in addressing the pest problem.

- *To supplement landholder income in agricultural areas of marginal viability and/or where commercial markets for the pest species is unavailable*

  A bounty payment can form a secondary income for landholders particularly susceptible to the pest but who, due to location, are unable to participate in existing commercial markets. Although this social benefit consideration could be argued as being important to some rural families, in Australia the per pest payment is generally low and where large, funds for bounty payments are raised through taxes against the same rural families (Whitehouse 1976).

2.2 Why have previous bounty schemes failed?

Maxwell Smith (1990) in his seminal work reviewing bounty control programs around the world concluded such schemes have failed to achieve a significant and/or cost-effective reduction in the damage caused by the targeted vertebrate pest. This study identifies a number of reasons why such programs have failed:

- *Public perception of what is a pest*

  The perception of what is a pest is not consistent. What is considered to be a pest to one person can also be seen as an essential income source to another, and a source of recreational pleasure to a third. For example the feral pig to one landholder may be a pest damaging crops and fences, whereas another sees it as an asset to be sold to the local chiller, and another may place considerable value on it for recreational hunting (through personal enjoyment and actual expenditure). This problem is exacerbated when

considering native animals, for example the kangaroo, which introduces those concerned with conservation as yet another player.

O'Brien (1987,1993) estimated feral pigs caused $50 to $80 million in damage, have a $15 million commercial market, and support a $15 million per annum recreational hunting industry. Although the net community benefit from an absence of pigs is considered to be positive, it is to the detriment of the two latter parties and thus in their interest to ensure the continuing presence of pigs which is considerably easier to achieve.

- *Fraud*

Fraud has been synonymous with bounty payments throughout the world (Smith 1990). Bounty payments create an income source and therefore dampen efforts to eradicate or reduce the pest species population on a permanent basis. In the past such payments have been capable of providing a significant income through continuous harvest on a sustainable basis. The presence of a bounty payment scheme is blamed for the failure to use more suitable control options (such as poisoning) because they have the potential to remove too great a proportion of the population (Rolls 1984). A bounty that is seen as an income source will do little to encourage the long-term control of pests in such areas.

- *Rapid reproduction of controlled species*

Most Australian vertebrate pests have a high natural rate of increase and dispersal so the benefits of control activities will quickly diminish. Under favourable conditions one pair of rabbits have been shown to be able to increase to 184 in 18 months (Williams et al. 1995); one pair of mice can give rise to over 2,000 in just six months (CSIRO 1994); and feral pigs and goats are capable of doubling population size annually (Parkes et al. 1996; Choquenot et al. 1996).

'No bounty scheme in Australia has had a noticeable short or long-term impact on vertebrate pest populations that have a high reproductive rate.'

Many landholders feel there is little incentive to control such animals as a reduction in pest numbers simply increases the "resources" available to those remaining. This is especially true if there is no community coordination in control activities. For example, Hone and O'Grady (1980) found that following a one-off control program that removes 90% of the target population, feral pigs only require two years to return to the pre-control population. This finding is supported by Caughley (1977), Benson (1980) and O'Brien (1987) who all found that an annual cull of approximately 70% was required to prevent the feral pig population from increasing.

No bounty scheme in Australia has demonstrated an ability to achieve the above population reduction figures or have any noticeable short or long-term impact on vertebrate pest populations that have a high reproductive rate (J. Thompson, Queensland Department of Environment and Heritage, pers. comm. 1995; R. Benson, Bureau of Sugar Experiment Stations, pers. comm. 1995; Smith 1990; Tisdell 1982).

- *Program inability to address site-specific issues*

Often bounty programs have been operated in areas of ideal habitat for the identified pest where it is arguable that any non-biological control effort would have failed.

- *Substitution Effect I: moral hazard*

  If the bounty payment is not considered by potential participants to be a sufficient incentive it will not induce further hunting. If the bounty is too high, the scheme encourages fraud and farming for bounties. There does not appear to be a happy medium. This point is highlighted by the following South Australian experience described in Smith (1990). In 1969 the bounty payment for dingo scalps was increased from $2 to $6 resulting in a 680% increase in the number of scalps presented (from 2865 in 1969 to 19 382 in 1970). In 1971 the payment was reduced to $4; the effect was a fall in scalp presentations to less than 2000.

  A similar response was noticed by the Bureau of Sugar Experiment Stations when the payment for pig scalps was increased from $2 to $4 in 1983. In this case scalp presentations were some 150% over the previous six year average (R. Benson, Queensland Bureau of Sugar Experiment Stations, pers. comm. 1995).

  Logic would indicate that if an animal is given a readily discernible value (the bounty payment) there is an inducement to go out and capture a greater proportion of the target population. If society values the damage at $14 but the landholder values it at only $10 then it is reasonable for a $4 bounty to be introduced to address this market failure. In theory the landholder would not deliberately increase pest numbers as the damage is greater than the return ($10 versus $4) but would increase efforts to reduce the number already present - that is, they should be willing to expend up to $14 per animal. The problem is when those who value damage at less than $4 collect the bounty. These individuals have an incentive to increase pest numbers as they consider themselves to be financially better off with such a scheme.

- *Substitution Effect II: bounty payments have been perceived as a source of income*

  Very few landholders actually know the level of damage caused by pest animals (Braysher 1993; Williams et al. 1995; Saunders et al. 1995). Without this, few know the level of control they "should" be undertaking or the increase in control activity a bounty should induce. Although the intent of giving money to increase efforts seems rational, there is no way of ensuring this will occur. Many see a bounty as an opportunity to earn some money even if it is not a cost-effective use of their resources. The bounty reward could result in the subsidisation of existing activities (that is, no more effort expended but a reduced cost to the landholder for existing measures) or even a reduction of effort to allow greater earnings at a later date.

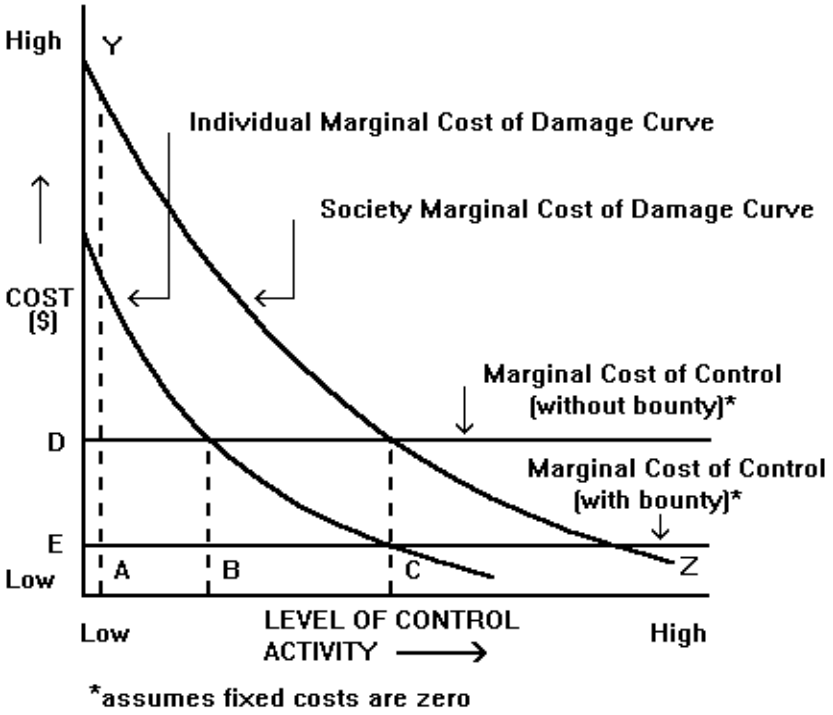
- *Substitution Effect III: the "free-rider" problem*

  Bounties are intended to induce increased efforts to capture pest animals. Traditionally the payment is made on all animals destroyed and not just those over and above the number that would have been captured without the bounty. Such a program will cost significantly more, and reduce the population significantly less, than anticipated.

  The impact of the three substitution effects described above are illustrated in Figure 2.2, where a bounty payment of $(D - E) should increase control activities from B to C by lowering the individuals marginal cost of control curve. The first year cost of such a bounty scheme is $(D - E) multiplied by the number of pests removed (B - C). Thereafter the annual cost of such a program (in the absence of fraud) should be the bounty payment multiplied by the pests' natural rate of increase at density C.

  Nevertheless, the introduction of a bounty scheme cannot ensure the population will be reduced to C as there is no way of determining if the landholders perception of the bounty is a reduction in the cost of control. If the bounty is perceived as an income source (Substitution Effect II) there is no downward shift in the cost of control curve. In this event it is reasonable to expect the landholder to maintain control activities at B and consider the bounty as profit. This outcome would be to the satisfaction of landholders as they would continue to undertake control to a level they have previously determined to be satisfactory (B) but are financially better off. Such a bounty would have no effect on the pest density or the level of damage but result in considerable misallocation of resources (Substitution Effect III).

  Figure 2.2 *The impact of substitution effects on the success of bounty payment schemes*



- *Lack of damage focus*

'Bounty schemes have tended to focus on reducing pest population size rather than minimising the damage caused by the pest population.'

Historically, bounty schemes have tended to focus on reducing pest population size as opposed to attempting to minimise the damage caused by the pest population. With this mindset the solution was to kill as many pests as possible rather than considering alternative management options to reduce the level of damage. For example, bounties for wombats were justified up to 1966 in Victoria, and later in South Australia, on the basis of damage to fences even though:

(a) the damage could by this time be largely prevented by electric fencing;
(b) apart from damage to fences the animal is relatively harmless; and
(c) the payment was known to encourage trapping in areas where there are plenty of wombats and no fences (Rolls 1984).

- *Secondary effects*

Some bounty schemes have resulted from the misunderstanding of the nature or source of the problem. For example, the undertaking of one control program may in turn create the need for another There is some evidence that dingo control in south-east Australia is linked to increases in feral pigs (CSIRO 1986). The non-commercial cull of kangaroos could create a food supply for carnivorous vertebrate pests such as pigs, foxes, cats and wild dogs. Alternatively, the control of rabbit populations may encourage predators such as the fox and dingo to seek alternative sustenance from native animals or livestock.

- *Inadequate evaluation*

With any control program it is desirable to have adequate information on the following prior to implementation:

(a) quantification of the relationship between pest density and the level of pest damage;
(b) total target population;
(c) population biology;
(d) behaviour patterns;
(e) response to various control tools (trapping, shooting, mustering etc.); and
(f) the consequences of incomplete control on population re-establishment and distribution.

If examination of the above is undertaken it should be possible to determine the optimal strategy for the management of the identified pest.

For many bounty schemes there is little knowledge or records of essential aspects and workings of the program that allow anything more useful than a report of the total number of payments made. Quite often no evaluation of the pre-bounty population level has been undertaken, nor was there any updated assessment of population, age structures, projected populations, the migratory effects of surrounding populations, source of scalps, the actual damage done or any other way to measure the success of such a scheme.

'There continues to be support to use bounties for dingo control despite evidence that such a control measure has not and will not work.'

The lack of adequate evaluation measures of the bounty control impact has an additional effect of failing to illustrate the inadequacy of such a control measure. For example, there continues to be widespread support throughout Queensland for the use of bounties in dingo control, despite scientific opinion that such a control measure has not and will not work. Anecdotal evidence suggests this is due to an evaluation of success by the wider public, based simply on the basis of total scalps presented (an average of 15 200 annually over the last six years) and a refusal to accept information discrediting bounty payments (J. Thompson, Queensland Department of Environment and Heritage, pers. comm. 1995).

- *Bounties used for political purposes but without economic justification for government intervention*

  There are two necessary conditions for economic justification of government intervention in private decision making. The first is that market failure must be demonstrated to exist, the second is that evaluation through cost-benefit analysis must indicate the intervention will result in a net gain to society (Kirby and Blyth 1987). A failure to meet the second criterion can result in an even greater divergence from the theoretically most efficient allocation than in the situation prior to any intervention.

  A review of available literature on previous Australian bounty schemes indicates little evidence of a full evaluation of the potential gain to society being undertaken, or that there was a market failure. The introduction of a subsidy simply because there is a large pest population does not constitute a market failure.

  Similarly, a bounty enacted in the absence of market failure for political reasons is perpetuated as long as its popularity outweighs the management deficiency of having no obvious impact on pest numbers (Thompson 1995; Smith 1990).

- *Non-differentiation of target animals within a species*

'Bounties often result in the capture of the younger, less harmful animals in pest populations.'

It is commonly believed that bounty schemes result in the capture of inexperienced or "harmless" pest animals, usually younger individuals, while the more elusive rogues that cause the majority of the damage escape, perpetuating the need for a bounty. Traditionally, most bounty schemes seek to capture all animals of a particular species instead of those located in particular problem areas or the ones inflicting damage.

Many of the failings described above are evident in recently terminated and continuing Australian bounty schemes. In the Queensland Sugar Research Stations (now Bureau of Sugar Experiment Stations) pig bounty, which ceased operation in 1986, an increase in bounty payment from $2 to $4 resulted in a 100% increase in presentations (from 175 to over

300 annually). Of these, over 50% were believed to have originated from "non-bounty" areas despite the need for a signed letter from the landholder stating the pig was caught on their property. Less than 5% of the local population was believed to be captured, with the majority of payments being for juvenile animals. In addition to this, despite the payment there was no obvious sign of reduced agricultural damage which was believed to have increased during the operation of the scheme (R. Benson, Queensland Bureau of Sugar Experiment Stations, pers. comm. 1995).

The Bureau of Sugar Experiment Station's experience is similar to that of the recent bounty schemes in Victoria (foxes discontinued in 1982 and wild dogs discontinued in 1992). These Victorian schemes failed due to widespread fraud and an inability to reduce pest damage or make a noticeable impact on the local population (K. Regan, Victorian Department of Conservation and Natural Resources, pers. comm. 1995).

2.3 Requirements for a successful bounty

Following a review of the literature collected while undertaking the study and consultation with industry participants, the following observations regarding the use of bounty payments have been derived:

- any scheme should have an in-built evaluation process that, as a minimum requirement, incorporates pre and post-control population assessments, the number of payments made and an assessment of damage inflicted by the pest. In planning any control campaign it is essential to have enough information to determine its impact on the target population. This requires an understanding of the relationship between pest numbers, damage levels and control efforts;

- there must be a genuine desire of the control scheme participants to address the pest problem and remove pest animals. The only successful bounty schemes have been those directed to animals widely disliked. Overseas examples included the wildcat in Pennsylvania, wolves in areas of Russia and the coypu in Eastern England (Whitehouse 1976; Appendix 5). Additionally, in the past, bounties seem to have worked better when the control program objective was eradication and not simply population reduction;

- bounties should be seen only as assistance in deferring the cost of pest control. While the payment must warrant the effort required to collect an animal, if used to induce hunting for profit there is a considerably greater incentive for the farming of bounties and fraud resulting from the presentation of ineligible animals;

'Bounty schemes should only be implemented where the damage to society is greater than to the individual so a sub-optimal level of control is being undertaken.'

- schemes should only be implemented where the damage to society is greater than to the individual so a sub-optimal level of control is being undertaken. Such a payment is necessary to compensate landholders for doing control they feel is unwarranted but society wishes to see done. That is, a bounty should only be used to overcome situations where it is perceived that sub-optimal levels of control are being undertaken by land managers;

- a bounty should as a minimum requirement induce a kill rate which is appreciably higher than the natural mortality rate. Such a payment would preferably be able to address the natural rate of pest population increase, plus account for the impact of migration. Available statistics suggest the majority of payments are for juvenile animals less than one year old, which for many pest species have a natural mortality of 50% or more. Control utilising bounty payments successfully removed wombats from areas of Victoria and South Australia. Rolls (1984) attributed this to their low natural rate of increase;

- targeted animals should not be abundant in surrounding "non-bounty" areas; and

- the proof of destruction should allow positive confirmation that it is from the target animal and not be readily substitutable.

The following section evaluates several possible bounty options directed towards overcoming the problems associated with previous bounty programs.

3. "SMARTER" BOUNTIES

The Bureau of Resource Sciences is developing national "best practice" guidelines for managing several major vertebrate pests. Best practice according to BRS should:

- focus on reducing pest damage rather than just pest numbers;
- involve technology readily accessible to farmers to facilitate adoption;
- be able to be readily incorporated into existing property management duties;
- incorporate commercial use where this is practical and economically sensible;
- involve control techniques which are humane (including targeting populations when they are at naturally low levels and the use of non-lethal techniques to reduce damage where practical); and
- optimise the cost-benefit ratio of pest management (as part of this, "up-front" costs should be minimised so they do not pose barriers to initial landholder involvement and the long-term cost-benefit relationship should be considered).

In addition to these, best practices should also consider socially desirable objectives for the landholder and the potential for conflict with larger conservation objectives.

By their definition previous bounty schemes have required lethal control techniques though live capture through the use of traps and mustering is possible. The previous use of bounty programs indicate they are by no means the optimal pest management option in terms of cost-benefit. It is the intention of this study to determine and evaluate if modifications to the concept of bounty payments are able to overcome the latter deficiency and through this, determine the potential of bounty payments as a pest management strategy.

Seven scenarios have been examined. These are:

1) Time-limited bounty (limited open season);
2) Restricted access, spatially-limited bounty;
3) Bounty to encourage the collection of non-commercial members of a commercially harvested pest species;
4) Subsidise commercial harvesters to take a second, non-target species;
5) Bounty to control a small, established population;
6) Bounty to control the spread of an established population; and
7) Rogue animal bounty.

3.1 Time-limited bounty (limited open season)

The principal characteristic of a time-limited bounty is that it is not available year-round. Such a scheme is directed towards reducing the impact of pest species causing damage in a specific location during a pre-determined period. This may be an annual migration stopover point, during lambing or calving, the emergence of a crop or a drought event.

A bounty payment on species responding to seasonal patterns could address the problem of a pest species that is seen as beneficial in one area but, due to high density, as a pest in another. For example, ducks are considered desirable in city parks but are known to

damage crops in agricultural areas. The same can be applied to parrots that damage forestry and horticultural crops.

During adverse seasonal conditions (for example, drought) a landholder's financial constraints are often greatest. Such periods usually see the cessation of what is considered to be inessential expenditure. Pest control is often put in this category. The provision of a financial incentive during this period is directed to ensure ongoing pest control activities.

The timeliness of the payment would be implemented at the discretion of the scheme administrator, with the option of tight controls (financial and time) to help prevent cost overruns and/or fraud.

3.1.1 Management issues

Aim:
Such a bounty would be implemented to fulfil either of the following:

(a) to encourage landholders' to reduce resident vertebrate pest populations *prior* to, or *during*, damage occurrence, or an anticipated population explosion; or
(b) to encourage the hunting of an animal when it is most vulnerable. Such occasions include during the mating season when target pests are more active and vocal, or more particularly during periods of drought when the control area population is already stressed and likely to be concentrated around limited water sources.

Pest control objective to be addressed by the bounty:
The primary objective is the prevention of damage through manipulation of hunter effort. The secondary objective is to encourage landholders to make opportunistic use of the reduced cost of removal resulting from the increased pest activity or concentration of a species.

Animal or geographic suitability/limitations:
To meet the first aim such a payment is best applied to animals known to cause seasonal damage to agricultural enterprises or capital assets (such as pigs, foxes, rabbits, wild dogs and ducks).

The alternate aim applies to species with a behavioural pattern that reduces the cost of control such as those that concentrate at regular roosts (starlings, Indian mynas) or rely on daily watering points.

Eligibility:
In determining those able to collect such a payment the following factors should be considered:

- target species characteristics (mobility, ease of capture etc);
- duration of the damage;
- area of impact; and
- effect of increased control activity on the activity of target species, non-target species and the local ecosystem.

For example, if the damage is restricted to a relatively short period but over a wide area, a larger number of participants (that is, more than the affected landholder population) may be necessary for any impact on the pest population to be achievable. However, based on the experiences of previous schemes it is reasonable to state that the larger the number of participants, the greater the potential for fraud and related difficulties. These include farming for bounties, presentation of out of area pests and other causes of bounty failure as described in Chapter 2.

'The larger the number of participants, the greater the potential for fraud and related difficulties.'

The impact on the local ecosystem and target animals resulting from increased activity associated with the payment must also be considered. Increased human activity in environmentally sensitive areas may cause significant damage in itself. For example, people attempting to collect a time-limited bounty intended to reduce the damage in an area that includes a native bird nursery may be as damaging to the nursery as the pest. In addition to this, the temporary increase in hunting pressure utilising methods favoured for bounty collection (trapping and shooting) entices activity that frightens the target population. This makes the use of more efficient control measures, such as poisoning and mustering, increasingly difficult if they are to be undertaken at a later date (Tisdell 1982; B. Toseland, South Australia, pers. comm. 1995).

Ability to address the problems of traditional bounty schemes:
Such a scheme would have the same working and intent as traditional bounty payments (inducement to reduce pest populations and through this the damage they cause). The scheme is however a more targeted application. It focuses on implementing the most efficient method of reducing the level of damage to landholders as opposed to simply reducing the population level.

Potential problems with the proposal:
The main concern with such a payment is that landholders should be responsible for the control of pests on their property and in areas where they are the principal beneficiary. Even if a pest is a problem to landholders, or those involved in environmental management, for only a limited duration, it is in their interest to reduce this damage, regardless of any financial inducement. This is especially the case when the pest's only impact is expressed as an enterprise loss through crop or livestock damage.

'Greater coordination of control activities between neighbouring properties is likely to be more effective than a bounty scheme.'

It must also be asked why society should subsidise the removal of such pests even if the landholders' pest problem results from inflow from neighbouring properties. The predicability of damage occurrence should be built into a farm's operation and management calender and thereby be addressed by good farming practices. Greater coordination of control activities between neighbouring properties is likely to be more effective than a bounty scheme.

Other factors inhibiting the effectiveness of this form of bounty include the following:

- potential control methods (mustering and shooting) have a large "scare component" - that is, animals subject to such disturbance become flighty. A bounty program may scare pest animals away, thereby reducing damage without the actual cost of destruction. However, this non-lethal reduction in damage may simply transfer the pest problem to another area where there may be no such control activity;

- the general public may not believe the animal is a pest worthy of destruction (for example, dingoes, trout, feral horses);

- if the payment is implemented on a regular or predictable basis, it may prevent continuous or even opportunistic suppression;

- the payment may reduce the incentive to alter management that would prevent damage from ever occurring. The payment also may inhibit alternative methods of addressing the problem, such as the opening up of properties to recreational or commercial shooters during this time. Such an action provides income and reduces on-farm costs, though admittedly has its own risks;

'The payment may reduce the incentive to develop alternative management strategies to prevent damage.'

- the scheme intention is to target areas where the damage is high as opposed to areas where populations of feral pests are high but have little impact on agricultural activities. As a result there is a need to find a project region where this is true across the whole region, not just in one or two isolated pockets;

- it is almost inevitable that there will be the capture and presentation of animals not inflicting any damage or from outside the intended control area; and

- depending on presentation requirements, body parts collected during the "non-bounty" period are likely to be stockpiled. Smith (1990), describes such a problem in Queensland. A regional authority matched the State Government's wild dog bounty for a limited time (five months). To prevent fraud, in addition to the normal bounty's scalp requirement, the authority specified the left foreleg as evidence of destruction. Following the expiration of the additional payment only a small number of dog scalps were presented. It was subsequently found that many landholders were withholding scalps with all four legs attached to cover a future time limited bounty that may specify the scalp include the skin of any other leg. This could be avoided by requiring the presentation of "fresh" evidence such as a whole bird or a fresh scalp. However, such a requirement has problems in itself, namely:

  a) the presentation of whole carcasses could significantly increase the program running costs as they must then be disposed of; and

  b) a need to present fresh evidence would increase participation costs and thereby limit the schemes area of impact to locations geographically convenient to bounty collection points.

The tying of bounty payments to a reduction in damage may be possible but existing technology makes measurement highly subjective and difficult to administer on a large scale. Even bounties tied to a target reduction in pest densities would be better than a bounty reward for animals killed without any reference to what this means in terms of population reduction.

3.1.2 Evaluation of the bounty option

Such a bounty scheme is unlikely to be implemented to address a market failure, but rather, as a response to lobbying for financial assistance from landholders. As such there is no economic justification for government intervention.

Although it is reasonable to expect that such a control program will induce greater control activity, there are more efficient and cost-effective methods of control available to landholders. Problems resulting from seasonal damage could be better addressed through the provision of greater information to landholders on alternative management options that will reduce the level of damage.

Year-round control is not possible for seasonal migrators. Prior to the control of a migrating species there is a need to assess the total impact of the animal year-round (it may be doing good or even be an essential part of the food chain elsewhere) before encouraging its destruction in a particular problem spot.

If the animal congregates in large numbers and significant control prior to or during the risk period is the objective, it is likely to be more cost-effective to poison, make use of a sacrificial crop or modify the production enterprise and/or habitat to reduce damage (Bomford 1988).

3.2 Restricted access, spatially-limited bounty

In an attempt to reduce the potential for fraud, this scheme examines the feasibility of restricting the number of eligible scheme participants. The exact limits of eligibility could be varied according to site-specific circumstances such as the intention of the control program, the local resident population and the pest to be controlled.

Spatially limited refers to the notion that the proposal would have strict geographic limits as to its area of influence.

3.2.1 Management issues

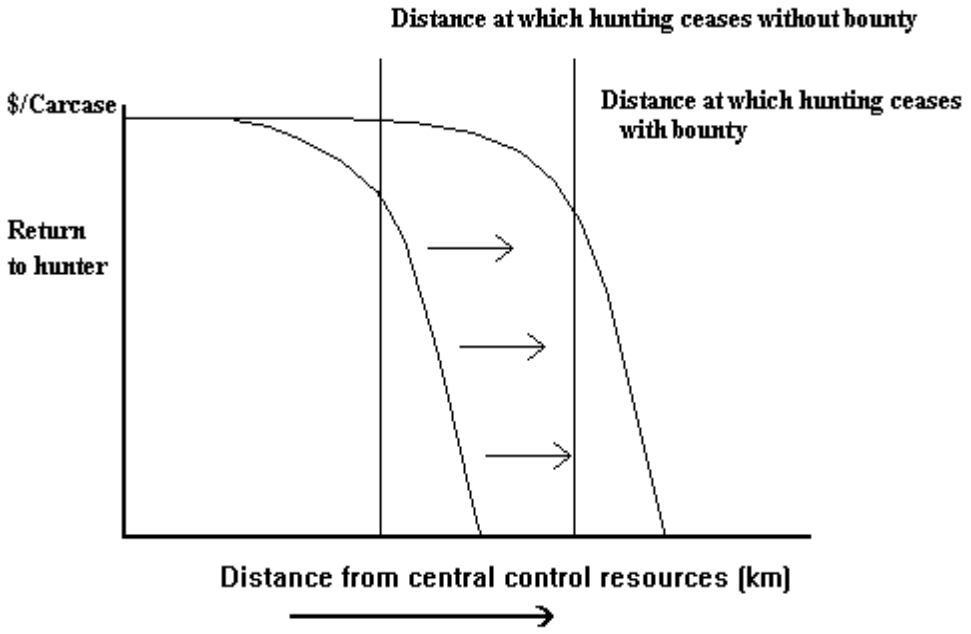
Aim:
The scheme is directed towards inducing those involved in pest control to travel beyond "without bounty" economic/financial boundaries and collect pest animals inflicting damage in areas that are uneconomical to control without financial assistance.

Such a payment would apply to a finite region to encourage the taking of pest animals in that region and is directed towards:

(a) encouraging harvesters to travel beyond their economic boundary through cost subsidisation thereby extending the area with control activities (Figure 3.1); or

(b) increasing the amount of damage/pest reduction within an existing control area to remove a greater proportion of the resident population than in a "without bounty" situation.

Figure 3.1 *Anticipated effect of bounty on harvester activity*



Pest control objective to be addressed by the bounty:
As described above such a bounty scheme has two distinct aims. The advantages of the first aim [Aim (a) above] are that it:

- reduces the speed of reinfestation of a sensitive area by reducing population pressure in a buffer zone; and
- encourages the taking of animals in areas where there would not normally be a regular control program (because of geographic isolation or the perception that damage caused by animals is less than the cost of control).

The advantages of the second aim [Aim (b) above] are that it:

- encourages the removal of pest animals beyond those that are the easiest (most cost-effective) to remove; and
- encourages the removal of a greater proportion of the population, which should result in greater damage reduction and delay the period before damage returns to the "pre-control" level.

Animal or geographic suitability/limitations:
Such a payment could be made on any animal perceived to be a pest and considered by the implementer of such a bounty to require greater control efforts.

The geographic limitations would vary according to a number of variables including the pest species and who is eligible for payment. For the case studies to be examined in this section it is assumed that such a payment is restricted to existing commercial harvesters and is paid on commercial species only.

As the examined bounty is directed to commercial harvesters it should be based around areas that contain a suitable collection point such as a chiller or sales marshalling point.

Aim (a) from above is directed to areas containing pests for which there are existing commercial markets, but no commercial activities are being undertaken.

Aim (b) from above is directed to areas where a level of control is already being undertaken.

Eligibility:
The examined scheme is formulated for commercial harvesters to limit the opportunity for fraud by restricting those able to collect payments[2].

Ability to address the problems of traditional bounty schemes:
Such a program has the potential to extend the area in which control measures are undertaken and/or intensify the efforts in existing areas of "commercial influence". It is also able to direct activity to an area particularly susceptible to pest damage.

'The payment aims to expand the area and/or intensity of existing commercial use management.'

If such a payment is used to initiate commercial control activities, the program is best targeted to eligible harvesters utilising a quota allocation. To prevent bounties being paid on animals that would have been part of the commercial harvesters normal cull it would be necessary to allocate a quota to each participant. From records of previous activities, an individual's average cull could be determined. With a spatially-limited bounty, numbers above this average would be eligible for the bounty payment. Such a policy would ensure bounties were only paid on those animals captured as a result of additional hunting effort.

[2] It is possible to open this program to the general public or landholders. For example the landholder contracts a professional harvester to reduce pest numbers. As a contract condition the professional is required to present the landholder with the necessary body parts and the landholder is then able to partially/fully offset the cost of pest reduction by collecting the bounty.

Potential problems with the proposal:
In acknowledging the past and continuing failure of commercial harvesters to permanently control pest populations, the success of such a payment must recognise the need for commercial harvesters to maintain their livelihood. The aim of the commercial shooter is to harvest a percentage of the population annually, preferably without driving it to decline (Bath 1993). This requirement has resulted in the long-term farming of pest populations. It is up to the administrators of the control program to evaluate if the expected increase in the level of control can be justified.

Without a quota system in place the introduction of such a payment would require a bounty payment on all pests taken. This poses the problem of commercial harvesters presenting an identical number of pests with or without the bounty and simply collecting the reward. A bounty without a quota provides the professional harvester an opportunity to earn more from an identical effort or even reduce pest control activities while maintaining income level.

Additional problems include the following:

- the problems identified in Section 3.1.1 associated with the transfer of the pest problem through relocation, pest perception and the presentation of ineligible, out of area pests;

- not all commercial markets have a structure of suppliers that would readily lend itself to the introduction of a quota system - for example, the feral pig market;

- the introduction of a quota system would require continuous monitoring in all aspects of the program from the determination of base quota levels to assessment of damage levels. The quota allocation is likely to require annual re-evaluation to account for changes in the resident pest population. This can be expected to have a significant cost;

- commercial harvesting does not adequately cater for situations of heavy pest concentration as only the larger animals are selected. This bounty scheme does not encourage the destruction of non-commercial (juvenile and undersized) animals - thus harvesting is unable to ensure there is no build-up of pest numbers;

- the level of payment must offset all the additional costs associated with catching the additional animal. For both aims of this scheme identified in Section 3.2.1 (extending search area and intensification of current area) this is likely to be quite high;

- if the payment is introduced where no control activities are currently undertaken [Aim (a)], the pest population is likely to be at the maximum sustainable level. Limited control will lower this population but any benefit is likely to be of limited duration (Tisdell 1982); and

- in areas commercially harvested the replacement rate of controlled pests is often high. In such cases the additional bounty-induced control cannot ensure a noticeable benefit.

3.2.2 Evaluation of the bounty option

The bounty option utilising a quota benchmark level was evaluated as a potential management tool for kangaroos in western NSW. While a native animal, kangaroos are a good model to test the option. They are harvested for their commercial value and for pest control and there is a good information base from which to draw data. The same principles used here can be applied to other animals such as feral goats and feral pigs.

In this example the examined scheme is open to commercial harvesters and directed to encourage increased control activity within a specified area (Aim (b) of Section 3.2.1).

Kangaroo control bounty scheme

The bounty scheme is evaluated below via the following process:

- estimation of the optimal level of kangaroo control, based on the level of damage inflicted on grazing enterprises, utilising marginal cost analysis - that is, where the marginal cost of damage equals the marginal cost of control;

- estimation of the "without bounty" level of control likely to be undertaken by commercial harvesters - that is, where the marginal cost of kangaroo removal equals the marginal revenue;

- determination of the number of kangaroos removed in the "with bounty" and "without bounty" situations;

- estimation of the likely administrative costs of implementing such a control program, the level of bounty payment necessary to cover the commercial harvesters marginal cost of control and the benefits arising from the bounty scheme; and

- assessment of the feasibility of the bounty option to achieve the optimal level of control based on the program's cost per animal.

Utilising the model developed for this study (described in Appendix 2), the following assumptions have been made:

- the area under consideration is 3000 km^2 with a first year average density of 20 pests per km^2;
- the analysis is for a 20 year period;
- a discount rate of 7% has been adopted;
- non-commercial individuals are ignored by commercial harvesters;
- one kangaroo has a grazing equivalent of 0.75 dse (Overton 1994);
- reproductive rate is 100%;
- there is no immigration from surrounding non-bounty areas;
- there are no fraudulent presentations;
- in the "without bounty" situation, the commercial harvester aims to maintain the resident population at approximately 20 per km^2 as at this density the marginal cost of control equals the marginal revenue (see below);
- in the "with bounty" situation, a quota is implemented limiting bounty payments to the additional animals harvested;

- for efficiency, payments are made by the operator of the commercial collection point on commission and administered through the relevant funding body; and
- the amount of the bounty payment varies according to assessed population density at the beginning of the year. The level is determined as being the differential between the relevant density removal cost calculated in Appendix 3, Table 1 and the price received ($7.50 per head).

Optimal level of control:
Using the assumption of an increasing time requirement to remove each kangaroo as the population density declines, marginal cost of control and damage curves have been estimated for the removal of kangaroos by shooting. Presented in Appendix 3, Table 1, the figures are based on variable costs of $25 per hour for undertaking the control activity, and an assumed annual damage level of $19.70 per animal resulting from reduced grazing capacity and damage to property.

From the derived marginal cost curves presented in Appendix 3, Figure 1, the optimal level of kangaroo control is at a cumulative time of some 6.75 hours of control activity. From Appendix 3, Table 1, this level of control activity is equivalent to a kangaroo population density of approximately 12.5 per km^2 (the density at which Column B approximately equals 6.75).

Commercial harvester level of control:
Assuming the price received by commercial harvesters for kangaroos is $7.50 per head (Hassall & Associates 1994), commercial control activity would cease at a density of approximately 20 kangaroos per km^2. At this point the selling price of harvester output (kangaroos) approximately equals their marginal cost of $6.53 per head (Appendix 3, Table 1).

Kangaroos removed in the "with bounty" and "without bounty" situations:
The assessment described below examines the cost of undertaking a control program directed towards reducing pest populations from 20 to the above determined optimal level of control at 12.5 kangaroos per km^2. From the model run results, the number of target animals brought in for bounty payment is some 37 036 over the assessment period (see Appendix 3, Table 2).

Administrative costs of the bounty scheme:
Based on the number of animals removed under the bounty scheme, it is reasonable to assume the administrative position necessary to oversee the program could be part time and only require one day per week. In this assessment it is assumed that labour costs are $112.50 per day ($15 per hour at 7.5 hours). From this, the undiscounted annual program administrative cost per kangaroo presented is estimated to be $7.77, with a NPV of $4.01 (see Table 3.1).

Table 3.1 *Restricted access, spatially-limited bounty scheme program administrative costs*

Administrative Cost Item	Annual Cost ($)	Program Cost ($)	Program NPV ($)
Collection point wages + assoc. on-costs	5 850	122 850	63 388
Program administration costs	5 850	122 850	63 388

Vehicle running costs	2 000	42 000	21 671
Total administrative costs	**13 700**	**287 700**	**148 447**
20-year administrative cost per pest presented under the bounty scheme	**7.77**	**7.77**	**4.01**

Commercial harvester cost recovery level of bounty payment:
From the removal cost of kangaroo figures in Appendix 3, Table 1, it can be seen that at animal densities below 20 per km^2 the commercial harvester's marginal cost of removal is greater than the marginal return (for example $7.74 against $7.50 per head at a density of 19 animals per km^2 in Column G). Utilising the per pest cost of removal from Column G, the pest densities and the additional "with bounty" numbers for removal figures of Appendix 3, Table 2, the bounty cost can be calculated. The estimated net cost to commercial shooters of undertaking the bounty program is $324 051 over 20 years with a NPV of $132 776. This would require a NPV equivalent bounty of some $3.59 per head to compensate the increased removal cost.

Benefits of the bounty scheme:
The principal benefit from undertaking the control program is that the payment resulted in a reduction in the pest population by 38% over the analysis period (from 60 000 to 37 525). This has allowed an increase in both the level of commercial harvesting activity and the pasture biomass available for livestock. In making this conclusion it should be noted that in the "without bounty" control program it was assumed the controllers intention was to maintain a stable resident population level.

Assuming one kangaroo imposes a cost of $19.70 per annum on the landholder through competition for feed and water and damage to fences etc, such a bounty has the potential to reduce damage in the control area by $729 609 over the analysis period. This has a NPV of $414 334 and given the total cost of $281 223 gives the program a favourable benefit:cost ratio of 1.5.

Assessment of the bounty scheme:
In viewing this positive benefit:cost ratio, the following points should be considered:

- the $7.60 total cost per pest removed (made up of administrative cost and the bounty payment) is significantly greater than could reasonably be expected from non-bounty control techniques. This is largely due to the significant administrative cost component of any bounty scheme;

- the benefit:cost ratio is sensitive to the value associated with damage such that if damage is halved the benefit is reduced to $207 167 giving a benefit:cost ratio of less than one. Sensitivity testing indicates the break-even level of damage is at $13.40 or 68% of the assumed level; and
- the assumed capture percentages may be optimistic. Review of previous bounty schemes indicate a very low percentage (less than 10% of the target population) is normal.

Despite the favourable benefit:cost ratio, such a bounty would be of limited value as a kangaroo control tool. Although having a noticeable impact on the target population, it is at a high cost of $7.60 per pest.

Nevertheless, the option may be more viable for other species such as feral goats as they offer the opportunity for more efficient harvesting techniques such as aerial and ground mustering. The use of such techniques allows a greater capture rate of the local population and reduced harvesting costs. The impact of aerial mustering on goat populations is examined below.

Goat control bounty scheme

Following a similar evaluation process as in the above example, the examined scheme is applied to the commercial harvesting of feral goats. The scheme is directed to encourage an increase in harvesting activity within a specified area (Aim (b) of Section 3.2.1).

The following assumptions were made in evaluating the scheme:

- the area examined is 250 km^2;
- the analysis is for a 20 year period;
- a discount rate of 7% has been adopted;
- the natural uncontrolled population goat density is 10 per km^2;
- the only control in the area is commercial harvesting by aerial muster;
- an aerial muster is assumed to occur whenever goat density reaches 10 per km^2;
- in deriving marginal costs the following removal rates are assumed -
  (a) the first control operation removes 60% of the total population,
  (b) a second control operation removes a further 20% of the total population,
  (c) a third control operation removes a further 10% of the total population, and
  (d) a fourth control operation removes a further 5% of the total population.
- reproductive rate is 58% (Parkes et al. 1995);
- non-marketable individuals (10% of the total population) are destroyed at the muster site;
- there is no immigration from surrounding areas;
- the gross margin for a self-replacing merino ewe is $15 per dse (Parkes et al. 1995);
- one goat has a grazing equivalent of 0.64 dse (Parkes et al. 1995); and
- goats are sold for $6.50 per head (Hassall & Associates 1994).

Optimal level of control:
Using the assumption of increasing cost of removal as population density declines, marginal cost and damage curves have been estimated for the removal of goats by aerial muster. Presented in Appendix 3, Table 3 the figures based on control activity variable costs of $372.50 per hour can be used to derive the optimal level of control activity.

From the derived marginal cost curves presented in Appendix 3, Figure 2 the optimal level of control is at a cumulative time of 33 hours of control activity. This level of control will reduce the goat density from 10 to approximately 2 per km^2 (Appendix 3, Table 3, Column E). This would be achieved by undertaking the first and second control operation, removing 80% of the resident population.

Commercial harvester level of control:
Using the methodology as for the evaluation of a kangaroo bounty, commercial control activity would cease where the marginal revenue from goat sales equals the marginal cost of obtaining the last goat. Given an assumed price received for goats of $6.50 per head (Hassall & Associates 1994), control activity ceases at the end of the first control operation as average cost of removal for the second control operation is $9.17 per goat (Appendix 3, Table 3, Column J). At this point the resident population has been reduced by 60% to a density of 4 per km^2.

Goats removed in the "with bounty" and "without bounty" situations:
From Appendix 3, Table 4, the "without bounty" situation requires control activity to be undertaken in Years 0, 7 and 16. The total number of goats removed is 4822. The average goat population over the 20 year assessment period is 1688 (6.8 per km^2).

The "with bounty" situation requires control activity in Years 0 and 12 only with 4042 goats removed. The average goat population over the 20 year assessment period is 1307 (5.2 per km^2).

Administrative costs of the bounty:
Such a scheme is envisaged as being adopted by landholders and land managers to increase the level of control undertaken by commercial harvesters. The desired increase in control activity and associated level of payment is determined on a case-by-case basis and the cost born by the land manager. As such there is no central administrative body or associated costs.

Commercial harvester cost recovery level of bounty payment:
From Appendix 3, Table 3 reducing goat populations below 4 per km^2 gives rise to a situation where the commercial harvesters marginal cost of control activity is greater than control activity returns ($9.17 versus $6.50 per head). For the example given here, the cost recovery level of payment necessary to reduce goat numbers in Year 0 from 4 to 2 per km^2 can be calculated as follows:

- the total number of goats removed is 1975. Of this 1500 can be removed for less than the marginal revenue in the first control operation. The remaining 475 incur a marginal loss of $2.67 per head ($9.17 less $6.50) for a total loss to the commercial operator of $1268. Averaged over all the goats removed in Year 0, a minimum bounty of $0.64 per head is required to cover the increased control cost of undertaking the second control operation.

Similarly, for the Year 12 control program a minimum bounty of $0.54 is required.

Benefits of the bounty scheme:
Although a reduced total number of animals are removed from the examined area in the "with bounty" situation, the additional control activity is able to increase the time between control programs while significantly reducing both average pest density and total damage levels.

Using the assumptions of one goat being equivalent to 0.64 dse, and a gross margin of $15 per dse, the "without bounty" and "with bounty" options have expected damage levels of $340 282 and $263 557 respectively. These have an equivalent NPV of $177 970 and $137 228 (Appendix 3, Table 4).

The increased control activity has the potential to reduce the NPV of damage in the control area by approximately $40 742 over the analysis period.

Assessment of the bounty scheme:
For an investment of $2385 (NPV $1647), those implementing the above option are able to reduce the losses resulting from a resident goat population by $40 742 and at the same time cut the number of control initiatives undertaken by 33%.

Such a control scheme can also be applied to directing commercial harvesters to increase the range of control activity. Such an evaluation would simply require a modification of the marginal cost of control curves to reflect the increased set-up and transport cost and the recalculating of necessary levels of control activity.

For the examined situation such a bounty principle would appear to have merit as a control tool but would require more detailed examination and field testing prior to implementation.

Despite the significant benefits of undertaking the second control operation, the widespread applicability of such a scheme is doubtful for the following reasons:

- it is believed that such a control program should be more appropriately considered as being part of good farm management and thus not require a third party funded and/or implemented bounty system. Each goat removed in the second control operation, at a cost of $2.67, has a direct financial benefit of $9.60 to the landholder (0.64 * $15.00);

- the feasibility of such a bounty scheme is further diminished in that the analysis assumes there is no direct financial benefit to the landholder for allowing the commercial harvester to undertake the first control operation. A landholder-imposed charge on the commercial operator of $0.85 for the Year 0 and $0.68 for the Year 12 first control operations is sufficient to cover the landholders cost of requesting the second operation while still ensuring a profit to the commercial operator; and

- the analysis does not account for the commercial operators profit derived from the first control operation ($1.54 per goat) that may be used to subsidise the cost of further control.

3.3 Bounty to encourage the collection of non-commercial members of a commercially harvested pest species

With the development of commercial markets for certain non-farmed species there will be a change in attitude towards such animals by those choosing to participate in the market. Where commercial markets exist, a resident feral animal population may be seen as an alternative income in hard times and bringing with this, a reduced incentive to control what is potentially a future income base. What was once seen as damage is now reassessed and perceived as being a tolerable production cost for a future economic gain.

Participation in the commercial harvesting of feral pests introduces an incentive for landholders to undertake selective control programs. Such a program sees the removal of commercially acceptable pests and the deliberate release of others. There is, as such, an unofficial "minimum size" rule. This problem was experienced by the Bureau of Sugar Experiment Stations where feral pigs under 30 kg were known to be released from traps as they were not acceptable at the local freezer (R. Benson, Queensland Bureau of Sugar Experiment Stations, pers. comm. 1995). Landholders utilising the services of professional shooters for the control of kangaroos also face the situation where only the larger animals are removed (Tatnell 1992).

3.3.1 Management issues

Aim:
This bounty payment would work in direct association with existing commercial control activities. The scheme intent is to overcome the problems of selective control associated with the commercialisation of feral pests.

'The scheme intent is to overcome the problems of selective control associated with the commercialisation of feral pests.'

This scheme is directed to encourage the collection of pest animals for which there is an existing commercial market but due to age, sex, size, colour or other characteristic they are unmarketable.

Juvenile animals are often easier to locate (and thus have a lower acquisition cost) and are usually found in the pursuit of larger pests. The bounty allows a payment to be collected from animals that have been captured either in musters, traps or a shooters sights that would have otherwise been let go on the basis of having no commercial value at the time of capture. As such the acquisition cost has already been incurred.

Such a program would reduce the incentive to avoid the capture of pest individuals on the basis that they may have a greater value in the future.

Pest control objective to be addressed by the bounty:
The continuing growth of commercial markets for Australia's feral animals has resulted in income earning opportunities from the ongoing harvest of pest populations and in some areas a growing acceptance and even the encouragement of pest populations. An acceptance of pest presence leads to complacency, increased risk of disease spread and tolerance of environmental damage.

Animal or geographic suitability/limitations:

The scheme by definition is limited to species for which there are established commercial markets. As the intention of the payment is to collect those pests that would normally be overlooked in commercially worked areas, implementation should be limited to locations under the influence of a commercial chiller or live animal drop-off point.

In the assessment of suitable areas there needs to be consideration of why the commercial activity is undertaken there. The intent of the program is to reduce the level of damage resulting from pest activity but not necessarily pest numbers. For this reason chillers located in areas with a large number of pests, but a relatively low level of agricultural and/or environmental damage, would not necessarily be suitable.

Eligibility:
Such a payment would be available to all participants of the commercial market and the general public.

Ability to address the problems of traditional bounty schemes:
The requirement of close proximity to a chiller or live animal drop-off point would ensure a close correspondence between the catchment area of existing commercial activity and the bounty program. Such a location would assist in preventing spatial and temporal abuse of the payment. For example, it would allow the payment requirement to be the presentation of the pest in a condition "acceptable at a commercial operation" (freshly killed or live). Such a presentation condition would prevent abuses identified in previous bounty schemes, such as Queensland bounties paid for dingo scalps taken in NSW and bounties paid in 1995 for scalps taken in 1993.

Potential problems with the proposal:
Problems that may be faced by those implementing such a control initiative include the following:

- there is no way of ensuring the payment will change the behaviour of individuals. Collectors of the payment must be willing to accept a guaranteed payment now in exchange for higher but riskier future payment[3];

- a certain level of feral pests are now seen by some farmers as an asset. Feral animal markets are a good fallback in hard times and there is a growing willingness by urban hunters to pay for access to properties with pests (Graham 1994);

- the payment may not be well received by chillers as if successful it may require them to relocate. Chiller relocation would necessitate a re-evaluation of the bounty as it works in direct association with the commercially-oriented activity;

- commercial chillers are not necessarily located where pests are causing significant damage. Location is also determined by site availability, access to markets and labour, proximity to associated business activities and other determinants of commercial viability; and

[3] Risky in that the animal may not be recaptured in the future.

'Pest control funds may be better spent elsewhere rather than on established populations that are likely to quickly regenerate.'

- the scheme raises the question: Would the limited funds directed to pest control be better spent elsewhere rather than on established populations that are likely to quickly regenerate?

3.3.2 Evaluation of the bounty option

Following the previously used method of bounty evaluation, a case study for feral pigs has been undertaken.

Utilising the model developed for this study the following assumptions were made:

- the area under consideration is 3000 km^2 with a first year average density of 0.9 pigs per km^2;
- the analysis is for a 20 year period;
- a discount rate of 7% has been adopted;
- non-marketable individuals are ignored by commercial harvesters;
- reproductive rate is 125%[4];
- there is no natural migration from surrounding non-bounty areas;
- there are no fraudulent presentations;
- 60% of captured pigs are saleable;
- the price received is $39.50 per head (Hassall & Associates 1994);
- in the "without bounty" situation, the commercial harvester aims to maintain the resident pig population at approximately 1.0 per km^2; and
- for efficiency, payments are made by the operator of the commercial collection point on commission and administered through the relevant funding body.

Optimal level of control:
Using the assumption of an increasing time requirement to remove each pig as the population density declines, marginal cost of control and damage curves have been derived.

From the marginal cost curves, the optimal level of pig control is at 10.24 hours of control activity. In this example, this level of control activity is equivalent to a pig population density of approximately 0.6 per km^2 (Appendix 4, Table 1).

[4] As indicated in Section 1.4.1, the population model used is not suited to high reproductive rates. Hence the assumed rate of reproduction for pigs is conservative and is countered by assuming a low infant mortality rate (10%).

Commercial harvester level of control
Assuming the price received by commercial harvesters for pigs is $39.50 per head (Hassall & Associates 1994), commercial control activity would cease at a density of approximately 0.9 per km^2. At this point the selling price of harvester output (pigs) approximately equals their marginal cost (Appendix 4, Table 1)[5].

Pigs removed in the "with bounty" and "without bounty" situations:
The assessment described below examines the cost of undertaking a control program directed towards reducing pest populations to the optimal level of control to 0.6 pigs per km^2. From the model run results, the number of target animals brought in for bounty payment is 1772 over twenty years (see Appendix 4, Table 2).

Administrative costs of the bounty scheme:
Based on the number of animals removed under the bounty scheme, it is reasonable to assume the collection point and administrative position necessary to oversee the program can be part time and only require one day per month at a cost of $112.5 per day ($15 per hour at 7.5 hours). From this, the undiscounted annual program administrative cost per pig presented is estimated to be $43.85 with a NPV of $22.63 (see Table 3.2).

Table 3.2 Non-commercial bounty scheme program administrative costs

Administrative cost item	**Annual cost ($)**	**Program cost ($)**	**Program NPV ($)**
Collection point wages + assoc. on-costs	1 350	28 350	14 628
Program administration costs	1 350	28 350	14 628
Vehicle running costs	1 000	21 000	10 836
Total administrative costs	**3 700**	**77 700**	**40 092**
20-year administrative cost per pig presented under the bounty scheme	**43.85**	**43.85**	**22.63**

Assessment of the bounty scheme:
Contributing to the high cost per pest presented are the following:

(a) the presentation of juveniles that may have died as an infant mortality;
(b) the presentation of animals killed now and not in the future for commercial markets; and
(c) the disposal cost associated with the analysis payment assumption requiring the presentation of a whole carcass.

The principal benefit from undertaking the control program is that the payment resulted in a significant reduction in pest population over the analysis period from 2700 to 1715 (Appendix 4, Table 2). It was assumed the "without bounty" control program was directed towards maintaining the target population (which increased from 2700 to 2972 over the analysis period).

[5] It is assumed that 60% of captured pigs are saleable; 60% of $39.50 equals $23.70.

Assuming the level of damage resulting from the pest at a density of one per km^2 is $58 per pig (Choquenot et al. 1996), the bounty has the potential to reduce the NPV of damage in the control area by $394 126 over the analysis period (Appendix 4, Table 2).

In viewing this substantial benefit the following should be considered:

- a significant but hidden cost of the program is the reduced number of pigs taken to chiller. The intention of this program is to fill a gap resulting from commercial harvest. If the reduced pest population results in the commercial interests becoming unviable either all harvested pigs will be presented for a bounty or the control activity will cease.

  Assuming the commercial interest in the above evaluation can sustain a 30% reduction in throughput, the operation would become unviable by Year 13 of the analysis. On the basis that control activities continue at the "with bounty" level for the remainder of the analysis period, total bounty presentations can be expected to significantly increase. Program operation costs and administration costs would also increase to undertake work previously contracted to the commercial operator;

- the benefit level is sensitive to the value associated with damage. If the level of damage is only $20 per pest, the benefit is reduced to $135 923; and

- the assumed capture percentages may be optimistic. Review of previous bounty schemes indicate a very low percentage (less than 10% of the target population) is the normal.

'Commercial shooters are unlikely to jeopardise their longer term future by reducing pest populations to very low numbers.'

Despite the favourable benefit:cost ratio, such a bounty would be of limited value as a control tool. Although having a noticeable impact on the target population, it has a high per pig administrative cost. Other pest control tools not possible with a bounty scheme, such as poisoning, harbour destruction and heli-shooting, are known to capture a greater proportion of the pest population at a lower cost (Hone et al. 1980; Bryant and Hone 1984; Parer and Pech 1988). For this reason it is not a recommended control tool. Additionally, in the analysis undertaken here the program is almost certain to make the commercial activity unviable. Commercial shooters are unlikely to jeopardise their longer term future by reducing pest populations to very low numbers.

3.4 Subsidise the removal of a second, non-target species

Such a payment is intended to encourage the destruction of a secondary pest species that can be captured as a bi-product of the principal control activity - that is, to kill pests located while searching for another. An example of this is a kangaroo shooter spotting a pig, cat or fox.

As the individual is already on location undertaking control, the acquisition cost of the second species is lower than for others involved in pest control. The actual cost is arguably only ammunition and compensation for the time required to collect required evidence of destruction.

A bounty payment in this form needs to consider the following:

- is the second animal actually doing harm in that area or posing a potential threat (knowledge/quantification of pest damage);

- the relationship between the pest controller and other animals in the region. For example, an individual with the sole objective of reducing rabbit numbers may not wish to control foxes. Alternatively, the commercial rabbit shooter already has an incentive to control foxes as it allows rabbit numbers to increase;

- an evaluation of the potential for a bounty-induced incentive to encourage further spread of the pest, and/or landholders from non-bounty areas lobbying for an expansion of the program; and

- to what extent will the bounty-induced activity contributes to the control tally. There is a pre-implementation need to estimate the total damage resulting from pest activity followed by estimates of the impact of different control activities on this damage level. This must then be weighed up with the "no control" scenario and the cost of implementing such a program.

3.4.1 Management issues

Aim:
The aim is to induce commercial harvesters to take animals that are of no value to them individually, but are inflicting or have the potential to inflict damage on agricultural or environmental resources.

Pest control objective to be addressed by the bounty:
Such a payment would overcome the problem identified in Chapter 2 where managing one pest problem may cause another. For example, 'shoot-and-let-lie' kangaroo control programs provide foxes, dogs, cats and pigs with an easily obtained food supply.

Animal or geographic suitability/limitations:
Such a program should be limited to areas where secondary pest animals are in low densities and/or extremely difficult to find (thus the acquisition cost is high). Ideally the area would also be isolated from locations where the secondary pest is readily available thereby reducing the potential for pest farming and the presentation of out-of-area animals.

This payment is most appropriate where the pest damage is currently low but anticipated to increase or spread in the future or where individual animals are capable of significant damage.

Eligibility:
In order to address the problems of open access that reduced the effectiveness of traditional bounty schemes, it is recommended the option be restricted to a pre-determinable and easily identifiable group such as commercial harvesters.

Ability to address the problems of traditional bounty schemes:
This form of bounty is somewhat different from the traditional application in that it would be applied to animals that are at present uncommon but with a potentially more significant future impact.

To a large extent the scheme still relies on the professional integrity of participants to prevent moral hazard issues.

Potential problems with the proposal:
In the past similar programs have been introduced to address emerging pest populations but have failed to prevent establishment in the control area. Throughout Australia the target pest has become established and the number of bounty payments has increased with little evidence of these schemes having any impact (Smith 1990). There is evidence to suggest that the rate of spread has been encouraged by those employed to prevent it (Whitehouse 1976, Rolls 1984).

'If pest numbers are already high the commercial hunter is unlikely to make an impact on the adult breeding population.'

If pest numbers are already high the commercial hunter is unlikely to make an impact on the adult breeding population. In addition, the use of such a payment in areas where the pest is established may result in a shift of activity such that the secondary pest actually becomes the primary target due to a higher financial return.

3.4.2 Evaluation of the bounty option

There are two likely outcomes of introducing a bounty payment in areas facing the threat of pest establishment:

(a) if a large payment is offered there is a temptation for abuse through importation or substitution; and

(b) if a small payment is offered there is the temptation to allow the population to become more established thereby increasing future returns as acquisition costs are reduced.

Similarly, if the animal is regionally uncommon it is possible there will be sufficient interest directed to its capture without a bounty. The interest would arise from either the novelty, financial or prestige value from the animal's removal.

In light of the abovementioned problems, such a bounty scheme is not recommended and not evaluated further here.

3.5 Bounty to control a small, established population

So as not to limit the scope of this study to widespread or well established pest species, a bounty program directed towards the control of a "new arrival" has been examined. The targeted animal may be an exotic arrival new to Australian shores or the appearance of a pest not usually found in a region.

Such a bounty payment incorporates elements of the *time-limited* and *spatially-limited* bounty while providing an opportunity to incorporate a flexible financial incentive to manipulate hunter efforts. Such a bounty is based on the program that successfully eradicated the coypu in Eastern England. Details of the Coypu Control Organisation are at Appendix 5.

3.5.1 Management issues

Aim:
It is envisaged such a bounty could be implemented to remove a small pest animal population before it establishes further. Such a program would be focused on localised eradication and perhaps best undertaken by government agents.

Pest control objective to be addressed by the bounty:
The program objective is to control a localised pest population before it becomes established and spreads further.

Animal or geographic suitabilitylimitations:
The program should be limited to pests causing or potentially causing damage that are found in relatively low numbers. Additionally, the target population should be geographically confined at present but have a capacity to disperse, causing more widespread damage.

Eligibility:
The control initiative is likely to be most effective where participation is limited. The use of government agents or coordination through landholder groups such as Landcare are possibilities.

An open access program may result in the implementation of inappropriate control tools, disjointed initiatives and a failure to achieve program objectives.

Ability to address the problems of traditional bounty schemes:
If undertaken through restricted access there is likely to be a greater understanding by scheme participants of the big picture problem of pest establishment and thus a greater desire to achieve program objectives.

As the target population and distribution is likely to be well defined, such a scheme has the possibility of incorporating a flexible financial incentive. This can be made in two ways:

- a sliding scale of payment where participants receive a higher reward as the pest population falls; or

- a lump sum upon the satisfactory completion of the program objectives.

The use of the latter payment was successfully implemented in England to eradicate the coypu. In order to financially compensate trappers who were essentially working themselves out of a job, a time conditional bonus of up to three times their annual salary was offered.

Potential problems with the proposal:
Problems that may be faced by those implementing such a control initiative include the following:

- there remains the potential threat of deliberate release of the pest in new areas with the intent of obtaining an expansion of bounty availability. This problem is a particular problem if the pest has a high recreational hunting value, for example feral pigs;

- there is, to a large extent, insufficient knowledge of the relationship between trapping effort and population for most Australian pest species. If the resources required to successfully control the population are even moderately underestimated the effectiveness of the control measure is greatly reduced;

- such a program is likely to be at significant cost compared to the level of local damage;

- in order to obtain the community and political support required for such a program the pest must be perceived by the public as a pest (or at least potential pest) and not as a harmless animal, for example rusa deer in Sydney's Royal National Park.

  Another example is the Indian palm squirrel. Established in Perth since escaping from the zoo in 1898, the squirrel is considered to be aesthetically pleasing and is not seen as a pest by local residents. This is despite observations that the animal had a serious impact on local populations of native birds adjacent to Sydney's Taronga Zoo (from which they also escaped) and required considerable control efforts over a number of years to eradicate (N. Martin, NSW National Parks and Wildlife Service, pers. comm. 1994).

3.5.2 Evaluation of the bounty option

Utilising the model developed for this study, the bounty option with the intent to eradicate the target pest was evaluated using the following assumptions:

- the original area under consideration is 40 km^2;
- the analysis is for a 20 year period;
- a discount rate of 7% has been adopted;
- the first year pest density is 25 pests per km^2, a total population of 1,000. This is assumed to be the areas maximum sustainable population density and any further increases in population will result in increased distribution;
- the eradication analysis period is for two years of active trapping and six months observation. This is compared to a 20 year "do nothing" and three other control possibilities, namely -
  (a) bounty induced annual removal of 25% of the juvenile population and 20% of adult population[6];

(b) bounty induced annual removal of 10% of entire population with an intensive control effort on Year 10 removing 60% of the population. Years 11-20 return to 10% removal; and
(c) bounty induced removal of 35% of the entire population for the 20 year analysis period;

- reproductive rate is 90%;
- there are no fraudulent presentations;
- in the eradication situation, one full time equivalent (FTE) is capable of removing 350 pests per annum;
- the labour cost per FTE is $30 000 per annum;
- the equipment costs per FTE or part thereof is $15 000 per annum;
- program administration costs are $5 000 per annum;
- an annual population assessment is undertaken at a cost of $5 000;
- the alternate control options utilise a bounty payment in the form of an increasing financial incentive to induce pest removal. The analysis assumes the payment schedule in Table 3.3. The same payment is made for all pests removed during the year on the basis of the annual population assessment.

Table 3.3 Assumed per pest bounty for a small, established pest population

Pest population	Per pest bounty payment ($)
0-100	22.50
101-300	9.00
301-700	4.00
701-1000	2.00
1001-2000	1.50
>2000	1.25

Based on model run findings, the number of target animals brought in for bounty payments and Year 20 populations under each scenario is presented in Table 3.4 below:

Table 3.4 Bounty payments and pest population at year 20*

Scenario	Base year population	Final year population	Number of bounty payments over assessment period
Do nothing	1000	28 835	0
Eradication	1000	0	1020
Scenario (a)	1000	327	3178
Scenario (b)	1000	2358	5413
Scenario (c)	1000	5	1719

*See Appendix 6, Table 1 for details.

Assuming for the eradication option one FTE can remove 350 pests, from Appendix 6, Table 1 it can be concluded that 2.15 FTE's are required in the first year and 0.7 FTE in the second. For analysis purposes the labour requirements for the first and second years are calculated at 2.0 and 1.0 FTE. The observation period following the intensive control activity requires 0.5 FTE.

On this basis, the total costs and benefits (damage avoided) of undertaking each of the examined control scenarios has been undertaken. The results are presented in Appendix 6, Table 2 and summarised in Table 3.5 below.

In light of the findings, in cases of a small, established vertebrate pest population there may be some applicability of this form of bounty payment. The simulation undertaken has demonstrated that a well constructed control program utilising financial inducements is an economically viable and effective tool for pest management. It is important to note that the 20 year assessment period considerably enhances the benefits of control activity.

A review of the current pest status in Australia does not justify the introduction of such a payment but this control option should be considered if an isolated vertebrate pest population was to become established.

Table 3.5 Costs and benefits for the control of a small, established pest population

Scenario	Average annual cost	Total program cost	NPV Total program cost	NPV Total program benefit	Benefit:cost ratio
Do nothing	0	0	0	0	0
[per pest removed]		[0]	[0]		
Eradication					
- labour and equip	52 500	157 500	141 784		
- admin & pop. assess	9 167	27 500	24 202		5.1
TOTAL	61 667	185 000	165 986	840 574	
[per pest removed]		[181.37]	[162.73]		
Scenario (a)*					
- admin & pop. assess	10 000	210 000	108 355		
- bounty	414	8 690	4 584	767 820	6.8
TOTAL	10 414	218 690	112 939		
[per pest removed]		[68.82]	[35.54]		
Scenario (b)*					
- admin & pop. assess	10 000	210 000	108 355		
- bounty	348	7 316	3 620	658 709	5.9
TOTAL	10 348	217 316	111 975		
[per pest removed]		[40.15]	[20.69]		
Scenario (c)*					
- admin & pop. assess	10 000	210 000	108 355		
- bounty	438	9 198	5 738	815 513	7.1
TOTAL	10 438	219 198	114 094		
[per pest removed]		[127.52]	[66.38]		

*Scenario will incur continuing costs to control remnant population beyond the analysis period.

3.6 Bounty to control the spread of an established population

It may be possible to restrict the spread of a pest from areas where it is already established. All living organisms have certain biological tolerances/requirements and preferred habitats restricting their movement and distribution. For example, the spread of the feral buffalo is

limited by its habitat preference of flood plains with permanent fresh water (Wilson et al. 1992).

This type of bounty scheme is based on the successful starling control program undertaken by Agriculture WA (AWA). A narrow coastal strip at the head of the Great Australian Bight is the only gap in an otherwise impassable barrier from established populations in South Australia. Based in Eucla, this program has the task of preventing starlings from entering Western Australia where it is estimated infestation could cause damage of $7.5 million per annum to agriculture-based industries (Nixon 1992).

Unlike the AWA program in which government employees undertake the control measures, the bounty scheme examined below would be available to the general public.

'The payment would help address the problem of animals found in low numbers that may develop into pest proportions.'

The payment would help address the problem of animals found in low numbers that may develop into pest proportions. This is particularly the case in areas where the animal may do little damage (it is only "passing through") but may cause greater damage further afield. Areas suffering little damage or inconvenience by the pest must be expected to have a reduced incentive for control.

3.6.1 Management issues

Aim:
To control the continuing spread of a pest species by taking advantage of physical or biological limitations that reduce the acquisition cost of the pest.

Pest control objective to be addressed by the bounty:
Once a pest becomes established control measures usually prove ineffective. Across Australia millions of dollars are spent annually in control efforts but pest populations continue to increase and spread. This bounty is directed to preventing pest establishment in new areas.

Animal or geographic suitability/limitations:
Such a payment should be limited to animals capable of inflicting significant agricultural and/or environmental damage in areas where they are currently absent.

A necessity of a program directed to control the spread of a widely distributed pest is the ability to identify corridors of opportunity. Such a corridor acts as a funnel or bottleneck, reducing to a manageable area the front of a pest's advance.

Eligibility:
The scheme is open to the general public.

Ability to address the problems of traditional bounty schemes:

This scheme is confined to a specific location where it has been determined a satisfactory level of pest removal using this method of control is possible. The scheme is a more targeted application of the traditional bounty principle.

Potential problems with the proposal:
The following have been identified as potential problems:

- the problems identified in Section 3.1.1 associated with the perception of the pest and the presentation of ineligible, out-of-area pests are still present in this scheme; and

- the primary intention of the scheme is to prevent pest establishment in regions beyond the control area. It is possible that the pest does not inflict much damage in the control area and as such there is little urgency by local residents to ensure its control and no local consequence from such a failure.

3.6.2 Evaluation of the bounty option

A feature of the corridor option is the continuous migration of a small percentage from a larger pest population in the established area to the threatened area. As such the requirements for culling of the total pest population is small (since the aim is not total area pest control), instead culling is concentrated in the corridor region.

'The bounty option requires perpetual control and is restricted to vertebrate pests distributed within a limited region.'

The principal feature of this bounty option is that it requires perpetual control to ensure its effectiveness and is restricted to a vertebrate pest distributed within a limited region. A review of vertebrate pest distribution within Australia, however, reveals few identified regions with this characteristic.

Additionally, because the damage caused by pests in corridor regions may be relatively minor, the need for total control is underestimated by the local community. This is because the individuals are less motivated to enforce the control since they do not bear the consequences of failing to meet the control's objective nor receive significant benefits from its success. Hence programs are unlikely to be instigated by the public and are left to be initiated by government. The WA experience has relied most heavily on public awareness programs to raise the profile of the potential threat. As a consequence the control programs effectiveness is reliant on voluntary community participation (spotting).

3.7 Rogue animal bounty

Individual animals are known to be able to cause serious damage to agricultural enterprises (O'Brien and Korn 1989). The activity of these rogue animals is often associated with age or a disability preventing the hunting of normal prey, or simply the pest developing a taste for a particular crop (Capstick 1978, Tisdell 1982).

The traditional bounty-induced response is to encourage the destruction of all animals of that species. The implementation of a rogue animal bounty would allow for the removal of problematic animals while leaving untouched those not impacting on landholder activity[7]. Such a control mechanism is more able to satisfy the public perception of what is a pest, is unlikely to be "farmed" and better addresses conservation goals for native animals (such as the dingo) or those threatened/endangered in their native habitat (such as Bali cattle).

3.7.1 Management issues

Aim:
To motivate hunters to capture individual pests that cause significant damage by helping to meet the cost of removal.

Pest control objective to be addressed by the bounty:
Rogue animals tend to be elusive and have a higher than normal cost of removal. The damage pattern is often widespread resulting in ineffective, uncoordinated control efforts by individuals or no action at all. This is because the damage to each individual is insufficient to initiate significant control efforts.

The bounty would bring to the public's attention the damage being caused by the identified pest and encourage participation in its capture and removal.

Animal or geographic suitability/limitations:
The pest must be in sufficiently low concentration to be able to positively identify the problem animal. Alternatively it must display individual characteristics allowing identification of the rogue. Consideration must be given to the likelihood of the rogue being quickly replaced by another equally problematic animal.

Eligibility:
Open to all but directed to encouraging those with particular skills to participate in the control program such as professional doggers and trappers.

Ability to address the problems of traditional bounty schemes:
In the past bounty schemes have been introduced because damage has been done to agricultural enterprises by pests. The approach was to encourage the destruction of all pests even if the damage was being inflicted by a small proportion of the population. This scheme is a more focused approach to the problem, requiring the landholder to undertake general control at their own expense but assisting with the capture of particularly problematic animals.

[7] This scheme offers an advantage over previously discussed bounty options in that pest animals that are considered to be a pest but are not impacting on landholder activity may be removed in pursuit of the rogue and at no cost to the bounty scheme financiers.

Potential problems with the proposal:
The following have been identified as potential problems with such a payment:

- the pest must be identifiable;

- the scheme requires a field officer or local farmer/land manager able to identify damage attributable to the pest and certify the pest has been removed;

- the payment deals with problem animals but does not address the control of the pest population as a whole. There may still be a need for general control;

- the payment is likely to encourage the overstating of damage attributable to the rogue;

- if the animal is a major problem the landholder will be forced to act regardless of a financial inducement; and

- a large bounty may enhance disjointed control activity as individuals attempt to collect the payment. Such a result may actually inhibit control efforts.

3.7.2 Evaluation of the bounty option

Such a payment is still used in Queensland for the control of specific dogs causing significant damage. A large bounty ($100 to $500) has been successful in motivating people to pursue such animals (J.Thompson. Dept of Lands, Qld, pers. comm. 1995). The notification of a bounty for a particular pest allows specialists to be used in control programs, potentially reducing the overall cost of removal.

Despite the above, the payment does not seem to address an obvious market failure. A large amount of damage being caused by a single animal in association with a high control cost does not necessarily justify outside intervention in the pest control process. Rogue animals inflict damage on an individual, or group of individuals, who will be forced to initiate some action regardless of a bounty. The action may be the coordination of activities to efficiently deal with the problem, or the contracting of a specialist to remove the animal, justified on a beneficiary pays basis.

'Rogue animals can be adequately addressed by private agreements between affected individuals and specialist pest removers.'

There does not seem to be sufficient justification for the establishment of the necessary government framework to implement and administer such a payment. The problems associated with rogue animals can be adequately addressed by the existing opportunity of private agreements between affected individuals and specialist pest removers.

For the reasons described above a rogue animal bounty is not recommended as a government body administered scheme.

4. THE USE OF BOUNTY PAYMENTS IN CONJUNCTION WITH OTHER CONTROL PROGRAMS

The use of bounty payments as a pest control mechanism has been largely unsuccessful in addressing the damage caused by vertebrate pests. In Chapter 2 it was determined that traditional bounty payments are unsuitable for the control of animals that are present in large numbers, are widely distributed or have high reproductive rates.

'Traditional bounty payments are unsuitable for the control of animals that are present in large numbers, are widely distributed or have high reproductive rates.'

Even when refined in an attempt to overcome these and other inherent faults of traditional bounty schemes, such a payment when applied to a large area with changing landform and pest population densities is at best a clumsy control tool. Despite these shortcomings, bounties should not be dismissed before determining whether they may play a supplementary role within certain pest control programs.

To a large extent the seven bounty schemes specified in Chapter 3 describe situations that may result following the implementation of another control program. Examples include the following:

- a *time-limited bounty* could be implemented following the completion of a one-off control measure to determine its success;

- the *restricted access, spatially-limited bounty* and *the non-commercial individuals bounty* operating concurrently are directed to address pest control gaps in the commercial harvest of pest populations;

- a *bounty to control a small, established population* could be applied to isolated pockets of a pest following an intensive control program; and

- a *bounty to control the spread of an established population* would be most useful as a measure of another initiative's effectiveness. For example, a bounty on starlings spotted within 10 kilometres of the West Australia/South Australia border to monitor the success of continuous control programs undertaken further east.

The incorporation of a bounty scheme to be used in conjunction with alternative control measures would, on investigation, seem to carry with it the flaws of a bounty on its own. When used in conjunction with a poisoning program, a time-limited bounty implemented on a predictable basis or even suspected of being implemented is likely to suffer fraudulent claims from the presentation of ineligible scalps.

While the case study for goats presented in Section 3.2.2 indicates the use of a financial inducement to increase the level of control activity has significant benefits, such a scheme is not envisaged as being part of a widely available scheme. The increased control would be funded by the landholder to offset the increased cost of a commercial harvester resulting from

additional pest removal. As such, this form of payment should be seen as a private agreement between a land manager and the commercial harvester whereby the harvester receives a financial inducement to increase the level of control activity.

Bounty schemes, which have at best demonstrated an ability to capture only a small proportion of the target population, are unlikely to be an effective monitor of another control initiative. Simply applying a bounty in association with other control measures is not likely to enhance a bounty's ability to capture a greater proportion of the target population.

Following the beneficiary pays logic, if the landholder has invested in or is the beneficiary of a large scale control program, it is in their interest to control or report the pest regardless of a financial inducement.

The general application of bounties is not enhanced simply by use in conjunction with other vertebrate pest control programs.

5. STUDY CONCLUSIONS

The traditional objective of pest control programs, to eradicate the problem animal, has had limited success for introduced vertebrate pests on mainland Australia. The result of this has been a re-evaluation of control program objectives and under most conditions an ongoing program of control is the preferred management option (O'Brien 1993).

The use of "smart" bounty options remains a clumsy, costly and unreliable method of pest control. Though able to produce a positive benefit:cost ratio and potentially more effective than a traditionally applied bounty, the fundamental flaws of moral hazard and an inability to ensure a beneficial change to ongoing pest management approaches remain. As a result the use of bounty payments, except in the case for the control of a small, established population, is not recommended under Australian conditions.

'The use of bounty payments, except in the case for the control of a small, established population, is not recommended under Australian conditions.'

The failings of "smart" bounty options are principally due to:

- the potential of feral pests to provide significant income to individuals. This aspect is becoming increasingly important as the market for such animals develop. There are some areas on agricultural holdings where the control of pests is difficult and the agricultural enterprises relatively unprofitable. In these areas the returns from the collection of feral pests may be significant compared to conventional agriculture;

- for a bounty to be a cost-effective control measure it must be able to do one or both of the following: (a) allow an equal number of animals to be captured at a lower cost than other control measures; or (b) ensure a greater percentage of the population to be captured than by other control measures to offset an increased control cost. Past bounty schemes have not demonstrated an ability to do either;

- there is an argument that the function of a bounty payment is simply to increase public awareness of an animals' pest status and is therefore used as a political tool and not necessarily as a control tool. Such situations arise when it is important for the government to be seen to be doing something about a perceived problem. The potential for misuse through the political application of a bounty payment continues; and

- it is difficult to determine the impact of a bounty scheme on the target population with estimates ranging from a 2% to 10% reduction in numbers. Estimates in several publications indicate up to 50% of the total pest population for some pest species must be culled annually simply to maintain the status quo (see Connolly and Longhurst 1975, Hone et al. 1980). A bounty scheme requiring control through shooting or baited traps is unlikely to be able to achieve this.

Limited pest control funds should be invested in a way that will achieve long-term population reduction - through the development and promotion of strategic management approaches - as opposed to financing an inefficient program that can at best, only address a problem in the very short term. The low cull percentages that result from a bounty program make eradication impossible under most conditions and even a temporary reduction in damage unlikely. Recolonisation by remnant populations and migratory influences quickly negate the benefits of a bounty program.

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APPENDIX 1:
AN ECONOMIC FRAMEWORK FOR PEST MANAGEMENT

APPENDIX 2:
VERTEBRATE PEST EVALUATION MODEL

APPENDIX 3:
EVALUATION OF BOUNTY OPTION, RESTRICTED ACCESS, SPATIALLY LIMITED

APPENDIX 4:
EVALUATION OF BOUNTY OPTION, NON-COMMERCIAL MEMBERS OF A COMMERCIALLY HARVESTED PEST SPECIES

APPENDIX 5:
“EXTINCTION TO ORDER”
THE COYPU CONTROL ORGANISATION
ERADICATION CAMPAIGN

APPENDIX 6:
EVALUATION OF BOUNTY OPTION TO CONTROL A SMALL, ESTABLISHED POPULATION