TOWARDS "BEST PRACTICE" VERTEBRATE PEST MANAGEMENT IN AUSTRALIA

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ABSTRACT: Australia has 26 species of introduced pest mammals that cause extensive damage to agriculture and the conservation of native wildlife. Past efforts tried to eradicate them. This focus on reducing pest numbers rather than the outcome, reduced damage, has had limited success. Under its Vertebrate Pest Program, the Bureau of Resource Sciences has developed principles and a strategic approach to managing pest damage. Close cooperation with land managers as co-researchers and co-learners is an essential element, as is a coordinated group approach to pest management. The approaches is illustrated with an example.

KEY WORDS: pest animals, pest control, pest management, pest damage

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INTRODUCTION

The 26 species of introduced vertebrate pests represent approximately 10% by species of Australia's mammal fauna (Wilson et al. 1992). Pest problems were recognized early in Australia's settlement, but despite considerable effort, pests such as rabbits, feral pigs and feral goats still cause extensive damage to agriculture and to the conservation of native wildlife.

Past research concentrated on pest biology and controlling pest numbers. While it appeared to serve us well at the time, we now realize that there were flaws in this approach. An understanding of pest biology and their response to control is important, but we have neglected to quantify pest damage and the relationship between pest density and damage. Without this information, it is difficult to know how much effort should be put into pest control, or indeed whether the effort is reducing damage.

The challenge is to clearly identify what we want to achieve from pest management and where and how we apply our limited resources to obtain maximal return. This requires a more strategic and coordinated approach to managing pest damage. This paper outlines the approach to pest management adopted by the Bureau of Resource Sciences through its Vertebrate Pest Program. The principles of pest management are explained and illustrated with an example.

The final question is "where to now?" We suggest that it would be better to adopt a coordinated and strategic approach and work cooperatively with private and government land managers to address this nationally significant problem.

AUSTRALIA'S VERTEBRATE PESTS

A vertebrate pest can be defined as an animal that has a significant net deleterious impact on a valued resource. It is important to note that pests are a human concept and that pest status changes as human perceptions and values change. For example, if feral goats were worth $25.00 a head, they would be a valued resource, not a pest.

Between 1840 and 1880 more than 60 species of vertebrates were introduced into Australia (Myers 1986; Redhead et al. 1991). Many were introduced by English immigrants to bring a semblance of England to the new colony (Rolls 1969; Lever 1985). Others were introduced to spread the world's useful and bountiful species (Myers 1986). Some, like foxes, trout and deer, were introduced for sport, others as biological control agents (e.g., mongoose, *Herpestinae*). Some established feral populations from captive stock (e.g., cat, horse, pig, goat, camel) or from pets or ornamental species (e.g., goldfinch, *Carduelis carduelis*).

Luckily, many introductions failed despite the efforts of acclimatization societies (Rolls 1969; Myers 1986; Long 1991; Bomford 1991; Redhead et al. 1991; Wilson et al. 1992), but others prospered. A major factor in the success of some species was the creation of disturbed habitats such as cultivated or urban land. The rabbit is a good example. Myers (1986) suggests that its establishment and spread was enhanced by the increased availability of grasses and the availability of burrows formerly occupied by some native species. The fox also undoubtedly benefitted from the spread of rabbits which provided its main food. Similarly, the pastoral industry, by establishing numerous water points and improving pasture, helped the successful establishment of other species such as the feral horse, donkey and goat.

For about the first 150 years of European settlement, the links between human land use, environmental damage and vertebrate pest impact were not widely acknowledged. Early control centered on destroying pests by shooting, poisoning, trapping, exclusion fencing, or, with rabbits, by encouraging the spread of cats and other predators. Legislation required land owners and occupiers to control and to destroy pests on their land. Laws also prohibited the keeping of declared pests. Similar legislation is still in force throughout much of Australia.

Pest control was often heavily subsidized through the provision of cheap equipment, government labor, and through government bounties. For example, the Western Australian Government spent $25 million between 1901 and 1907 to build a rabbit-proof fence 1700 kilometers long to prevent the westward movement of rabbits (Rolls 1969). It failed. In 1885, the South Australian government paid $1.6 million in bounties for rabbit scalps (Newland 1971), while Queensland, in the period 1945 to 1959 paid bounties on 240,000 fox scalps at a cost of $0.9 million (Fennessy 1962). The main objective was to

kill as many pests as practical and, if possible, to eradicate them. Landholders were not accountable for government funds expended on their land, and as a result, there was little pressure on land managers to ensure that pest control funds were spent wisely.

PROBLEMS WITH PAST MANAGEMENT

Focus on Numbers

While early efforts sought to eradicate pests, it is now known that there are sound reasons why it is rarely possible. Bomford and O'Brien (1994) have outlined these. Briefly, for eradication, the pest must be removed at a rate greater than replacement at all densities. There are a number of criteria which must be satisfied to achieve this:

Essential

- Immigration must be zero.
- All individuals must be at risk from the control techniques used.
- The animal must be able to be monitored at low densities.

Desirable

- The socio-political environmental must be suitable.
- Discounted cost-benefit analysis favors eradication over control.

The failure of eradication as a goal is clearly illustrated by the fact that no pest has been eradicated from mainland Australia. An indication of the cost is provided by the removal of rabbits from Phillip Island, a 200 hectare island off Norfolk Island. Although costs were not fully documented, it took about 700 field-person days. The manager of the national park at the time also states that rabbits were eradicated twice, once in 1986 and again in 1988.

If eradication is not feasible, then in most instances managers need to adopt a strategic approach to meet defined outcomes.

HOW MUCH CONTROL IS ENOUGH?

Past pest management in Australia has been hampered by inadequate knowledge of the impact of pests, and inadequate knowledge of the effect of control activities on the level of damage. For example, what is the impact of feral cats on Australian fauna? The answer is that we do not really know. Studies of cats' diets tell us what cats eat and little more. They do not tell us about the impact of cats on the population of prey species. Diet studies are a necessary first step, but are insufficient for developing an understanding of the impact of cats on prey populations.

We also have limited knowledge of the effects of control on damage. For example, we do not know what effect 1080 baiting for foxes has on livestock losses, although that is a very rapidly growing practice in parts of Australia (Saunders et al. 1995). We now know that more emphasis needs to be placed on quantifying pest damage and the relationship between pest density and damage.

However, for most pests, the level of damage has not been quantified, let alone the relationship between density and damage determined.

WHY IS KNOWLEDGE OF THE RELATIONSHIP BETWEEN PEST DENSITY AND DAMAGE IMPORTANT?

We need to keep a clear focus on pest animal impact and be concerned about the level of impact that we consider acceptable or desirable. The number of animals is not our focus—rather it is their impact on things we value. Because pest density and damage are not always directly matched, we need to focus on damage management. For example, rabbits at a density of less than one per hectare, an almost imperceptible density, can eat all seedlings of some native plants and prevent regeneration of some trees in the semi-arid rangelands. Reducing rabbits to two or three per hectare may not help tree regeneration in these areas and may be a wasted effort.

Figure 1 shows three hypothetical relationships between pest density and damage. Line "A" might represent the damage feral goats cause to palatable endangered plants that they seek out even when goats are at low densities. Line "B" could represent direct competition between feral goats for a limited resource. Line "C" could occur if there is little competition between feral goats and sheep for pasture at low goat densities. The shape of these lines will depend upon the type of damage and other variable such as stocking rate and seasonal conditions.

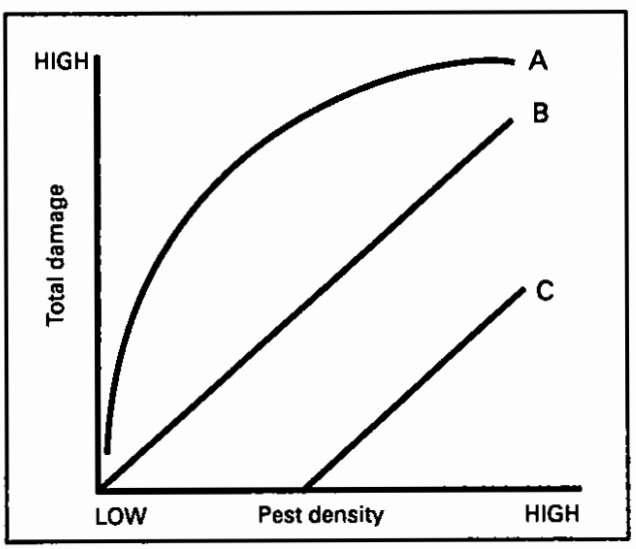

Figure 1. Possible relationship between pest density and damage.

COMPLEXITY OF PEST ANIMAL MANAGEMENT

In addition to our inadequate knowledge, there are several other reasons why managing pests animals is complex.

- Widespread and common. Pests occur throughout Australia from the tropics to alpine areas. Most are mobile and can breed rapidly. A feral rabbit can produce 25 young a year.
- Pests of agriculture. Pigs can take up to 40% of lambs born in an area. Rabbits are estimated to cost $16 million annually in South Australia alone.
- Pests of the environment. In Australia's rangelands, especially during drought, rabbits can strip and ringbark native plants. Even at very low densities rabbits can prevent regeneration of long-live species such as mulga (*Acacia aneura*).
- Exotic disease threat. Australia is free from many serious exotic animal diseases. Many pests came from domestic livestock and can carry similar diseases, which they could spread if they were to enter Australia. While difficult to quantify, the cost could be as high as $6.6 billion annually from lost livestock exports should a disease such as Foot-and-Mouth Disease become established over a significant part of Australia.
- Commercial use. Commercial use of wild animals is worth in excess of $73 million annually, primarily as export. Feral goats alone are worth more than $19 million a year. At present, commercial and pest management objectives are not well integrated. We need to investigate management that uses the value of the pest to achieve the broader goals of protecting agriculture and the environment.
- Animal welfare concerns. The welfare of pest animals is already a major community concern and the subject of international attention. Future solutions to pest animal management are likely to receive increasing scrutiny from this perspective. Failure to give adequate consideration to the social and animal welfare implications of control techniques may result in the loss of some techniques and thwart the introduction of new ones. Appropriately, there is now much wider consultation with animal welfare organizations concerning pest control.

VERTEBRATE PEST PROGRAM

In recognition of the need for a more strategic and coordinated approach to managing vertebrate pests in Australia, in 1991 the Bureau of Resource Sciences, in cooperation with Australia's national Vertebrate Pests Committee, commenced the Vertebrate Pest Program (VPP).

Under its VPP, the Bureau of Resource Sciences (BRS) is developing a series of guidelines for managing the damage caused by Australia's major vertebrate pests (Braysher 1993; Dobbie et al. 1993; Williams et al. 1995; Saunders et al. 1995; Choquenot et al. in press; Parkes et al. in press). The Bureau has worked closely with the States and Territories and relevant community groups including farmers, conservationists, animal welfarists and the Aboriginal Community in this program. The guidelines promote cost-effective management of vertebrate pests through better coordination, planning and implementation of control programs based on current scientific and technical information. Pests being addressed are the feral horse, rabbit, fox, feral pig, feral goat and rodents.

To encourage adoption of "best practice" pest management, BRS has supported several large-scale, field-based projects to demonstrate the principles and strategic approach to pest management developed under the VPP. We will explain thse further later in the paper.

The basic elements for planning and implementing a program to manage pest damage are explained in Braysher (1993) and summarized below:

- Defining the problem in terms of the desired outcome and determining major stakeholders and all major factors operating.
- Collecting the information necessary to clarify the problem.
- Setting clear, quantifiable and, if possible, time-limited objectives and developing performance criteria.
- Identifying management options and, if practical, experimentally testing the alternatives.
- Implementing the strategy.
- Monitoring effectiveness and efficiency of the management strategy against the objective.

RELIABLE KNOWLEDGE—ADAPTIVE MANAGEMENT

It would be trite to say that pest animal management should be based on reliable knowledge in the future, if it was not so clear that much of our past activity was not. We need to obtain reliable information about impact and about the response of impact to control. Obtaining reliable knowledge is a difficult task. One very promising way is the use of adaptive management, or large-scale experimentation. This involves conducting experiments within the management systems that are currently used for pest control. Champions of this approach, Walters and Holling (1990), refer to it as "learning by doing." In pest animal management and elsewhere in agricultural and rural science, we have tended to keep the learning and the doing (usually called the research and the management) separate. It has compromised the relevance of the former and the progressiveness of the latter.

Involving land managers as co-learners and co-researchers is being encouraged in the demonstration projects supported under the VPP. State government agencies and Landcare groups have been supported to determine and demonstrate "best practice" pest management for various situations. Most projects are large-scale, involve several properties, and compare several management strategies. Rather than simply providing land for the research, land managers are an integral part of the projects and help determine management options for their particular area. Their involvement also facilitates the dissemination of project findings to other land managers.

The approach will be illustrated with a hypothetical case study taken from the soon to be published feral pig management guidelines (Choquenot et al. in press).

Example of the strategic planning process centered on the Wet Tropic World Heritage Area of north Queensland:

Scenario

A typical example of the problems of feral pig management in the wet tropics region of northern Queensland could occur anywhere between Townsville and Cooktown. The region covers about 125,000 square kilometers and consists of three major geomorphic areas; a belt of coastal lowlands, an intermediate Great Escarpment, and the Tablelands of the Great Divide. Mean annual rainfall varies throughout the region from 1,200 millimeters on the western edge to over 4,000 millimeters near the coast, and occurs mainly during the wet season (December to April). The dominant native vegetation consists of rainforest species, which occur largely as a continuous belt along the Great Escarpment, with pockets on the Tablelands and coastal lowlands. Most areas of forest, which represent about 80% of the remaining rainforest in Queensland and contain many plants and animals unique to the region, are included within a World Heritage Area (WHA). The majority of the adjacent lowlands are used for production of sugar cane, bananas and other tropical fruits. There are a number of tourist resorts or high focus visitor areas along the coast only a few hours by road transport from an international airport. Feral pigs occur throughout the area but are mainly confined to the forests during the wet season and roam more widely, particularly to sugar cane crops, during their search for food in the dry season (May to October/November).

Defining the Problem

Feral pigs are estimated to cause at least $0.4 million damage to sugar cane crops in the region each year as well as an unmeasured amount of damage to bananas and other crops. They also pose substantial threats to WHA values, particularly protection, conservation and rehabilitation of the environment, even though there is little objective information available on their impact. In addition, they may have an actual or potential role as hosts or vectors of a number of important endemic and exotic diseases and parasites of animals, including humans, in the region.

The main problem with feral pig management in this region is that adjacent landholders regard the WHA as the source of the pigs affecting their crops and mostly expect the authorities responsible for the WHA to control the pigs within the WHA. This is generally not practical, given the large and elongated size and shape of the WHA (9,000 square kilometers), its often rugged, steep topography, and the difficulties and constraints involved in using control techniques for pigs within the WHA, particularly during the wet season.

Objectives

The objective of feral pig management in a region including both conservation and agricultural land uses should be to reduce their impacts within and outside the conservation area to acceptable levels, and to maintain this situation. This requires studies to quantify the impact of feral pigs on WHA and other values such as agricultural and horticultural and experimental reduction of pig populations through adaptive management, to determine threshold densities for acceptable levels of impact. It will also require basic research, including modeling, of the likely outcomes of outbreaks of exotic diseases in feral pigs in the region, and greater public education over the risks of people being infected by diseases and parasites from eating or handling feral pigs.

Management Units

Because of the large size of many conservation areas, the diversity of values that pigs can affect, and the likely costs of control, a ranking system is necessary to decide which particular areas should receive priority pig control. This system could include measures of potential or actual impact on biological, agricultural and other values, and should involve all major interest groups concerned. Once these areas are selected, decisions need to be made on whether local eradication or sustained control of pigs is the appropriate action. In deciding this, the following factors need to be considered:

- level of future financial support;
- when to conduct control;
- degree of population reduction necessary to achieve program objectives; and
- what control methods and strategies are best.

Decision analysis models can help to determine whether different management or control techniques are economically desirable, technically possible, practically feasible, or socially and environmentally acceptable (Norton and Pech 1988). These authors also describe pay-off matrices which can be used to determine the outcomes or benefits associated with using particular control methods and strategies for different types or levels of impact by pigs.

Control Strategy

A combination of techniques may be necessary for effective control of feral pigs in many areas. Poisoning, although potentially the single most effective technique for the region, is generally not acceptable in the WHA and sometimes on adjoining properties, where captured or shot pigs are subsequently used for food. Poisoning could be used in certain ares (for example, margins of the WHA) if more specific poisons, baits, or delivery systems were used. Trapping techniques require extensive free-feeding prior to the establishment of traps, are very labor intensive and are not practical for larger, more remote areas, but are potentially effective for many small areas or local situations, particularly as part of coordinated programs between government authorities and landholders. Ground hunting, with or without dogs, is generally considered to be ineffective for sustained control or eradication, may affect non-target animals, such as cassowaries (*Casuarius casuarius*), but is a way of life in the region that will not be stopped by legislation. Aerial shooting, untried in the area, could be considered in specific areas, including the margins of sugar cane farms. Fencing, including electric fencing, is probably only cost effective around small ecologically significant areas or for some instances of endangered species protection, but may be useful to direct feral pigs to areas where they can be trapped. Biological control, while feasible, is not likely

to be available in the near future. Although individual techniques used alone are thus unlikely to be effective, a carefully selected combination of techniques can usually be found to work with coordinated trapping being the central method. While trapping may be the most efficient technique, it is readily used by growers because they can receive $75 for a 45 kg pig delivered to the commercial chiller operator.

Implementation

Group Action. The most effective control strategy for the region is to carry out simultaneous control programs against pigs inside the margins of the conservation area and on adjacent properties such as sugar cane and tropical fruit farms during the dry season. Priority should be given to areas where pigs are having significant impacts both within and outside the conservation area during the late dry season when pig numbers are likely to be at their lowest during the year and many are searching for food outside the WHA. A coordinated approach, using funds that would otherwise be spent separately by control authorities, Cane Boards, and farmers during this period could have several benefits for both the WHA and adjoining landholders. These include a closer working relationship and recognition of the pig problem by all major interest groups, with legislation if necessary, to enforce compliance by non-cooperative and disinterested landholders. More coordinated control between various landholders, land management and conservation agencies, and where practical, commercial harvesters of feral pigs, could also minimize costs, possibly provide benefits to some landholders with low or negative cash flows, provide a means for disease surveillance, and result in more cost-effective control compared to the current, often spasmodic, ad hoc efforts undertaken.

Special control programs may also have to be undertaken against pigs deeper within the WHA where they are known to be having a negative impact on WHA values. Such programs should be based on a priority ranking system, and if sustained control is required, should be given a guarantee of continual financial support.

Monitoring and Evaluation. Measurements of impact and indices of pig density before and after control programs are necessary to help determine threshold densities and evaluate whether the control programs are achieving their goals or not. If the goals are not being achieved, improved strategies and community involvement will be necessary. Monitoring and evaluation can also indicate the best techniques to support, help promulgate research results, such as new trap designs or baits (for example, bananas) and provide more motivation and direction to control efforts. It may also indicate whether further research is required, such as on the intrinsic rate of increase of pigs after different levels of population control, including the effects of environmental factors on this rate. These include delays in the onset of the wet season or a poor fruiting year in the rainforests. Such information, along with that on the relationship between effort expended on control and the resulting densities obtained can be used to evaluate different methods and strategies to maintain sustained control or eradication in different areas.

What is the Future?

The final question is "where to now?" It can be more of the same—which would be a shame, because we have learned enough from Australia's past pest animal management to do much better.

The approach to pest animal management developed by BRS, and summarized in this paper, can help to deliver a better knowledge-based way of managing this nationally significant problem. The approach also is applicable to other land management problems including weeds and dryland salination.

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