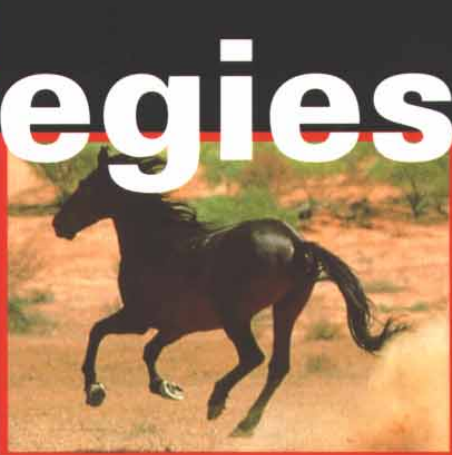


Managing Vertebrate Pests

Principles and Strategies



Department of Primary Industries and Energy
Bureau of Resource Sciences

Managing Vertebrate Pests: Principles and Strategies

Mike Braysher

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The Bureau of Resource Sciences is a professionally independent Bureau in the Department of Primary Industries and Energy. It was formed in October 1992 from the existing Bureau of Rural Resources and the resource assessment branches of the former Bureau of Mineral Resources.

The Bureau's role is to support the sustainable development of Australia's agricultural, mineral, petroleum, forestry and fisheries industries by providing scientific and technical advice to government, industry and the community.

FOREWORD

This publication is the first in a series of titles providing land managers with 'best practice' national guidelines to manage the agricultural and environmental damage caused by major vertebrate pests. Australia has at least twenty-six species of introduced mammals that have established wild populations. They are a complex management problem because they are: widespread and common, difficult to control, major pests of both agriculture and the environment, a commercial resource, and an animal welfare concern. Australia needs an effective strategic approach to managing pest animals, one that treats pests as a key element of agricultural and environmental systems within the context of Ecologically Sustainable Development. Until now, this has been prevented by a lack of resources and, to some extent, information.

This first publication sets the scene for 'best practice' pest management by establishing the principles and strategic basis for managing vertebrate pest damage. Others in the series include guidelines for managing feral horses, feral goats, feral pigs, rabbits and foxes.

The Bureau of Resource Sciences (BRS) developed this publication in cooperation with the Vertebrate Pests Committee, which consists of senior officers from State and Territory pest animal authorities. To ensure that the guidelines are widely accepted as the basis for vertebrate pest management,

the Bureau sought comment from government and private land management, community and other organisations including: the Australian Conservation Foundation, the National Farmers' Federation, the National Consultative Committee on Animal Welfare, Aboriginal Land Councils, relevant Research and Development Corporations, and the State, Territory and Commonwealth Standing Committees on Soil Conservation, Agriculture and Forestry. The Standing Committee on Agriculture and Resource Management has endorsed the approach to pest management set out in this BRS publication.

It is anticipated that Landcare and similar community-based groups will be involved in both the development and implementation of local pest management programs. Community-based groups provide a forum for government input and for dealing more effectively with off-site problems without needing strict regulatory controls. Importantly, they facilitate local ownership of the pest problem and effective pest management is more likely.

This publication and subsequent pest animal guidelines will assist land managers to reduce agricultural losses and environmental damage through use of scientifically based management that is humane, cost-effective, and integrated with ecologically sustainable land management.

Neil Williams

Executive Director
Bureau of Resource Sciences

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ACRONYMS AND ABBREVIATIONS

ACANZ	Agriculture Council of Australia and New Zealand	ICM	Integrated Catchment Management
ACT	Australian Capital Territory	IGAE	InterGovernmental Agreement on the
ALC	Aboriginal Land Council	Environment	
ANPWS	Australian National Parks and Wildlife Service	Landcare	Commonwealth Landcare Program
APB	Agriculture Protection Board (Western Australia)	LandCare	Victorian Landcare Program
APCB	Animal and Plant Control Board (Western Australia)	NCCAW	National Consultative Committee on Animal Welfare
APCC	Animal and Plant Control Commission (South Australia)	NSW	New South Wales
AQIS	Australian Quarantine and Inspection Service	pers. comm.	Personal communication
AUSVETPLAN	The Australian Veterinary Emergency Plan	RLPB	Rural Lands Protection Boards (New South Wales)
BRS	Bureau of Resource Sciences (formerly BRR)	RSPCA	Royal Society for the Prevention of Cruelty to Animals, Australia
BRR	Bureau of Rural Resources	SCA	Standing Committee on Agriculture
CCNT	Conservation Commission of the Northern Territory	SCARM	Standing Committee on Agriculture and Resource Management
CSIRO	Commonwealth Scientific and Industrial Research Organisation	SCAW	Sub-committee on Animal Welfare
DPIF	Department of Primary Industry and Fisheries (Northern Territory)	VPC	Vertebrate Pests Committee
ERIN	Environmental Resources Information Network	WCED	World Commission on Environment and Development
ESD	Ecologically Sustainable Development	WEDPP	Wildlife and Exotic Disease Preparedness Program
		ZCA	Zone Control Authority

SUMMARY

Vertebrate pests such as the rabbit¹, feral pig, feral goat and fox¹ together cost Australia hundreds of millions of dollars annually in lost agricultural production, as well as causing serious damage to native wildlife and the natural environment. On the positive side, pest animal management, principally by State and Territory vertebrate pest agencies, has greatly reduced the damage, particularly to agriculture. The challenge is to make better use of available information and resources, especially to protect natural biodiversity.

Several bodies have recognised the need to review past pest management and to develop a national coordinated approach to managing vertebrate pests (RSPCA 1990; ESD 1991; Landcare 1991; InterGovernmental Agreement on the Environment 1992; Senate Select Committee on Animal Welfare 1991).

This publication outlines background information and establishes the principles of and strategic basis for managing vertebrate pest impact. Major emphasis is on managing pest mammals although the principles and approach developed are applicable to other vertebrate pests. Guidelines for managing pest species are published as separate documents, and should be used with this publication.

Why review current vertebrate pest management and prepare national guidelines?

Principal reasons are:

- the need to ensure the effectiveness of national initiatives such as Ecologically Sustainable Development, the Endangered Species Program and those under the Decade of Landcare;
- to make more effective use of Australian

and international developments in the science of vertebrate pest management;

- a recognition that management should concentrate on reducing pest impact which may be best achieved by methods other than reducing pest numbers;
- a recognition that pest impact is one key factor among others which influence land resource systems, and should therefore be considered with climate, grazing pressure, pasture management, soil loss and commodity prices;
- endorsement by the Commonwealth, States and Territories of the beneficiary-pays principle, as a result of which more responsibility for pest management is placed on land managers;
- greater recognition of the need to consider animal welfare in vertebrate pest management; and
- the need critically to assess the role of commercial uses of some vertebrate pests in the management of their impact.

Recognising these needs, the Department of Primary Industries and Energy through the Bureau of Resource Sciences provided funds to develop national guidelines for managing vertebrate pests. Subsequently, the Vertebrate Pests Committee of the Standing Committee on Agriculture, now the Standing Committee on Agriculture and Resource Management, endorsed the project and agreed to coordinate it.

National guidelines

The aims are to:

- prepare scientifically based, humane, national guidelines based on 'best practice' for managing the agricultural and environmental impacts of major vertebrate pests;
- identify information deficiencies and establish research priorities in vertebrate pest management; and

¹ Unless otherwise stated, 'rabbit' refers to the European wild rabbit (*Orytolagus cuniculus*) and 'fox' to the red fox (*Vulpes vulpes*).

- have the guidelines endorsed and adopted by the major organisations concerned with vertebrate pest management, namely the State and Territory agencies responsible for vertebrate pest control and other relevant government and private land managers, community and other organisations.

How the guidelines were developed

State and Territory vertebrate pest agencies, through the Vertebrate Pests Committee, had a central coordinating role. Other interest groups were also closely consulted in preparing the guidelines, in particular the Standing Committee on Conservation of the Australian and New Zealand Environment and Conservation Council, the Australian Conservation Foundation and the National Farmers' Federation, each of which was represented on the Vertebrate Pests Committee's Working Group overseeing the project. For each pest, the Bureau of Resource Sciences contracted expert national task forces to prepare guidelines.

Who manages vertebrate pests?

Primary responsibility for vertebrate pest management lies with the landholders and occupiers whether government or private. Each State and Territory, and the Commonwealth, has its own structural arrangements and suite of legislation to regulate vertebrate pest management. Although all have strong powers to coerce appropriate action, the usual approach is to inform the landholder of the action required and to advise and encourage compliance.

Principles

The principles on which to base vertebrate pest management are:

- **consistency with the principles of Ecologically Sustainable Development, especially:**
 - maintaining and enhancing material and environmental qualities;

- ensuring that the actions of some individuals do not compromise the needs of others either currently or in future generations;
- protecting biological diversity and maintaining ecological processes and life support systems; and
- applying the 'precautionary principle' of dealing cautiously with risk, uncertainty and irreversibility;

- **adoption of beneficiary-pays:**

- Governments have endorsed the beneficiary-pays principle. The objective is to ensure that the costs of management are identified and assigned to the beneficiary, be they private individuals or the local or national community.
- Imperfect knowledge of the cost of impact and benefits can be a major barrier to effective pest management. Governments can help through supply of education, research and other information, through leadership, and by facilitating community-based groups to address common local problems.
- As major land holders, governments also have a role in pest management where the public is the major beneficiary, rather than individuals or local groups, or where market forces fail to deliver the desired outcome;

- **managing the inherent variability of land management systems:**

- The Australian environment is highly variable both between regions and over time. Land managers need relevant information to manage the associated risks;

- **defining the role of various policy instruments to ensure desired management goals are met:**

- *Legislation.* The major aim should be to encourage appropriate management. The 'big-stick' approach, although sometimes necessary, should preferably be used only as a backup.

- *Extension.* Information packaging, field days, training programs and other forms of information transfer encourage appropriate pest management.
- *Taxation and other monetary incentives or disincentives.* Government intervention through targeted subsidies or taxation measures can influence relative prices and therefore land management practices, and thus can be more effective than legislation;
- **involving all major interest groups in ownership of pest problems, and in planning and implementing management programs;**
- **managing total grazing pressure:**
 - For the vast majority of Australia's grazing land, especially the rangelands, total grazing pressure from both domestic and wild animals has a major impact on long-term viability; and
- **considering animal welfare:**
 - There is a growing expectation within society that minimising animal suffering should be an integral part of managing vertebrate pests.

What the guidelines contain

The approach for managing vertebrate pest impact was developed at a workshop in Canberra in June 1991 (Braysher 1991). It has since been endorsed widely by major government and non-government agencies with a major interest in pest management. The approach has been used to develop guidelines for each pest, based on:

- problem definition in terms of impact;
- determining objectives and performance indicators;
- identifying and evaluating management options; and
- implementing, monitoring and evaluating the management program.

The guidelines also contain critically assessed background information for each pest including history, biology, damage, pest

management and social implications. Information and other deficiencies are identified.

How the guidelines will be used

The guidelines are principally for the use of State and Territory land management agencies in managing pests within their jurisdictions.

In his 1992 Environment Statement, the Prime Minister announced a \$5.18 million, four-year program for a series of demonstration projects based on the pest guidelines. The program aims to demonstrate the effectiveness of integrated pest management based on the guidelines, to evaluate the effectiveness of the guidelines and to develop a greater awareness of pest animal damage and what can and should be done to alleviate that damage.

'\$5.18 million program to demonstrate and evaluate effectiveness of integrated pest management.'

States and Territories have structures and mechanisms for managing vertebrate pests. Although these will continue to constitute the primary mechanism for managing vertebrate pests, it is expected that Landcare and similar community-based groups will become increasingly involved. These groups may be established independently or in association with formal structures such as regional soil and land management boards. Community-based groups provide a forum for government input into major interest groups and for dealing more effectively with off-site problems without the need for strict regulatory controls. Importantly, they facilitate local ownership of the problem, making appropriate and effective vertebrate pest management more likely.

Species for which guidelines have been developed

The feral horse was chosen as the pilot species because it incorporates most of the elements of the vertebrate pest management problem. Feral horses cause both economic

and conservation damage, they are an animal welfare issue, and they are commercially harvested.

Guidelines have also been developed for the rabbit, fox, feral pig and feral goat.

The need to review current management arrangements

Currently, in some States and in the Commonwealth Government, agricultural and natural resource management is spread across several agencies, often with independent policies and programs, including those for vertebrate pest management. This can reduce the effectiveness of program delivery

through lack of coordination, insufficient or inappropriately directed resources and regulatory distortions leading, for example, to contradictory management practices. The Standing Committee on Agriculture's working group on sustainable agriculture identified the need to review government delivery of resource management programs, including pest animal and weed control (SCA 1991). This need was endorsed by the Ecologically Sustainable Development (ESD) working group on sustainable agriculture (ESD 1991). If the national pest management guidelines are to be used effectively, it is essential to review current management practices.

1. Background

1.1 Introduction

Pests such as the European wild rabbit², feral pig, goat, horse and the European red fox² cause major damage to agriculture, native wildlife and the natural environment, and cost hundreds of millions of dollars annually in lost agricultural production. The rabbit has been estimated to cause annually \$17 million loss to pastoral industries in South Australia alone (Henzell 1991). Rabbits (Lange and Graham 1983; Foran *et al.* 1985; Cooke 1987) and other pests also severely impair the regeneration of native vegetation. Many vertebrate pests are also potential vectors of major exotic diseases of livestock (e.g. foot-and-mouth disease) or humans (rabies) should these diseases enter Australia. The associated costs could be enormous. For example, an outbreak of foot-and-mouth disease in Australia could cost \$9000 million in lost exports (Hutchinson 1991).

While acknowledging the current serious deleterious impact of vertebrate pests in Australia, it is important not to underestimate the effectiveness of past and current pest management, principally by State and Territory vertebrate pest agencies. In the absence of such effort, the cost to agriculture and the environment would have been substantially greater. For example, Henzell (1991) estimated that rabbit control in agricultural areas of South Australia costs \$1.6 million for an annual benefit of \$62 million. The challenge is to improve this using available information, particularly for the protection of natural biodiversity.

The need for a national coordinated approach to pest management has been recognised in several forums (RSPCA 1990;

SCA 1991; Landcare 1991; ESD 1991; InterGovernmental Agreement on the Environment (IGAE) 1992; Senate Select Committee on Animal Welfare 1991).

In 1990, the respective Commonwealth ministers responsible for the environment and primary industries agreed that the Commonwealth should promote the development of national guidelines for the coordinated management of major vertebrate pests. Subsequently, funds were provided within the Department of Primary Industries and Energy for the then Bureau of Rural Resources (BRR) to develop national guidelines.

In April 1991, BRR put a proposal to develop national guidelines to the Vertebrate Pests Committee (VPC). Under its terms of reference VPC is required to undertake a continuing review of established vertebrate pests in Australia with particular reference to their effective management. VPC agreed to coordinate the development of the national pest animal guidelines. Appendix A shows the structure of VPC, its terms of reference, its relationship to the Standing Committee on Agriculture (SCA), now the Standing Committee on Agriculture and Resource Management (SCARM), and its relationship to the Agricultural Council of Australia and New Zealand (ACANZ).

The States, Territories and the Commonwealth saw that a cooperative approach to pest management offered significant potential savings through a reduction in duplication of effort (IGAE 1992). The need to review vertebrate pest management and to develop national coordinated management guidelines is presented in Section 2.

The current vertebrate pest scene needs to be set in its historical perspective³, to understand why a fresh approach is required.

² Throughout the rest of the report the European wild rabbit and European red fox will be referred to as the rabbit and fox respectively.

³ Most examples in this document are based on the agricultural industry despite the expressed aim that the guidelines should address both the production and conservation impacts of pests. This is because research has tended to concentrate on the agricultural damage, probably as a result of directed funding. The balance, however, is changing, as illustrated by the establishment of the National Endangered Species Program, which has a major emphasis on managing threatening processes such as the impact of vertebrate pests. The guidelines will help redress the imbalance.

1.2 History of vertebrate pest management

A vertebrate pest is an animal that has a significant net deleterious impact on a valued resource. It is important to note that pests are a human perception. If feral goats were worth \$30 a head for example, they would be considered by some to 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. the mongoose). Some formed established feral populations from captive stock (e.g. horse, pig, goat, camel) or from pets or ornamental species (e.g. cat, goldfinch).

Luckily many introductions failed despite the efforts of acclimatisation societies (Rolls 1969; Myers 1986; Long 1988; 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 benefited from the spread of rabbits, which provided it with a major food source. Similarly, the pastoral industry, especially by establishing numerous water points, helped the successful establishment of other species such as the feral horse, donkey and goat. As a result, Australia has a suite of vertebrate pests that cause extensive agricultural and environmental damage.

For about the first one hundred and fifty years of European settlement, the links between human land use, environmental

damage and vertebrate pest impact were not perceived, or at least not widely acknowledged.

Early control centred on destroying the pest by shooting, poisoning or trapping, exclusion by fencing, or, with rabbits, by encouraging the spread of cats and other predators. Strong legislation was promulgated requiring land owners and occupiers to control and destroy pests on their land. The keeping of pests was also prohibited. Similar legislation is still in force throughout much of Australia.

'Links between human land use, environmental damage and vertebrate pest impact were not perceived.'

Control was often heavily subsidised by Government, which provided bounties and cheap equipment and labour. For example, the Western Australian Government spent \$33 million (\$A, 1991) between 1901 and 1907 to build a rabbit-proof fence 1700 kilometres long to prevent the westward movement of rabbits (Rolls 1969). The fence failed. In 1885, the South Australian Government paid \$2.1 million (\$A 1991) in bounties for rabbit scalps (Newland 1971). Between 1945 and 1959 the Queensland Government paid bounties on 240 000 fox scalps at a cost of \$1.15 million (\$A, 1991) (Fennessy 1962). The main objective of landholders and government was to kill as many pests as practicable. Landholders were not accountable for government funds expended on their land.

The main phase of pest research started in the early 1950s with the development of equipment and control programs based on the government-funded research of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and State departments of agriculture, mainly into rabbits. It was also very much driven by landholders and the rest of the agricultural industry, with an emphasis on finding better ways of killing the pests. Investigation of the real needs for vertebrate pest management and a definition of the risks posed to our nat-

ural heritage or agriculture often were not pursued.

1.3 Current framework underlying vertebrate pest management

There have been several developments, many relatively recent, that have changed the way in which land management in general, and vertebrate pest management in particular, should now be viewed. Any review of vertebrate pest management needs to consider the following points:

- recognition of the need to manage whole-land systems and consideration of the links between the elements of the systems, whether for conservation, production or both;
- identification of the many groups interested in vertebrate pest management, including community conservation and animal welfare groups, research organisations and financial institutions, and recognition of the need to involve them in policy development and other aspects of the decision-making process;
- decline in traditional pest management services provided by some States and Territories (ESD 1991);
- damage caused by vertebrate pests such as rabbits, foxes and feral goats is considered to be a major endangering process threatening the survival of many native species, particularly in the rangelands;
- extensive reduction of native habitat, with many remaining examples being small and often highly fragmented, particularly in broad-acre cropping land, making isolated native animal and plant populations particularly vulnerable to predation and further habitat destruction by vertebrate pests (CSIRO 1989, 1990);
- recognition that much of Australia's biodiversity depends upon the appropriate management of wildlife outside reserves; and
- consistently declining terms of trade for

primary producers, making cost-effective pest control essential.

Who is responsible for pest management?

Constitutionally, the major responsibility for vertebrate pest management lies with the State and Territory Governments. Under State and Territory legislation, landholders or occupiers, whether governmental or non-governmental, are required to control vertebrate pests on the land.

The Commonwealth Government has interests in vertebrate pests through its responsibility for the land it manages (national parks, Commonwealth-acquired land and external territories), its overseas trade responsibilities and its national responsibilities for exotic disease prevention and control. More recently the Commonwealth has been concerned about the potential impact of pests on national initiatives such as ESD and the Decade of Landcare.

What is the purpose of this document?

It provides background scientific information on vertebrate pest management, outlines the principles on which pest management should be based, and establishes a strategic, scientifically based approach for managing pest impact. Detailed guidelines for major pests have been published separately and should be used with this publication.

Why choose a single species approach?

It would have been preferable to prepare one set of guidelines for all pests, detailing the links between the species and the other aspects of the land management system. This would have been consistent with the holistic approach to land management advocated under ESD and Landcare. Unfortunately, logistics made it impracticable. Further, most management actions are directed at single species, even when more than one pest species is involved. Nevertheless, the need to consider interactions between species

(such as rabbit, fox and feral cat) and with other aspects of the system is stressed in this report and in the subsequent guidelines for each species.

Which species?

There is a wide range of non-native, vertebrate animals established in the wild in Australia. They include the cane toad, marine and freshwater fish, birds and mammals. The major pest species are considered in this project, although the principles and strategic approach developed are applicable to other vertebrate pests. Species were selected on the following criteria:

- severity of agricultural and environmental damage at the national level. In many cases this is not known or poorly documented;
- information available on each pest's biology and management techniques;
- availability of relevant experts for each species;
- community and political pressure for action; and
- applicability of information across species.

Based on this, the VPC's Working Group overseeing the project chose the rabbit, fox, feral goat, feral pig and feral horse.

Guidelines for the feral horse were prepared first. The horse was chosen as a pilot species because horses combine most of the elements of the pest management problem. They are a pest to both primary production and the environment, they are used com-

mercially, they pose significant animal welfare issues and are potential vectors of exotic disease.

What about potential new pests?

There are many potential pests which, if given the chance, could establish in Australia. They include species already kept in Australia, such as the five-lined palm squirrel (*Funambulus pennanti*), which has escaped from both Perth and Taronga Zoos, and the red-billed quelea (*Quelea quelea*), a major grain pest throughout Africa but which is kept in Australian private collections. A potential pest import is the golden hamster (*Mesocricetus accuratus*), which is a favourite pet but a major pest of growing and stored grain in Europe.

Control is partly through the *Quarantine Act 1908* administered by the Australian Quarantine and Inspection Service (AQIS), partly through the *Wildlife Protection (Regulation of Exports and Imports Act) 1982* administered by the Australian National Parks and Wildlife Service (ANPWS) and partly through various State and Territory legislation controlling the possession, movement and trade of exotic vertebrates. Bomford (1991) established criteria for assessing the pest risk of exotic vertebrates which are used by the VPC.

Advice on the control of the import and keeping of exotic vertebrates is provided by the VPC. The VPC undertakes a continuing review of pests in Australia, including measures for the exclusion of potential pests from overseas and measures for their containment within appropriately secure premises, if they are imported.

2. Nationally coordinated management of vertebrate pests

2.1 Why national guidelines?

The Commonwealth Government has embarked recently on several national initiatives aimed at conserving Australia's natural resources. These include Ecologically Sustainable Development (ESD), the Endangered Species Program, and the Decade of Landcare, which incorporates the Murray Darling Basin Commission Natural Resource Management Strategy, National Landcare, One Billion Trees and Save The Bush programs. The Commonwealth intends to invest \$320 million on Decade of Landcare programs.

Pests such as the rabbit, fox and feral pig threaten the effectiveness and objectives of these national programs. Effective management of pest impact is needed. States and Territories also have a major interest in the successful outcome of these programs to assist in achieving their respective land management goals for both nature conservation and agricultural production.

2.2 Why review current management?

The ESD Working Group on Agriculture (ESD 1991) recommended that objectives for agriculture and land resource management need to be reviewed to ensure that they meet nationally agreed ESD goals. Other reasons for reassessing current vertebrate pest management include the following:

- Management needs to focus on reducing detrimental impacts and not just pest numbers. Much current practice concentrates on the pest and its numbers, and the links between pest density and impact are poorly quantified. Consequently, it is often difficult to determine the cost-effec-

tiveness of control action (Example 1). Concentration on the pest can also divert attention from other system aspects, such as farming practice, that may be significant for deciding the best management strategy.

- The emphasis of resource management, whether for agricultural or nature conservation purposes, is now on managing the system and the links between the elements, rather than the separate elements of the system (Hawke 1989; Drought Policy Review Task Force 1990; SCA 1991; Landcare 1991; ESD Report on Sustainable Agriculture, ESD 1991; Braysher 1991). Social, political, biophysical and economic factors are all parts of the resource management system, and in many areas are probably more important than pest animals or weeds in determining land management outcomes. All factors and their interactions need to be considered.

'Management needs to focus on reducing damage and not just pest numbers.'

- The Commonwealth, State and Territory Governments have endorsed the principle of beneficiary-pays. The IGAE (1992) states that a user of goods and services should pay, based on the full costs of providing the goods and services. The trend is to ensure that, where practicable and where it is in the public interest, the costs of vertebrate pest management are identified and assigned to the beneficiary. The danger of subsidies is that landholders can be shielded from the economic and ecological implications of their management practices. Nevertheless, government still has an important role in pest management, especially for the land it manages, to achieve community goals, and where market forces fail to achieve the desired outcome (Section 4.2).
- There is an increasing expectation in society that minimising animal suffering should be a primary consideration in pest

Example 1: Relationship between pest density and damage

A knowledge of the relationship between changes in pest density and the level of damage inflicted can help determine the cost-effectiveness of management. The relationship will vary because of several factors including the nature of pest action, the resource to be protected and seasonal conditions. Figure 1 shows three theoretical relationships, A, B and C.

'A' represents a direct linear relationship between pest density and damage. An example might be the competition for pasture that is something assumed to occur between sheep and rabbits. It is the form often used to calculate the benefits to pastoralism of rabbit control (Sloane *et al.* 1988, Michelmore 1991). Assuming sixteen rabbits are equivalent to one sheep (Short 1985), reducing rabbit density should enable X/16 more sheep to be run where X is the number of rabbits removed from the property. This is simplistic. There is evidence that in the rangelands of New South Wales (NSW), competition between sheep and rabbits only occurs at high rabbit densities or when pasture biomass is less than 250 kg ha⁻¹ (Short 1985). That is, pest damage is often low until a threshold density is reached as represented by 'B' in Figure 1.

'C' represents a situation where pest damage remains high even at relatively low pest densities. An example might be pig predation of winter lambs where damage is due to a few rogue

boars (Pavlov *et al.* 1981). Reducing overall pig density may fail to take most of the rogue boars so damage remains high even at low pig densities. Another example of 'C' is rabbit browsing of regenerating native shrubs. Lange and Graham (1983) showed that rabbits at less than one per hectare can prevent regeneration of some rangeland species of acacias.

If the cost of reducing pest density is known, the threshold density required to achieve optimal cost-effective management of pest damage can be determined. (---) in Figure 1 represents a theoretical relationship between pest density and the cost of pest removal. Control costs usually increase exponentially as pest density decreases. In other words, the lower pest density the more difficult it is to remove additional animals. Studies have confirmed this relationship between pest density and cost of control for some species including a study on helicopter shooting of feral pigs, donkeys and buffalo (Choquenot 1991). Factors such as nature of the pest, control techniques used, operator experience and habitat will affect the shape of this curve. The theoretical density to which it is most cost-effective to reduce pests is where (---) intersects the graph of damage versus density (A, B or C).

The relationships shown in Figure 1 are only three examples out of many possibilities. Real relationships are usually difficult to determine accurately. Nevertheless, a better understanding of impact and its relationship to pest density will enable land managers to manage pest damage more effectively.

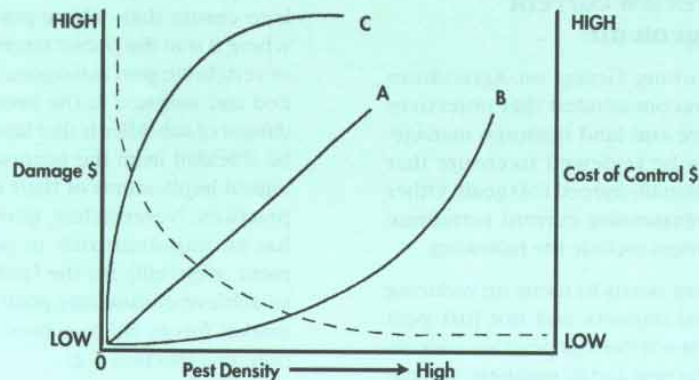


Figure 1: Relationship between pest density and damage for three theoretical situations (A, B and C) and between cost of control and pest density (---).

animal management (Section 4.8). As an indication, the Senate Select Committee on Animal Welfare which was established in 1983, conducted an inquiry into the culling of large feral animals in the Northern Territory. The animal welfare implications of current and proposed management strategies need to be critically assessed for each species and modified where necessary. In some cases the action needed is clear, for example, banning the use of steel-jawed traps for rabbit management, but other cases are more complex.

- Many vertebrate pests are commercially exploited. Examples include feral horses, feral goats, feral pigs and rabbits. The annual wholesale value of industries based on these animals is estimated to be \$A80 million with a major proportion of the trade being international (Ramsay, in preparation). Although this current value is small compared to the agricultural and environmental impact caused, there is, nevertheless, potential to integrate the commercial use of some species into pest management strategies. The impact and role of the commercial use of vertebrate pests in pest management needs to be assessed critically and integrated with other elements of management.
- There is an extensive amount of scientific and technical information on vertebrate pests and their management, much of it in scientific journals and relatively inaccessible reports. It needs to be critically assessed and, where appropriate, incorporated into 'best practice' pest management.

***'Role of commercial use of
pests in pest management
needs to be assessed.'***

For these reasons, it is timely for current vertebrate pest management to be assessed critically to ensure that best use is made of available scientific information and available resources. Until now the development of

coordinated national management guidelines for vertebrate pests has been limited by a lack of resources and, to some extent, a lack of information.

2.3 Goal, aims and desirable outcomes of developing national guidelines

Goal

To provide widely endorsed national guidelines that contribute to sustainable land use, including restoration of degraded land and protection of natural heritage values, through the effective management of the agricultural and environmental damage caused by major vertebrate pests.

Aims

- To prepare best-possible, humane, scientifically based guidelines for managing the agricultural and environmental impact of major vertebrate pests.
- To identify information deficiencies and establish research priorities.
- To have the guidelines endorsed and adopted by the major organisations concerned with vertebrate pest management, namely those representing relevant government and private land managers, and community and other organisations.

Outcomes

The project will provide the following products to government and non-government land managers:

- Guidelines for the coordinated management of vertebrate pests scientifically based 'best practice'. The guidelines will define the processes for planning and evaluating vertebrate pest management, including identification of control options and techniques for distinguishing between options. Further, they will link vertebrate pest management to Landcare, ESD and other initiatives to which State, Territory and the Commonwealth Governments are committed.

- A prioritised list of information deficiencies. This will help government, research and development corporations and other funding bodies as well as research organisations to appropriately target future research.
- Recommendations to governments on legislative and other changes necessary to enhance the management of vertebrate pests.

The community will benefit from:

- greater awareness of problems and choices in resource management relating to pests;
- more effective use of Australian and international developments in the science of vertebrate pest management;
- reduced management costs through more effective use of available techniques;
- better control of the environmental and agricultural impact of pests;
- a more equitable distribution of costs and benefits of vertebrate pest management through better identification of beneficiaries and the appropriate allocation of costs;
- recognition and appropriate action regarding community concerns about animal welfare aspects of vertebrate pest control;
- a greater understanding of vertebrate pest impact and what can and should be done to alleviate it; and
- more focused vertebrate pest research.

2.4 Who will use the guidelines?

The Commonwealth has a major stake in cost-effective pest management through the land it manages and through its investment in national land management programs. The guidelines will be the basis for pest animal management on Commonwealth land, and their use will be encouraged through national programs. However, national interests will be achieved primarily through appropriate

pest animal management by other land managers. Consequently, the guidelines have been prepared principally as resource documents for the use of State and Territory agencies responsible for vertebrate pest management, although they will also be useful for non-government organisations and other community groups. Being national in scale, the guidelines are necessarily broad. States and Territories can use them to develop more detailed and specific strategies to address local or regional needs in consultation with relevant interest groups. VPC has a primary role in this process both as a committee and through its member agencies.

In developing the national guidelines, it was recognised that there are many groups with a major interest in how vertebrate pests are managed. These include pastoralists, farmers, conservationists, Commonwealth, State and Territory national parks and wildlife services and vertebrate pest agencies, researchers and research funding bodies, animal welfare groups, Aboriginal communities and Australians in general. Consequently, a range of relevant interest groups was involved in the development process to encourage the adoption and successful implementation of guidelines (Section 2.5).

2.5 How the guidelines were developed

Role of VPC

The guidelines have been produced under the guidance of VPC, which endorsed the project in April 1991 and agreed to coordinate it through a working group. The working group has representatives of major organisations concerned with vertebrate pests, namely, VPC, the Standing Committee on Conservation of the Australian and New Zealand Environment and Conservation Council, the Australian Conservation Foundation and the National Farmers' Federation (see Appendix B for the terms of reference and composition of the working group).

Workshop

A workshop in Canberra on 6–7 June 1991 developed the approach for the project and the guidelines. The results of the workshop are presented in a Bureau of Resource Sciences (BRS) Working Paper (Braysher 1991). Ideas developed at and after the workshop form the structural basis of the guidelines.

Task force approach

Experts in extension, training, pest management and research were contracted by BRS to prepare the guidelines under the guidance of the VPC Working Group.

Endorsement of guidelines

VPC and BRS are keen to ensure that the guidelines are widely accepted as the basis for vertebrate pest management. Consequently, comments on and endorsement of the guidelines have been sought throughout their development from relevant government and private land managers, and community and other organisations besides those represented on the VPC working group, including:

- Aboriginal Land Councils;
- Environment and Conservation Policy Division, Department of the Arts, Sport, the Environment and Territories;
- National Consultative Committee on Animal Welfare;
- relevant research and development corporations;
- Soil Conservation Standing Committee, and through it the State and Territory Landcare coordinators;
- Standing Committee on Forestry; and
- Subcommittee on Animal Welfare.

2.6 How the guidelines will be used

The test of any document is the action that arises as a result of its publication. The

process will have failed if the document is simply added to the publications on agency shelves.

It is expected that State and Territory agencies primarily responsible for managing vertebrate pests will use the philosophy and procedures outlined in the guidelines for managing vertebrate pests within their respective jurisdictions.

In his 1992 Environment Statement, the Prime Minister announced \$5 million for a four-year program commencing in 1993, to implement 'best practice' pest animal control in key demonstration projects, and show the benefits for agriculture and the environment of this approach through a national education strategy.

'Demonstration programs will be conducted cooperatively with State and Territory agencies and community groups.'

BRS will oversee the program. Demonstration programs will be conducted cooperatively with State and Territory land management and conservation agencies, rural land protection boards, community groups and individuals according to endorsed 'best practice' guidelines.

Shared ownership

Greatest benefit will be obtained if relevant government and non-government land managers and other interest groups cooperatively use the guidelines as a base for assessing, planning and carrying out pest management programs. This cooperative approach is the basis of Landcare.

Recent experience with community-based groups, whether under Landcare or more formally organised through State and Territory soil and land management boards, has shown that pest control is more effective when individuals or groups responsible for and benefiting from the control are intimately involved in the development and implementation of the control program and share its objectives. This approach has potential

significant cost savings to land managers through, for example, shared use of equipment and other resources. This is best illustrated by Example 2.

Although the long-term effectiveness of community-based action groups needs to be established, they show great promise. Recognising this, the ESD report on sustainable agriculture (ESD 1991) sees the growing potential for Landcare and similar programs to foster collective action and the adoption of sustainable management practices. It recommends that Landcare should be extended to cover general farm manage-

ment issues (such as finance, risk, native vegetation and animal management, weed and pest control and chemical use). It recognises, however, that continued support for Landcare facilitators and technical services is essential for the expansion and effectiveness of these community-based groups (ESD 1991).

Sustainable management

Most States and Territories are developing or progressively implementing regional or Integrated Catchment Management (ICM) approaches to land resource management (ESD 1991; SCA 1991). Many also incorpo-

Example 2: An example of government and local community cooperation to conserve biodiversity

It is becoming widely recognised that the reservation of large tracts of suitable habitat is not sufficient to conserve our native biodiversity (Margules *et al.* 1988; Saether and Jonsson 1991; ESD 1991, 1992). Off-reserve management, much of it on private land, will be essential to maintain Australia's biological heritage. There are limited government resources available to acquire suitable habitat and appropriately manage it.

Peter Copley (pers. comm.) gives a South Australian example of government and local community cooperation to conserve natural resources on private land.

Mallee fowl (*Leipoa ocellata*) in the South Australian mallee are threatened by habitat fragmentation, rabbit damage to remaining vegetation, and by introduced predators. Remaining populations are on a mixture of private land and nature reserve. The traditional approach to conserving them is to acquire the private land, develop extensive networks of native habitat to connect remaining fragments, and to control rabbits, foxes and feral cats, an expensive undertaking in both initial land acquisition and ongoing management.

Following the introduction of native vegetation clearance controls in South Australia in the 1980s,

the management of remnant habitats has become a focus for community land management and conservation effort. For example, in the Mantung/Mageea district of the Murray mallee, landholders have established a land management group to carry out a district conservation plan under the national Save The Bush Program (Barrett *et al.* 1991). A major aim of the plan is to protect mallee fowl and manage their habitat. Shared objectives were developed between officers of ANPWS managing adjoining reserved land and the farmers and their families from eleven associated properties. A major task for the group was to coordinate fox and rabbit control across the mallee fowl habitat.

The group approach has helped the Mantung/Mageea farmers to:

- obtain government grants;
- develop and coordinate pest management to protect mallee fowl;
- provide a structure to test fox-baiting techniques and strategies; and
- gain easier access to advice and assistance from relevant government departments.

Although operating only since 1989, the group has made significant progress toward developing a district pest management strategy. It already shows promise as a useful model, with adjoining landholders seeking to join the group. Its effectiveness will be assessed by monitoring the mallee fowl population and the regeneration of native vegetation.

rate development of property management or whole-farm plans in cooperation with the landholder. The ICM approach and property management plans facilitate integrated management of all elements (including weeds, animal pests, production and grazing pressure) to protect resources and promote sustainable use. The ESD report on sustainable agriculture (ESD 1991) recommends that State and Territory ICM programs be strengthened and that governments support the whole-property approach to land management. Management guidelines for vertebrate pests are consistent with this approach.

Education and training

It is recognised that adopting an integrated approach to resource management may require different skills and extensive training for vertebrate pest field officers. The ability of extension officers and researchers to communicate technical and other information to land managers effectively is considered critical to sustainable land management (ESD 1991). Field officers need communication, farm management, soil conservation and other skills besides traditional pest animal management expertise. This training is likely to be slow and expensive, going by the New Zealand experience under the Rabbit and Land Management Program (Williams 1991). Governments at all levels need to consider strategies and funds for addressing these needs.

Other means of conveying information and encouraging appropriate vertebrate pest management also need to be developed;

for example, packaging the guidelines as either computerised or paper decision support systems, or both. These systems can assist the effective communication of relevant information and help develop a consistent and 'owned' approach to achieving land management objectives. RABBIT, TEAMS and RANGEPAK are a few examples (Stuth 1991).

Both SCA (1991) and the ESD sustainable agriculture report (ESD 1991) emphasise the need for information transfer to land managers using decision support systems as an important part of an increased emphasis on education and extension associated with resource management. Not all land managers have access to computers, so this method is perhaps more applicable to the community group approach to land management.

2.7 Review of the guidelines and their implementation

It is essential that there are arrangements for the systematic and regular assessment of the implementation of the guidelines and their review, the latter taking account of technological and other developments. The terms of reference of VPC make this the most appropriate agency for the task. VPC will annually review implementation of the guidelines and update them as necessary, but at least every five years.

The BRS pest animal demonstration program (Section 2.6) will assist VPC to implement the guidelines and assess their effectiveness.

3. Current Legislation and the Structure of Pest Management

Primary responsibility for vertebrate pest management lies with landholders and occupiers, whether government or non-government. Each State and Territory, as well as the Commonwealth, has its own structural arrangement and suite of legislation to regulate vertebrate pest management within its respective jurisdiction (See Appendix C).

Strong powers exist for governments to require owners and occupiers of land to undertake vertebrate pest control, or to take action and bill the landholder. Such action is usually a last resort. Usual practice is first to inform the landholder of the need for action, and to advise and encourage cooperation, an approach strongly endorsed in the ESD report on sustainable agriculture (ESD 1991).

A brief overview of vertebrate pest management for the Commonwealth, States and Territories is presented below. The summary necessarily concentrates on the agricultural sector because it is for this sector that most jurisdictions have established separate vertebrate pest management agencies.

State and Territory nature conservation agencies usually do not address vertebrate pest management as a separate issue, although their management is still a major concern. Consequently, it is not practicable to present the current situation for these agencies in a similar format. However, there is usually close cooperation and information exchange on vertebrate pest management between agricultural and wildlife conservation agencies. Some States and Territories, notably Victoria, have fostered this interaction by integrating into one department the major areas responsible for resource management.

The need to review the way natural resource management policy and program

delivery are practised at all levels of government is discussed in more detail in Section 3.10.

3.1 Commonwealth

The Commonwealth has one department and one agency with major responsibilities for vertebrate pest management, the Department of Primary Industries and Energy (DPIE) and the ANPWS within the environment portfolio.

DPIE is committed to the development and implementation of strategies for ecologically sustainable development, including the appropriate management of vertebrate pests. In cooperation with the States and Territories, it is responsible for administering relevant programs such as the National Landcare Program, as well as general oversight of the Decade of Landcare. DPIE also works cooperatively with the States and Territories through various mechanisms to develop and coordinate vertebrate management at the national level.

DPIE administers the *Quarantine Act 1908* that regulates Australian importation of exotic animals to ensure that unwanted diseases and pests are not introduced (Section 1.3). The Act also provides national powers to control outbreaks of exotic diseases. States and Territories have enacted complementary legislation to enable coordinated control of exotic disease outbreaks under the Australian Veterinary Emergency Plan (AUSVETPLAN), and to control the keeping and transfer of exotic animals with significant pest potential (Bomford 1991). BRS administers the Wildlife and Exotic Disease Preparedness Program (WEDPP), which has a primary aim to develop operational plans for controlling exotic diseases in wild animals, principally vertebrate pests. Information gathered under WEDPP is incorporated into AUSVETPLAN.

ANPWS is responsible for vertebrate pest control in Commonwealth national parks and, where relevant, it ensures that management is consistent with the objectives of the relevant State and Territory authorities. An example is ANPWS' management of Kakadu

National Park in relation to the Conservation Commission of the Northern Territory (CCNT).

ANPWS also administers the *Wildlife Protection (Regulation of Imports and Exports) Act 1982* that regulates the import and keeping of potential environmental pests (Section 1.3). In addition, it administers Save the Bush, One Billion Trees and the Endangered Species programs as well as providing assistance to States and Territories for research and management of national parks and reserves, including management of pest animals and plants.

Relevant Commonwealth departments are required to manage vertebrate pests on their Commonwealth-acquired land. The Department of Defence, for example, is a major land manager, controlling 3.7 million hectares (Landcare 1991). It is updating its land management policies to incorporate the principles of sustainable land management.

3.2 Australian Capital Territory

Principal Act and authority

The principal Act in the Australian Capital Territory (ACT) is the *Rabbit Destruction Act 1919*. The ACT Parks and Conservation Service of the Department of Environment, Land and Planning has primary responsibility for vertebrate pest management in the national park and nature reserves that represent approximately 40 per cent of the ACT. The Service provides advice and assistance on vertebrate pest control to rural lessees, although rural land is now a relatively small proportion of the ACT.

Advisory body

The Parks and Conservation Consultative Committee advises the Minister responsible for Environment and Land Planning on a range of matters including vertebrate pest management. It includes representatives of community conservation organisations and the Rural Lessees' Association.

Control/action/role

Private rural lessees, with advice and assistance from departmental officers, are required to manage pests on their leases.

Funding

Funds for research, inspections and administration come from consolidated revenue although lessees contribute to the costs of control through the provision of labour and some materials.

3.3 New South Wales

Principal Act and authority

The *Rural Lands Protection Act 1989* is the principal act regulating vertebrate pest management. It establishes the fifty-seven autonomous Rural Lands Protection Boards (RLPBs) which have primary responsibility for ensuring vertebrate pest management within their respective Boards. The RLPBs report to the Minister responsible for Agriculture and Rural Affairs.

The Department of Conservation and Land Management, which administers the *Crown Lands Act 1989* and the *Western Lands Act 1901*, has overall responsibility for resource protection of the leased Crown Land in the Western Division, approximately 40 per cent of New South Wales. It can issue orders to protect resources by measures including destocking and pest animal control. However, primary responsibility for vertebrate pests remains with the respective RLPBs. The Department of Conservation and Land Management works cooperatively with the RLPBs to ensure vertebrate pest management.

The Wild Dog Destruction Board established under the *Wild Dog Destruction Act 1923* has local landholder representatives and is responsible for the construction and maintenance of the New South Wales Wild Dog Fence.

Advisory body

The Minister for Agriculture and Rural Affairs is advised on vertebrate pest matters by the

Vertebrate Pests Control Advisory Committee which has representatives of the CSIRO Division of Wildlife and Ecology, the Wild Dog Destruction Board, three RLPB members and the New South Wales Farmers' Association.

Control/action/role

The Agriculture Protection Program of the Division of Animal Industries conducts vertebrate pest research, and provides training and advice to RLPBs.

Funding

The salaries of vertebrate pest research officers are paid from consolidated revenue although operational funds come almost exclusively from industry. The RLPBs obtain the bulk of their funds through landholder levies that are used to maintain their inspector staff and vertebrate pest officers. Funds for maintaining the Wild Dog Fence are obtained through levies on lessees.

3.4 Northern Territory

Principal Act and authority

The *Territory Parks and Wildlife Conservation Act 1988* is the principal act used to manage vertebrate pests. Vertebrate pest policy development and control is coordinated jointly by the CCNT and the Department of Primary Industry and Fisheries (DPIF). Pests or pest areas can be declared under this Act, which also has provisions to require control to be undertaken.

Advisory body

There is no advisory body following the lapse of the Feral Animals Committee. The need for a committee is being assessed.

Control/action/role

The Northern Territory is divided into five control regions with CCNT and DPIF staff in each region responsible for inspections and coordination of pest animal control. Vertebrate pest research, training and extension is shared between the two departments. Administration, research and operational

funds for CCNT and DPIF staff for pest management are provided out of consolidated revenue. The CCNT in cooperation with DPIF provides the technical and administrative support for overseeing the implementation of programs.

In recent years, the major concentration and expenditure on vertebrate pests have been on the Brucellosis and Tuberculosis Eradication Campaign administered by DPIF and the Commonwealth. The bulk of staff and other resources has been allocated to this program. Other pest management priorities are expected to be addressed as the program nears completion.

The majority of Aboriginal land in the Northern Territory has been acquired under the *Commonwealth Aboriginal Land Rights (Northern Territory) Act 1976* and control is vested in the Aboriginal Land Councils (ALCs). In general Councils ensure that management of Aboriginal land is consistent with Northern Territory vertebrate pest legislation and policy. This is difficult. Much of the Aboriginal land produces little income or has little economic potential. Only limited funds are available to assist through programs such as the BRS Aboriginal Rural Resources Program. Without additional resources, it is unlikely that Aboriginal people can carry out significant pest animal management other than at the level that can be achieved through commercial use of pest animals.

The national parks, Uluru and Kakadu, are Aboriginal land leased to the Commonwealth and declared under the National Parks and Wildlife Act. As with other land, the owner or occupier is required to manage vertebrate pests, consistent with the requirements of Northern Territory legislation and policies.

Funding

Except for relevant government staff and operational expenditure, the cost of control of vertebrate pests is borne by the landholder. Where considered appropriate, government assists with advice, poison and ammunition for culling large feral animals.

3.5 Queensland

Principal Act and authority

The *Rural Lands Protection Act 1985–1990* provides the principal powers for regulating vertebrate pest management. The Land Protection Branch of the Department of Lands is the primary vertebrate pest management agency.

Advisory body

The RLPB established under the Act advises the Minister for Land Management on vertebrate pest policy. It consists of fourteen members, including eleven primary producers and representatives of the Departments of Primary Industry, Lands and Local Government.

Control/action/role

The Land Protection Branch of the Department of Lands provides administrative, research, inspection and technical support for implementing and regulating vertebrate pest management. Staff are devolved to ten regional centres. They liaise closely with local shire councils and their stock-route supervisors to administer the Act and to advise on and assist with vertebrate pest management.

The dingo barrier fence is maintained by the Land Protection Branch and funded by the Rural Lands Protection Fund. It is partly financed through local authority levies based upon numbers of stock protected by the fence.

Representatives of both Commonwealth and State agencies with a major interest in vertebrate pests are involved formally in setting the strategic direction for vertebrate pest research. A business plan has been developed focusing on coordinating research between the Land Protection Branch Research Unit and relevant Commonwealth, State and Territory agencies.

Funding

The Rural Land Protection Fund is financed through landholder levies. The Land

Protection Branch draws on this fund for operations although the shortfall comes from consolidated revenue. Approximately 70 per cent of funds are provided through the levies, the rest coming from consolidated revenue.

3.6 South Australia

Principal Act and authority

The principal Act is the *Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986*. It establishes the Animal and Plant Control Commission (APCC), which reports directly to the Minister for Primary Industries. The Act binds the crown and requires owners and occupiers of land to control pests proclaimed under the Act. Government landholders, NPWS, the Woods and Forest Department and others undertake their own pest control consistent with State policy.

The *Dog Fence Act 1946* establishes the Dog Fence Board that reports to the Minister for Environment and Land Management and oversees maintenance of the dog fence.

Advisory body

The APCC consists of nominated representatives of the Department of Primary Industries, the Department of Environment and Land Management, the Local Government Association and primary producers. It advises the Minister on vertebrate pest policy and establishes priorities for pest control.

Control/action/role

The APCC undertakes research and provides training and technical advice on pest animal control as well as field staff who advise and provide technical assistance to local Animal and Plant Control Boards (APCBs), government agencies and the public.

The forty-one APCBs comprise nominees of local government councils. An APCC officer attends each meeting. The APCBs are responsible for administering the Act within their region. They have their own inspectorial staff who are trained by the APCC.

Funding

The APCC is funded from consolidated revenue although a significant proportion of the research budget is funded from various industry and other sources. The APCBs are funded approximately half by member council contributions and half from consolidated revenue. Control operations undertaken by the APCC are fully cost-recovered except for work on unallocated Crown Land. An allocation of the APCC budget is dedicated to control on this land.

All landholders with more than 10 km², except those on Kangaroo Island, are levied on a sliding scale to fund the Dog Fence Fund. Dingo control is overseen by the APCC although control is the responsibility of landholders. Landholders adjoining the fence maintain it using funds from the levy.

3.7 Tasmania

Principal Act and authority

The principal Act is the *Vermin Destruction Act 1950*. It regulates the management of declared vermin, currently only rabbits. It is administered by the Animal Health Branch of the Department of Primary Industry and Fisheries. Other major agricultural pests are native animals that are controlled through permits issued under the *National Parks and Wildlife Act 1970*.

The State is divided into thirteen districts, each with one or more officers responsible for animal health matters as well as for enforcing the Vermin Destruction Act and providing advice and assistance on pest management.

Advisory body

There is no formal vertebrate pest advisory body although the Wildlife Advisory Committee advises the Minister for Parks, Wildlife and Heritage on a range of matters including pest management.

Control/action/role

Research and supervision of poisoning is

provided by the Vertebrate Pest Section of the Animal Health Branch. Liaison with other departments on vertebrate pest management, for example, National Parks and Wildlife and Forestry, is informal.

Funding

There is no levy on landholders. Research, administration and inspection are funded from consolidated revenue. However, landholders and occupiers are charged the costs of control undertaken on their land.

3.8 Victoria

Principal Act and authority

The *Vermin and Noxious Weeds Act 1958* provides the principal powers for regulating vertebrate pests. It is administered by the Land and Catchment Protection Branch of the Department of Conservation and Natural Resources. The Department was formed by the amalgamation of former conservation, forest and land departments and elements of environment, planning and water resources departments. The aim was to bring together in one department all sections responsible for land and water resource management.

Advisory body

The Act also establishes the Land Protection Council, which advises the Minister for Conservation and Natural Resources on general land management matters including vertebrate pest management. It consists of eight elected landholders and four community representatives (Victorian Farmers' Federation, conservation groups, trade unions and a ministerial nominee). There are also sixteen Land Protection Regional Advisory Committees, comprising local landholder representatives and community interest groups.

Control/action/role

Land managers, including relevant government departments, are each responsible for managing pest impact on their land. Most public land is managed by the Department of Conservation and Natural Resources.

Victoria encourages and helps facilitate the formation and action of landcare and other community land management groups as a principal means of developing ownership of and action on land management issues.

The Land and Catchment Protection Branch works closely with the Flora and Fauna Branch and relevant government forestry agencies on pest animal control, especially regarding native pest management. The Branch is responsible for policy development, training, extension and research in relation to pest management under advice from the Land Protection Council. Management is devolved to sixteen land management regions.

Funding

There is no landholder levy scheme. All operations of the Land and Catchment Protection Branch are funded through consolidated revenue. There is a charge for services to landholders under some circumstances, for example, bait preparation or equipment hire, or where government undertakes control on private land. Research, however, is often funded through external grants and other sources.

3.9 Western Australia

Principal Act and authority

The Agriculture Protection Board (APB) is constituted under the *Agriculture Protection Board Act 1950*. Administration of the *Agriculture and Related Resources Protection Act 1976*, which is the principal Act for vertebrate pest and weed management, is delegated to the APB.

Advisory body

The APB comprises a representative of the Department of Agriculture (Director General of Agriculture as Chairman), the Chief Executive Officer of the APB and nine other members representing the State Zone Control Authorities (ZCA). Each ZCA has an APB officer as its executive officer. These authorities comprise representatives of their

Regional Advisory Committees, of which there are twenty-one. Members of these Committees are nominated by local government bodies and local industry bodies.

Control/action/role

The APB undertakes vertebrate pest research, and its field staff provide inspectorial, advisory and operational functions to public and private landholders.

The APB formally liaises with the Department of Conservation and Land Management on vertebrate pest matters, and informally with other government land management agencies.

The Regional Advisory Committees and ZCAs formulate local policy and recommend action to the APB regarding the effective implementation of policies, including expenditure of funds.

Operational plans are developed for each region. These are linked with species management plans that define the strategies for managing the pest and the underlying rationale.

Funding

The APB administers two major funds: the Agriculture Protection Board fund, which is financed from consolidated revenue and used to pay for APB research, administration, inspection and extension; and the Declared Plants and Animals Fund which is raised by a rate on all pastoral leases, matched by Government.

Operational costs for pest control, except for APB staff costs, are borne by the landholder in agricultural areas and by the Declared Plants and Animals fund in pastoral country.

3.10 Current arrangements for vertebrate pest management: the need for review

Although each State and Territory has the constitutional right to its own legislation and procedures for managing vertebrate pests, there is scope for a more consistent

approach. Currently, agriculture and natural resource management in some States is spread between several agencies often with independent policies and programs. This can reduce the effectiveness of program delivery through lack of coordination, insufficient or inappropriately directed resources and regulatory distortions leading, for example, to contradictory management practices. In recognition of this, SCARM, in its report on sustainable agriculture (SCA 1991), recommends that there be a regular review of all relevant Commonwealth and State and Territory programs and structures to ensure that they become or remain consistent with the principles of sustainable agriculture, and, in particular, that attention be given to an integrated approach to the management of the natural resource base of agriculture and associated ecosystems.

Further, the SCA report recommends that Commonwealth, State and Territory Governments examine the nature of and respective roles in the formulation and delivery of resource management programs including pest animal and weed control, to

achieve appropriate coordination. At State and Territory level this should include service delivery and determining the extent to which this should be regionalised. The need for review has been reinforced in the ESD Sustainable Agriculture Report (ESD 1991) and the IGAE (IGAE 1992).

These recommendations are being addressed in the Commonwealth component of the Decade of Landcare Plan (1991), and by a joint working party comprising representatives of each of the standing committees of the ministerial councils for agriculture, forestry, soil conservation and water resources and the Working Party on the Coordination and Integration of Natural Resource Policies and Programs. The latter has been established to develop options for improving the coordination and integration of natural resource management policies and programs, especially cross-portfolio issues such as resource pricing, biodiversity, soil erosion and pest animal and weed control, at Commonwealth, State and local levels.

4. Principles of Vertebrate Pest Management

The purpose of this section is to outline the principles on which managing the impact of vertebrate pests should be based. Some of these are covered in detail in other reports, most notably the ESD report on sustainable agriculture (ESD 1991), and will be mentioned only briefly in this section.

4.1 Consistency with ESD principles

The Commonwealth, in cooperation with the States and Territories, recently embarked on developing an ESD strategy for Australia. The idea of sustainable development was brought into focus in the 1987 report of the World Commission on Environment and Development, the Brundtland Report (WCED 1987). This report defined sustainable development as that which 'meets the needs of the present without compromising the ability of future generations to meet their own needs'.

In the Australian context, this concept was addressed in the Commonwealth discussion paper 'Ecologically Sustainable Development', June 1990. Following public comment the Commonwealth established nine sectoral working groups under three chairmen to consider the implementation of ESD principles in those sectors of the economy which have significant interrelationship with the environment.

Many principles for ESD were identified to guide the working groups. Those principally applying to land management can be summarised as:

- maintaining and enhancing material and environmental qualities;
- ensuring that the actions of some individuals do not compromise the needs of others either currently or in future generations;

- protecting biological diversity and the maintenance of ecological processes and life support systems; and
- applying the 'precautionary principle' of dealing cautiously with risk, uncertainty and irreversibility.

Protection of biodiversity is currently receiving special attention through the National Strategy for the Conservation of Australia's Biological Diversity being prepared by the Biological Diversity Advisory Committee. Its goal is to ensure that Australia's biological diversity survives and flourishes. The draft strategy out for discussion strongly emphasises conservation of species. Little consideration is given to the ecological processes which underlie species conservation. The value of the Strategy would be improved if greater recognition was given to the impact that environmentally sensitive land management practices could have on the conservation of biodiversity. The challenge is to strike a balance between the use of natural resources for monetary gain and conservation of natural resources.

'Need to manage vertebrate pest damage as part of the whole management system.'

The process for achieving this needs to be consistent with ESD principles, possibly through an analytical framework, to develop an optimal mix of land uses.

How do the national vertebrate pest guidelines link into ESD and the national biodiversity strategy?

Vertebrate pests can influence the success of initiatives for sustainable land management and the protection of biodiversity by, for example, preying upon native species, destroying habitat, and overgrazing leading to soils loss. Effective management of vertebrate pest damage, conducted in accordance with the national guidelines developed under this project, will provide an important mechanism for supporting and promoting ecologically sustainable development in primary production and protecting Common-

wealth, State and Territory natural heritage values. These guidelines will provide land managers with up-to-date, critically assessed information and a strategic approach for effective national pest management.

Achieving ecologically sustainable development that includes conservation of biodiversity will require a whole-system approach from problem appraisal through to planning and management. The need to manage vertebrate pest impact based on consideration of the whole system and the links between its elements will be strongly emphasised in the vertebrate pest guidelines. Both agricultural and resource conservation goals are to be addressed as well as the concerns of all major interest groups.

4.2 Adopting a beneficiary-pays approach

As outlined in Section 2.2, the Commonwealth, States and Territories endorse the principle of beneficiary-pays (IGAE 1992). The objective is to ensure that the full costs of management are identified and, where appropriate, assigned to the beneficiary whether they be a private individual or the regional, State or Commonwealth community. (Note that benefits refer not only to financial gains, but also to non-market benefits such as improved protection for a threatened native plant or animal. Management costs can be similarly identified.)

The identification of beneficiaries and the true costs of management has implications for all areas of land management, not least for conserving Australia's natural heritage. Reserve networks alone will never be adequate to conserve biological diversity because many species are not represented on reserves (Saether and Jonsson 1991; ESD 1992), and many reserve systems are fragmented. This is especially true of the south-west slopes of eastern Australia and the wheat belts of South and Western Australia. Protection of natural biodiversity should be a principal objective for non-protected areas, for example, agricultural and forestry land containing significant natural habitat (Margules et al. 1988; ESD 1991 and 1992).

Many landholders are willing to bear some of the additional management costs involved in protecting conservation values, for example, the control of predators such as the fox to a greater degree than required to protect agricultural production. Where the cost is likely to be significant and the landholder is not the principal beneficiary (for example, the general community may also benefit) government should contribute. Therefore, mechanisms are needed to identify the major beneficiaries and to ensure that they pay the management costs.

But what are the benefits or costs to a land manager as a result of management or mismanagement of pests by other land managers, that is, external benefits or costs? What mechanisms are there for identifying, valuing and appropriately apportioning these costs? Do market forces fail in this area? What is the role of government? These questions raise two major issues: imperfect knowledge of the system and the role of government.

Imperfect knowledge

If management costs are to be attributed to the beneficiary, full costs and benefits need to be known. This information is often either unreliable or unknown. Without reliable information, managers risk making inappropriate management decisions, (Section 4.7). For example, a grazier may be required to manage rabbits to protect the land resource base and to control their impact on production. However, rabbits may need to be reduced to much lower densities to ensure successful regeneration of native vegetation. The latter is primarily a community benefit, and the community should contribute substantially to the additional control costs. Knowledge of the damage inflicted by rabbits and the cost of reducing their numbers to low levels would be needed to assess the appropriate level of community input. Usually this information is not available so management decisions cannot be based on logical assessment of benefits.

Research has a major role in providing relevant information to reduce the risk of unin-

tended outcomes as a result of land management decisions. Consequently, the identification of information deficiencies and priorities for addressing them are essential components of the guidelines for each species.

The research results need to be translated into a comprehensible and useable form, not just academically presented in scientific journals. Appropriately designed and targeted extension material, as well as better use of under-exploited decision support systems such as RANGEPACK, have an important role in effective information transfer.

Having information in an appropriate form is a help, but it is relatively ineffective without an effective government extension service. Ensuring that there are sufficient appropriately trained and qualified extension officers to assist with pest management is expensive. Many State and Territory agencies are reducing these services because of declining operational funds. Working through community-based groups such as Landcare groups can increase the effectiveness and enable government agencies to target their extension better (Section 4.6).

Role of Government (also see Section 4.4)

Usually, government has taken on much of the responsibility for research, technology development and training in vertebrate pest management, on the understanding that few individuals have the resources to undertake these tasks. That many of the benefits are applicable to pest management on government managed land such as nature reserves, and hence of benefit to the community as a whole, has been a major influence.

The principles guiding Commonwealth Government involvement in research and development are (DPIE 1989):

- In line with the principle of beneficiary-pays, private land users should contribute to research and development costs associated with production in proportion to the benefits they receive; farmer levies to relevant research and development corporations being an example.
 - A case for government involvement exists to:
 - help fund research and development where market forces would not result in appropriate investment in, and where long-term gains are not available or not readily obvious to, the private sector; and
 - facilitate achievement of the government's Commonwealth, State and regional policy objectives, for example, protection of environmental values. At Commonwealth level, injected funds are considered most effective when directed toward extension services, demonstration projects, decision-support systems and other means of technology transfer facilitating adoption of research and development.
- Consumers may benefit from research and development that leads to more efficient vertebrate pest management in the form of cheaper and possibly higher-quality products from the land. Production land managers usually recover research, development and other land management costs (such as the farmer's levy to the relevant Research and Development Corporation) in the market. They do this by building these costs into the price structure of the product. Consumers pay for the benefits they receive in the price they pay for the product. Where external costs are significant, or potential beneficiaries are widely dispersed and costs cannot be appropriately allocated to producers and consumers, however, government action may be required so that management decisions take into account all costs and impacts. In instances like these, market forces are said to fail. One example would be when legislation and government financial assistance is provided through research and other programs to protect endangered animals.
- There is no simple formula for deciding how much public money should be invested. From a public perspective, the benefits and costs of appropriate (or inappropriate)

management of vertebrate pests include social and environmental benefits as well as those of the market. The former are less tangible and often difficult to estimate, although economists have developed techniques such as Hedonic Pricing and Contingent Valuation in an attempt to value these benefits (Streeter 1990; Wilks 1990; and Section 4.5).

4.3 Maximising benefit–cost ratio and managing the inherent variability of land management systems

Management of land resource-based systems, whether for agriculture, nature conservation or both, requires managing for risks associated with a variable and imperfectly predictable environment. Unpredictability results from variation in factors such as climate, the economy and commodity prices.

'Many managers are risk averse.'

In principle, most land managers aim to maximise benefits (monetary or other) in relation to costs. The challenge is to deal more effectively with associated risks in striving for this goal.

Risk assessment and management are complex tasks, as illustrated for control of lamb predation by feral pigs in Example 3.

Risk aversion

Many decision-makers are averse to risk. That is, they are likely to choose an option which will give an acceptable outcome even in the worst scenario. By choosing a safe option, they usually reduce their chances of achieving a more economically favourable outcome. For example, Hone (1980) used field data to assess the probability of mouse plague damage to crops in northern New South Wales. The cost of control is expensive, and farmers prefer to use it only when necessary. However, the state of knowledge in plague prediction is imperfect. Even if predictive analysis indicates that plague risk is low, some farmers prefer to poison 'just in case', because the loss of their crops would be economically intolerable.

Peer pressure

Factors such as peer pressure can also greatly influence the level of control that a land manager will undertake. For example, even where a certain level of feral pig control may be the most cost-effective, peer pressure may influence managers to reduce feral pig density further, rather than be perceived by neighbours to be bad managers because they have pigs on their land.

Risks associated with technology

Technological developments have been very important in achieving cost-effective control of vertebrate pest impact. A classic example is the introduction of myxomatosis to control rabbits. However, not all technologies are necessarily benign. The complex nature of the resource management system means that new technologies may have unexpected impacts, for example, on non-target animals, or through residues. This does not mean that new technologies should be rejected, but that caution is needed, particularly in objectively assessing risks and benefits. This applies particularly to biological control agents and genetically modified organisms, which are difficult to manage after they have been released.

4.4 Defining the role of policy instruments

Governments have several policy instruments that can be used to influence landholder behaviour in general, and vertebrate pest management in particular, to achieve more socially and/or environmentally desirable outcomes. Generally, government intervention should be assessed against clearly defined objectives that recognise the importance of a systems approach to land management integrating physical, biological, economic and social considerations (ESD 1991). Some of the policy instruments follow.

Direct regulation

Legislation and its enforcement have been, and will continue to be, a major part of ver-

tebrate pest management. It has an important role in establishing common standards and practices that may not otherwise be implemented. For example, strict regulation is necessary to control access to and use of poison and other dangerous chemicals used in pest animal management.

Most current vertebrate pest legislation is the command-and-control type that directs certain action be taken. The overall philosophy is often not stated, nor are the values that need to be protected.

The major role of legislation should be to facilitate appropriate management (ESD 1991). It should state the overall management philosophy and the resource values to

be protected. Although there is still a role for legislation to direct certain actions, for example, to take action on a particular pest, this should be invoked only as a last resort; for example, when rebellious landholders fail to cooperate to meet the objectives of their neighbours, or where other alternatives such as economic incentives do not work. This is how most States and Territories now administer their pest legislation.

'Major role of legislation is to facilitate appropriate management.'

The South Australian *Pastoral Land Management and Conservation Act 1989*

Example 3: Managing feral pig impact on lamb production. Optimising benefit and dealing with risk: a hypothetical example

Feral pig predation can cause an economically significant loss of winter lambs in western New South Wales (Pavlov et al. 1981; O'Brien and Saunders 1986; O'Brien and Korn 1989). Several actions are available either alone or in combination to reduce lamb predation. Each has economic costs and associated risks. The manager's objective is to maximise benefit while taking appropriate account of associated risks. The following list of actions and risks is not exhaustive:

- Poison or trap pigs in late summer to early autumn to reduce winter density:
 - Risks: pigs can be difficult to poison or trap outside winter, a few rogue boars that take the majority of lambs may not be removed (Pavlov et al. 1981), and the manager may lack motivation before the problem becomes apparent.
- Coordinate lambing with neighbours to saturate predator and spread losses:
 - Risks: neighbours may not cooperate because feral pig distribution is patchy, and chance weather fluctuations may devastate all lamb production in a district.
- Change lambing to spring when alternative foods are available to pigs:

- Risks: poorer lamb prices, and spring rainfall is less reliable, so more lambs may die or be stunted.
- Erect electric fence around lamb paddock:
 - Risks: fence may not exclude rogue boars, and a short-term break at a critical time could result in high loss of lambs.
- Only implement control when damage occurs:
 - Risks: losses may be unacceptable before action is taken and the range of control options is reduced.

Managers need to identify and evaluate each option or combination of options to determine which are suitable. Norton (1988) uses a decision matrix to determine if options are practicable, feasible and economically desirable. Norton also uses a 'pay-off matrix' to evaluate the economic benefit of options or combinations of options.

This example highlights the complexity of even a relatively simple land management system. Factors such as pig behaviour, markets, weather and the attitudes of neighbours complicate risk evaluation and management. Critical evaluation requires information on costs and benefits of control and the risks associated with each management option. Often this information is not known or is poorly known but systematic evaluation of the options, risks and likely outcomes can help maximise benefit. Appropriate investigations can refine the evaluation process.

is an example of the new approach to legislation. It and the associated policy documents establish the objectives for managing leasehold and pastoral land, and provide for negotiated property plans aiming for sustainable land management including control of excessive grazing from both domestic and wild animals. As a backup, penalties can be invoked for failure to abide by property agreements to protect the land.

Existing legislation needs to be assessed in terms of its context, effectiveness, resources available to carry out and enforce it, and its acceptability to its target audience (ESD 1991; Section 3.10).

Alteration of relative prices of inputs and outputs

This can be achieved by:

- subsidising desirable actions (e.g. tree regeneration) and taxing undesirable actions (e.g. clearing, swamp draining) through income tax concessions or penalties. For example, primary producers can claim 100 per cent write-off against income in the year of expenditure for pest animal control where it is to prevent or treat land degradation. New depreciation provisions in the 'One Nation Statement' further facilitate these write downs;
- levelling taxes or charges on undesirable outputs (e.g. salt or phosphate — the polluter pays).

These are discussed in more detail in the 1991 ESD report on sustainable agriculture, where it is argued that these mechanisms are generally more cost-effective than the command or regulatory approach, and the information required to operate them may be less.

Property rights

Security of tenure over land is important in developing a sense of ownership of the land and its sustainable management. Approximately 50 per cent of agricultural land is held under crown lease or licence (SCA 1991). This includes much of the pastoral land.

Landholders are less likely to take a long-term perspective on land management if they hold the land only on short-term tenure. A combination of secure tenures and appropriate covenants or lease conditions based on conservation of the base land resource could increase the incentive for sustainable management of leasehold land (SCA 1991).

4.5 The roles of discounting and valuing benefit

The effort applied to protect an agricultural or conservation resource will be influenced strongly by the resource's value and the discount rate applying to benefits that accrue. This section briefly discusses the influence of these factors on vertebrate pest management. (See Pearce *et al.* 1989, ESD 1991 and Johnston 1991 for more detail.)

Discount rates

Simply, discount rate refers to the fact that individuals prefer to receive benefits as early as possible and to pay costs as late as possible. The weighting of present over future is known as discounting, and the rate at which the weight changes is the discount rate (Pearce *et al.* 1989).

There is concern about the environmental implications of applying the market discount rate to production systems (Pearce *et al.* 1989; ESD 1991). The rate may be higher than society wants in order to protect a desired benefit. It may be protection for the future of the land resource and/or natural biodiversity. It has been suggested that government intervene to redress the balance between the objectives of the private landholder and those of society, although this may not always achieve the desired result (ESD 1991). Often, sufficient knowledge of the true costs and benefits are not available, or the benefits may not be easily valued (see Valuing benefit). The ESD report on sustainable agriculture urges caution on government intervention in this area.

Valuing benefit

Benefits that are normally subject to market forces, such as increased production of

crops or stock, are relatively easy to value in monetary terms, although, as mentioned earlier, the impact of pests and the costs and benefits of control usually have been poorly quantified. However, some benefits are not normally marketed and hence are not readily assigned a monetary value. Examples include animal welfare and the protection of native plants and animals, biological communities or landscapes.

There is considerable debate on how to value these non-market resources or, indeed, whether they should be valued other than in terms of their intrinsic value (Chisholm and Dumsday 1985). Some economists are optimistic but not confident that useful techniques for valuing non-market resources will soon be available to assist decision-makers. Current examples of these techniques include travel-cost analysis (Pearce *et al.* 1989), Hedonic Pricing (Streeter 1990) and Contingent Valuation (Wilks 1990). They are based mainly on the concept of ascertaining what individuals are willing to pay to protect or improve the environment (Pearce *et al.* 1989).

However, there is no assurance that eventually all natural resources can be valued accurately before they are extinguished or irreversibly damaged (Pearce *et al.* 1989).

Developments in these valuation techniques should be watched closely. In the meantime, funding agencies and researchers should ensure, where practicable, that studies of vertebrate pest damage better quantify the damage of pests on ecological sustainability of production and other systems, so that decision-makers can take all likely consequences into account.

4.6 Involvement of all major interest groups and developing ownership of the problem

Involving major interest groups in developing pest management strategies is likely to facilitate ownership of these problems, thus increasing the probability of appropriate management. Until recently, some interest

groups had little involvement in setting research priorities and policy development and implementation. Interest groups include animal welfare, farming and conservation groups, ALCs, research and development corporations, State and Territory land management agencies in addition to conservation and agriculture agencies and, very importantly, financial institutions who have a major stake in the rural industry through various financial arrangements, not least being property mortgages.

Community-based self-help groups also have a major role in pest management. The groups may be mainly independent of government, such as those under the Landcare program, or linked to more formal government arrangements such as the Soil Conservation Boards of South Australia and the Western Australian Land Conservation District Committees.

The prime purpose of involving community-based groups is to develop a partnership between government, the community and individuals to address land degradation problems, including the management of vertebrate pest impact. These groups can:

- help to mobilise resources at the base level;
- provide a mechanism for making relevant information available to land managers and the community, and for feedback to government;
- provide a forum for government to consult major interest groups to develop mutually agreed objectives;
- enable management to be targeted to deal with specific regional or local concerns and to use local knowledge and skills;
- provide a vehicle to deal with off-site and/or regional problems without the need to resort to regulatory control (for example, peer pressure to deal with pest animal problems affecting others, or regional pest animal control programs);
- enable governments to feed in resources to address regional problems such as those identified in Commonwealth, State and Territory Landcare programs; and

- facilitate local ownership of the problem, and hence a more likely appropriate and effective management.

The ESD sustainable agriculture working group (ESD 1991) strongly supported the role of Landcare and other community self-help groups as vehicles for change and action. Further, they recommended that Landcare should be extended to cover land management issues in general, including finance, risk management, management of native biota, weed and pest control and chemical use.

These groups are considered a primary mechanism for implementing vertebrate pest management strategies. State and Territory vertebrate pest agencies, notably in New South Wales, South Australia, Victoria and Western Australia are involving such groups increasingly. Expanding this approach to implement vertebrate pest management strategies is strongly encouraged. These groups need to be involved at all stages of the process, including planning, implementation and assessment of pest management programs.

Caution is also needed in relying too heavily on community groups. Although Landcare groups have grown rapidly (there were more than 900 in June 1991, representing approximately 20 per cent of farmers), the process has not been without problems (Campbell 1991). Importantly, in rural areas, there is a shortage of people who have the time, energy, experience and skills to coordinate these groups. Also, there is much reliance on support from relevant government agencies, yet many States and Territories are reducing the resources of their land management departments (Campbell 1991; ESD 1991). Planned reviews of the Landcare program should determine how Landcare and similar groups can become more effective.

4.7 Managing total grazing pressure

Excessive grazing pressure can cause severe land degradation through loss of vegetation

and subsequent soil erosion (Wilson and Hodgkinson 1991). It occurs on both Australia's improved pastures in the higher rainfall areas and on the unimproved or native pasture of the rangelands. Although land degradation of improved pastures is a significant problem, these areas are more readily treated than rangelands, so discussion is concentrated on the latter.

Almost 75 per cent of Australia's landscape is rangeland, most of which is in the arid interior (CSIRO 1989). Most of it is either controlled by pastoralists or is Aboriginal land. It is low productivity pastoral land, but it also has a rich assemblage of native flora and fauna including arguably the world's most diverse reptile fauna (CSIRO 1990). The extinction or decline of many species, particularly native mammals, is thought to be due to the use of rangeland for pastoralism (Morton 1990). Although some States and Territories have reserved significant sections of rangeland, survival of native species depends upon appropriate rangeland management, both within and outside of nature reserves.

Much of the rangeland is degraded, principally as a result of inappropriate grazing pressure both from domestic stock and uncontrolled grazing by native and other wild grazers. (Hodgkinson 1991a; Wilson and Hodgkinson 1991; Landcare 1991). In the case of domestic stock, most of the degradation was caused unwittingly, and was the result of management practices inappropriate for spatially highly variable systems which are also subject to extended droughts and intermittent big 'wets'.

'Degradation caused by management practises inappropriate for highly variable systems.'

Continued overstocking of rangelands leads to destabilisation of the natural pastures, mainly grasses and forbs in the north and shrubs in the winter rainfall areas (Hodgkinson 1991b). Natural pastures provide stability to the grazing system and essen-

tial habitat for much of the rangelands' native ground fauna. Grazing intensity beyond the threshold that the pastures can sustain, especially during drought, can lead to their replacement with less stable annual species, most of which are weeds.

Mutually agreed goals for production and nature conservation must be developed jointly between pastoralists, other landholders and government. Recent research has provided some guidance on the appropriate use of grazing and the other broad-scale tool, fire, for managing some rangeland systems for both production and conservation (Westoby *et al.* 1989; CSIRO 1990; Hodgkinson 1991a,b; Hutchinson 1991; Wilson and Hodgkinson 1991). More research is required to refine management practices and to determine the impact of different herbivores on various rangeland pastures.

Recognising the impact of grazing pressure, most States and Territories have or are developing legislation to regulate total grazing impact on leased pastoral land. For example, the South Australian *Pastoral Land Management and Conservation Act 1989* enables the Pastoral and Land Management Branch, in consultation with lessees and relevant State agriculture, nature conservation and soil conservation agencies, to set appropriate maximum grazing densities of stock and native and exotic wild herbivores. Although there is some flexibility in the Act to reward good managers, use of maximum stocking rates is far from ideal (Tynan, SA Department of Primary Industries). It reduces the manager's ability to take best advantage of good seasons by lowering stocking rates at poor times, an important requirement in the highly variable environment of the rangeland. There is an urgent need for simple and reliable indicators of rangeland health to assist managers in attaining maximal, ecologically sustainable use of their land.

Other States and Territories have or are developing similar arrangements. Community groups such as Landcare can have a major

role in this process. For them to be effective, considerable emphasis is needed on the packaging and transfer of relevant information to land managers, for example, using decision-support systems (Section 2.6).

4.8 Consideration of animal welfare

There is an increasing community expectation that all animals, including pests, will be humanely treated. Reflecting this concern, the Senate Select Committee on Animal Welfare was established in 1983. The Committee produced several reports. The report which is most relevant to vertebrate pest management is 'Culling of large feral animals in the Northern Territory' (June 1991). Despite its title, the report reaches conclusions and makes recommendations applicable throughout Australia. The outcomes of this review are likely to have significant implications for the management of wild and captive animals. Where appropriate, the recommendations have been incorporated into the relevant guidelines.

Most States and Territories have or are introducing comprehensive animal welfare legislation. In addition, under the Australian and New Zealand Standing Committee on Agriculture and Resource Management, the Subcommittee on Animal Welfare (SCAW) plays an important role in safeguarding the welfare of animals associated with agriculture, including pests, by developing codes of practice which define acceptable standards for their treatment. Established Codes of Practice are an important guide to determining humaneness under several State and Territory animal welfare acts. Pest management programs should be consistent with these codes (e.g. the SCAW Model Code of Practice for the Welfare of Animals, Feral Livestock Animals 1991). Where they have not been developed, practices should be adopted that minimise the suffering of target and non-target animals, consistent with effective control.

At the national level the Minister for Primary Industries and Energy has established the National Consultative Committee

on Animal Welfare (NCCAW) to advise him on animal welfare matters.

There are two major bodies that nationally represent animal welfare interests, the Royal Society for the Prevention of Cruelty to Animals (RSPCA) and the Australian and New Zealand Federation of Animal Societies. Both recognise that pest animals can cause significant damage to agriculture and the natural environment, and support the need to control their detrimental impact. While reluctantly accepting that current pest control needs to be based on methods available now, these groups stress the need to review these methods for their humaneness and, where necessary, to refine them or replace them with more humane ones. Where animal destruction is necessary it should be properly planned and coordinated using the most effective humane methods available, and aimed at reducing the need for extensive ongoing control.

The challenge for government authorities and other organisations responsible for vertebrate pest management is to ensure that animal welfare concerns are addressed appropriately. This includes ensuring that all aspects of the issues are considered, put into perspective and communicated effectively to the community.

The CCNT showed the effectiveness of this approach in dealing with the issue of feral horses. Public presentation of the reasons for controlling feral horses, both to reduce their deleterious impact and to reduce their suffering in extended dry periods, has developed in the community a greater acceptance of the need for and benefits of feral horse management.

Equally, publicity over animal welfare

concerns associated with feral horse control has caused government agencies to review the humaneness of control techniques and to appropriately modify practices.

'Humaneness of control techniques reviewed and practices modified appropriately.'

Failure to give adequate consideration to the social and animal welfare implications of vertebrate pest control may thwart the introduction and use of control techniques. O'Brien (1991) discusses these issues in relation to the possible introduction into Australia of rabbit haemorrhagic disease to control rabbits. That 45 per cent of New Zealanders object to the proposed introduction to New Zealand of myxomatosis is an example of the level of concern that can occur (Sheppard and Urquhart 1991).

Concern over animal welfare can also have significant trade implications. Examples are the recent pressure to stop the export from Australia of live goats, most of which are feral, and the banning in 1991 by the Parliament of the European Communities of imports of furs of certain species from countries where they are taken by leghold traps.

In addition to stimulating a continuing assessment of the humaneness of current techniques and identifying areas for research, and necessary changes, the national guidelines for each pest are expected to reduce animal suffering by increasing the effectiveness of current control, and so reduce the need for repeated control. This approach was supported by NCCAW (O'Flynn 1991, NCCAW 1992).

5. Strategic Approach to Managing Vertebrate Pest Impact — Planning and Evaluating

This section outlines the process for planning and evaluating vertebrate pest management. It is the basis of the separate guidelines. The strategic process can be applied generally to the management of vertebrate pests although emphasis is on mammalian pests for which management guidelines have been or are being prepared.

The input of participants at the workshop held in June 1991 to develop the strategic basis for the Strategic Vertebrate Pest Project was instrumental in developing this strategy. (See Braysher (1991) for a report of the workshop and Appendix D for an outline of the contents of the guidelines for each species being addressed.)

The separate components for planning and evaluating pest management are common to most problem-solving situations and comprise the following:

- problem definition;
- definition of objectives, performance criteria and criteria for failure;
- identification and evaluation of management options;
- implementation of the plan; and
- monitoring of program and evaluation against objectives.

The decision analysis process outlined by Norton (1988) and discussed by Braysher (1991) is helpful for planning and evaluating pest management. Norton's approach is not novel. Its value, however, is that it facilitates problem definition as well as the identification and systematic evaluation of alternative options.

5.1 Is there a problem?

The first step is to determine whether there is a real or perceived problem caused by each vertebrate pest. All components of the problem need to be identified and evaluated to discriminate between these two situations, as the solutions differ. Components include social, political, climatic, other biophysical, economic and land use factors.

A perceived pest problem can be addressed through education, whereas a real problem requires action. A possible example of a perceived problem is the cane toad, *Bufo marinus*. There is a widespread belief that the toad is a major conservation threat, but in the only Australian ecological study published to date, Freeland and Kerin (1988) could not demonstrate an impact of cane toads on a community of four species of native frog during the northern tropical dry season. If there is no significant impact where toads now occur, public information programs aimed at changing attitudes toward cane toads may be required.

Control strategies may be best targeted at preventing the spread of toads to unoccupied areas, rather than trying to control them across their current distribution.

The pest status of an animal can vary with time and the attitude of the observer. For example, some animals may be a pest only at certain times, such as at the end of an extended dry period, or where crops are grown close to a nature reserve; commercial harvesters and nature reserve managers will have different attitudes to feral pigs; Aboriginal communities may encourage high densities of camels or rabbits for food, or as an indicator of the health of the land.

Failure to obtain a broad perspective of the problem can prevent effective management.

Step 1

- Define the problem in terms that measure the harmful impact; for example, the percentage loss of a crop or degree of decline in the population of a rare species.

- If it is not possible to define the problem in measurable terms, then there *may not be a problem*.
- Alternatively, *the extent of the problem may not be sufficiently quantified*. In this case, the first task in developing scientifically based pest management is to establish techniques to measure and determine the scope of the problem. In this situation *Step 2* has a high priority.

'Define problem in terms that measure damage.'

If the problem can be quantified, then the outcome of *Step 1* will be used to set objectives and performance indicators.

Step 2

Assess available information and/or collect the data needed to evaluate the problem. It is important to note in the process that data collection can be expensive. A manager needs to take these costs into account. In many circumstances government or the relevant research and development corporation can assist, especially where the results benefit many land managers.

- Data collection may be simple due to previous knowledge of the system.
- In other cases impact may not be readily quantified; this is the situation concerning the environmental impact of many pests.
- Identification and assessment of the components of the system and links between them will indicate where research is required, be it technical, biological, social or economic.

Step 3

Identify the scope of the problem.

- Who has the problem (stakeholders⁴ and/or decision makers)?
- Where is the problem?
- How severe is it?

- Is it time-limited; will it continue at its present level, increase or decline?
- What are the spatial and temporal variabilities?

This three-step process places the problem in its social and biophysical context. Placing it in its social context requires identifying the most important stakeholders and decision-makers. In this process it is useful to rank the involvement of these two groups and identify inconsistencies between them. Ideally, major stakeholders should be also the key decision-makers or, alternatively, their objectives at least should be compatible. Misunderstanding or inefficient or conflicting management of a resource may result when the roles of these groups do not coincide, or their objectives differ.

Norton (1988) uses an interactive matrix to construct the basic structure of the vertebrate pest system, to highlight the most important interactions between the physical and biological components of the system and their consequences, and to avoid minor issues being unduly emphasised. The important interactions should be used also to define the temporal and spatial boundaries of the problem.

5.2 Objectives and performance indicators

Definition of the management problem and the identification of control options is not an end in itself. Interim and long-term goals need to be identified, and success or failure in achieving them monitored. The process includes determining:

- an outcome, and a time-frame for achieving it (that is a performance objective defined in measurable terms. For example, 'Within three years to manage grazing pressure by introduced and native fauna in the nature reserve so that native *Themeda* grassland sets seed over 50 per cent of its area during years of average or above-average rainfall'. Objectives may also be expressed in terms of numbers of

⁴ Stakeholders are defined as those who are affected by the pest, either through the damage caused or because they have to pay for pest control. They may differ from decision-makers. For example, farmers and crown land managers are stakeholders; politicians, and those responsible for setting policy are decision-makers.

animals, density or indices of numbers such as kills per unit effort, if the relationship between pest density and the values to be protected is known (Parkes 1990);

- a performance indicator (that is the measure of performance in achieving the objective, for example, 'the percentage of Themeda grassland within the reserve that sets seed each year'); and
- criteria for failure (that is, when to stop or reassess the program). For example, 'If only 10 per cent of *Themeda* set seed after three years, then the management action has failed and program review is required'.

5.3 Management options

Parkes (1991) discusses several strategic options for managing vertebrate pest impact. These include:

- eradication;
- one-off control;
- sustained control;
- sporadic control;
- commercial harvesting and hunting (note that Parkes (1991) treats hunting separately because it is extensively used in New Zealand); and
- no control.

Eradication

This is a special case of one-off control, but because it is often called for end point of pest animal management, it requires separate treatment. Eradication is the permanent removal of the entire pest population. It may appeal because of the freedom from ongoing costs and the cessation of pest impact. However, it is seldom achievable except on a local scale, and usually at high cost. Bomford and O'Brien (1991) established six criteria which they suggest must be met for successful and cost-effective eradication.

The primary criterion (*) which must be met for eradication is that the rate of population increase should be negative at all densities. However, to determine whether this is likely for a population, it is necessary to

assess whether the other criteria are likely to be met.

- *** The pest must be killed at a rate faster than replacement rate at all densities.** This is often difficult because pests usually have a high rate of increase. As the density declines it becomes progressively more difficult and costly to locate and remove the last few animals.
- **Immigration must be zero.** This is possible for offshore islands, where completely effective barriers can be erected and maintained, or where there are controllable margins, for example, the Western Australian starling control program on the Nullarbor Plain.
- **All individuals in the population must be at risk from the control technique(s) used.** If animals become trap-shy or bait-shy, then a subset may be no longer at risk.

'Eradication seldom achievable except on a local scale.'

- **The species must be able to be monitored at very low densities.** If this is not possible, survivors may not be detected.
- **The social-political environment must be suitable.** For example, if certain groups object strongly to the eradication of a species they can directly thwart the program or politically influence the program. Those involving species of major animal welfare concern are an example.
- **Discounted cost-benefit analysis favours eradication over control.** Discount rates are used to estimate the value of future benefits against the costs of actions in current dollars. This criterion is difficult to meet because of the high initial cost of eradication and because benefits accrue over a long period (Section 4.5). For example, at a discount rate of 8 per cent, it is unlikely that eradication will ever be cost-effective. Eradication has a large initial outlay but, if it can be achieved, there are no ongoing costs. For cost-effective eradication, each situation should be assessed to determine whether eradication costs

outweigh discounted benefits for the rate selected. However, eradication has been achieved without cost-benefit analysis mainly for the protection of conservation values to which it is difficult to assign a monetary value (Section 4.5).

Eradication has been achieved only on relatively small islands and, for coypu and muskrat in England, when populations were low and of limited distribution. Even so, it cost approximately \$A10 million to eradicate coypu, equivalent to \$1000 per animal removed (Gosling 1989).

An Australian example is the eradication of rabbits from Phillip Island, off Norfolk Island. Costs were not fully documented, but it took approximately 700 field-person days to eradicate them. The results of eradication are still being assessed, but prior exclosure studies and subsequent monitoring show that extensive recovery of vegetation is occurring through both natural regeneration and replanting, although exotic weeds have also done well (ANPWS 1989b; Hicks, per. comm.).

In Australia, eradication is likely to be practicable only on small islands off the mainland or in special local areas.

One-off control

Long-term or permanent reduction of the impact of some pests may be possible with one action or set of actions. Examples include exclusion fencing or netting, or one-off action to create habitat unsuitable for the pest. For example, Fenner and Myers (1978) suggest that the release of myxomatosis severely reduced rabbit numbers and the habitat was subsequently much less suitable for rabbits. They surveyed three 100-square-mile properties in the eastern Riverina before the release of myxomatosis in 1950–1951 and again in 1975. Despite little other control they found that infestation rates on the three sites had dropped from 38, 26 and 52 per cent to 0.26, 0.04 and 13 per cent, respectively.

An area where there is some promise for one-off control is the development of wide-scale biological control agents such as rabbit

haemorrhagic disease and viral fertility control agents. However, several sociopolitical implications must be assessed before they can be implemented (O'Brien 1991). In addition, techniques such as viral fertility control are based on long-term, high-risk research, and their likely effectiveness has still to be demonstrated (Bomford 1991).

A variation on one-off control is intermittent control, used to reduce a pest population to low levels to enable other factors to come into play. For example, Caughley *et al.* (1980) suggest that some species may be kept at low numbers by a predator in what they call a 'predator pit'. Control to reduce the predator population to a level where its prey can build up sufficient numbers to withstand further predation may negate the need for further control, unless the population of the protected prey species drops to low levels due to climatic or other factors such as large-scale fires.

Sustained control

If a threshold density can be established at which the benefit of control equals the cost of control, sustained control can be implemented on a regular basis to keep the pest population at or near that density (Example 1 in Section 2.2). Parkes (1991) outlines a sustained management program for controlling the impact of *Thar* on snow tussock in New Zealand. However, the relationship between pest density and impact is often not known, and even if attempts are made to establish it, it may be highly complex and not a simple relationship.

For example, pest impact may vary with seasonal conditions or it may be that only a small proportion of the population is causing the impact. An example of the former is damage due to pest rodents or birds. The latter is probably the case for wild dogs (Thompson 1990) and feral pigs preying on lambs, where only a few rogue animals appear to cause the majority of damage (Pavlov *et al.* 1981). In these circumstances, control targeted at these animals may be more effective than aiming to reduce the density of the whole pest population. The other difficulty

is that damage usually has not been quantified, which makes it difficult to determine the extent of control required.

A variant of this strategy has been suggested for species such as the rabbit, which has high reproductive potential that enables the population to return quickly to high densities (Coman and Parer, pers. comm.). A typical logistic growth curve for an animal is shown in Figure 2 (after Caughley 1977). At low population densities, population increase is slowed due to such factors as greater difficulty in finding a mate, and warren maintenance (see phase 1). Coman and Parer suggest that using a combination of techniques to reduce rabbit density to the initial phase of the growth curve, followed by ongoing maintenance, is more cost-effective than sustained control to maintain the population in phase 2 of the growth curve. This approach is intuitively appealing, but its benefits and costs need to be assessed experimentally.

Sporadic or occasional control

All too often, sporadic control is the norm, whether to protect conservation or production values. There is usually no clear objective for the control other than to kill pests, and pest numbers rapidly return to pre-control levels until the next hit. Considerable resources can be wasted in this strategy. For example, between 1979 and 1988, 5892 goats were shot in Mount Pirongia Forest Park, New Zealand, to protect native plants, at a cost of \$500 000. This outlay was wasted because goats were not held at a sufficiently low level to allow the target species to regenerate (Parkes 1991).

'Usually no clear objective for control other than to kill pests.'

Occasional control may be an appropriate strategy in some situations. For example, it may be sufficient for controlling browsers of regenerating native trees or commercial tree plantations until trees grow above browse height. In this case occasional control is a clearly chosen strategy to achieve a desired management outcome.

Commercial harvesting or recreational hunting

Despite conscientious control efforts, introduced vertebrates are still abundant and widespread. Some believe pests should be seen as a resource as well as a pest (Tisdell 1982, 1987; Tisdell and Takahashi 1988; Ramsay and O'Brien 1991; Wilson *et al.* 1992). Many vertebrate pests are harvested either in recreational hunting or for commercial gain (Ramsay, in preparation). The wholesale value of commercial harvesting industries is significant, estimated to be worth in excess of \$80 million annually. Much of the trade is international. Commercial harvesting generates significant income for some rural communities and export earnings. The effectiveness of harvesting as an aid to managing pest animal damage has not been assessed for most species, but it should be.

'Commercial harvesting of pests worth in excess of \$80 million annually.'

Commercial harvesting of pests has potential in the management of some species such as the feral horse, goat and pig, and possibly the fox. Nevertheless, commercial harvesting has rarely been built into pest management strategies. Exceptions include the management of feral goat and horse populations by mustering and selling the animals. Profit can be used to offset costs of follow-up control action. In other cases commercial harvesting has been conducted independently of other control actions, an example being most feral pig harvesting in Queensland and New South Wales.

Commercial harvesting has more potential to be integrated into pest management strategies than does recreational hunting. The industry is relatively easy to contact, market forces can be used to direct action, and inhumane and other inappropriate practices more easily regulated. On the other hand, recreational hunting is usually not concentrated in any particular area and, given the independence of hunters, their actions are difficult to coordinate and focus.

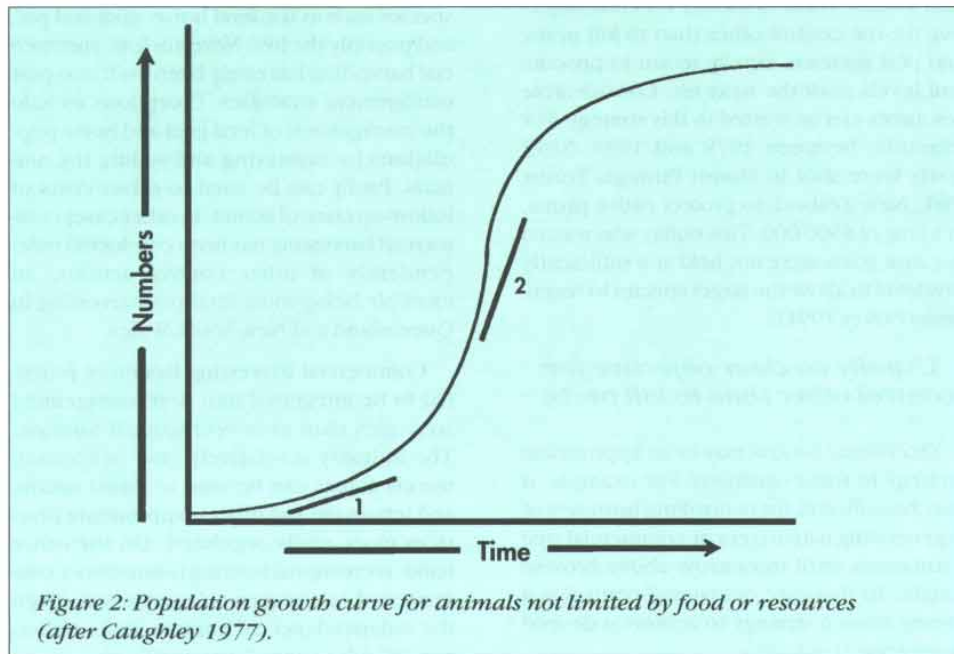
Commercial harvesting is usually concentrated relatively close to processing plants in areas where the pest is abundant, which often are not the areas where management is most needed. Nevertheless, there are advances which may make the commercial harvesting of species such as feral goats and other large feral animals more effective for pest control. These include the development of larger and more stable overseas and domestic product markets which will add stability to the industry, and large portable chillers which will enable harvesters to work in more remote areas (Ramsay, pers. comm.). The use of flexible financial incentives to manipulate harvesting effort, 'smart bounties' which are time-limited and location-limited, may also improve the effectiveness of hunting and/or commercial utilisation as a control strategy (Ramsay and O'Brien 1991).

Animal welfare groups generally are opposed to commercial harvesting of pest animals, especially where long-distance transport of live animals is involved. They are concerned that commercial harvesting may encourage some land holders to retain or

increase the numbers of some pests, a position they share with some land holders. These concerns will be critically examined in the guidelines for each pest to ensure that 'best practice' is adopted to achieve the ultimate outcome, humane, cost-effective management of pest damage. In some cases for example, registration or accreditation of musters and transporters under appropriate State or Territory legislation could help ensure that the appropriate animal welfare codes of practice are adhered to.

No control

Many vertebrate pests are not controlled over much of their range, especially on government managed lands. They include feral cats, foxes, camels, starlings and feral pigs. This situation is likely to continue due to limited resources. One result of this is that certain land use goals may not be practicable. For example, re-establishment on mainland Australia of small native mammals such as the stick nest rat (*Leporilis conditor*) is not practicable because of the presence of uncontrolled foxes and feral cats.



5.4 Evaluating pest management options

Each situation needs to be assessed and the appropriate control strategy or combination of strategies identified. Too often, costly but inappropriate control strategies are adopted in managing for both production and wildlife conservation values. Caughley (1989), in discussing deer density management to protect New Zealand forest habitat, states that:

'... management options must be stated in concrete form and anchored in ecological and geographic fact if they are to be anything more than wishful fancy. The appropriate density of deer is neither "commensurate with wise land use", nor that "consistent with the continuing health of the forest", nor some similar metaphysical construct. It is a specific level, indexed or measured, that meets the precisely defined management aims for the ecological system of that area'.

Norton (1988) used a decision matrix to determine whether alternative pest management options are economically desirable, technically possible, practically feasible, or socially or environmentally acceptable. Collection of data on the impact of the pest and the costs and benefits of control is an integral part of this process.

'Too often, costly but inappropriate control strategies are adopted.'

The decision analysis process outlined by Norton (1988) also helps to determine and evaluate options. Norton uses a decision matrix to decide if actions are practicable, feasible and economically desirable, and he uses a 'pay-off matrix' to determine the benefits. These may be economic, conservation or social. There is, however, a paucity of reliable data on the impact and the benefits of control for economic-based systems, particularly for systems managed for conservation values, on which Norton's analysis relies.

One solution to this dilemma is to use large-scale, scientifically designed management experiments as proposed by

Romesburg (1981) and Macnab (1983) and more recently highlighted by Walters and Holling (1990), Eberhardt and Thomas (1991) and Sinclair (1991), to obtain information. Scientists are unlikely to have complete knowledge of the system that they want to manage. Often chance or external events, such as climatic events and market fluctuations, drive systems in unexpected directions. Conventional reductionist science, sometimes referred to as the science of parts (Walters and Holling 1990), has increasing difficulty delivering research solutions that can be adopted directly to manage complex production or other land management systems. Reductionist science is entirely appropriate for analysing specific biophysical processes that influence the survival, growth and dispersal of system variables, appropriately being conservative and unambiguous but incomplete (Walters and Holling 1990). However, when conventional experimental design is used to understand complex experimental systems by manipulating and measuring the inherent variability and complexity, it is extremely costly to incorporate the replications and controls required to enable meaningful and robust conclusions to be made. An alternative is to use the management system to obtain the information by experimental studies on the impact of pests and the benefits of controls under different, broad-scale management regimes.

Management must also determine where pest operations should be targeted. Parkes (1990, 1991), when considering pest management in New Zealand, suggests that potential pest management operations for conservation purposes need to be ranked because resources are unlikely to be sufficient to effectively control all pests in all regions. This is true for Australia. Parkes' ranking is based on the following procedure:

- Each area is scored according to the conservation values present. Factors considered include rarity, occurrence of species elsewhere and degree of modification of the habitat.
- Each score is weighted according to the threat posed by the pest. Justification for control is based on the degree to which

the valued resource is affected by the pest. Assessment is based on the population dynamics of the pest, directness of pest impact and ecosystem resilience.

- Operations with equal weighted scores are sorted (if required) using a hierarchy of land attributes. Parkes (1991) suggests that secondary land attributes can be used to sort equal problems. Attributes used include tenure, presence of other valued biota, absence of other pests and control action on other pests.

This strategy could be applied in Australia and integrated with data storage and retrieval systems such as the Environmental Resources Information Network (ERIN) under ANPWS and similar State and Territory data systems. While ERIN is in its early stages, it is proposed to use a geographical information system to record the distribution and status of native animal and plant species and associations. Agencies planning pest management operations could use ERIN in combination with Parkes' ranking system to assess the rareness and vulnerability of native biota, and thus more strategically guide appropriate management.'

Similarly, Parkes' ranking system could be modified for production systems and used to target extension, training and other pest management activities of State and Territory vertebrate pest agencies. Information on production and other necessary data can be sourced through the National Resource Information Centre of BRS.

5.5 Monitoring and evaluation

Monitoring and evaluation are often forgotten aspects of vertebrate pest management. They should be an integral and budgeted component of management programs. There are two forms:

Operational monitoring and evaluation

The aim is to evaluate and, where practicable, improve the efficiency of control operations. Effort, materials and other costs, including those for planning and evaluation,

should be recorded. Many States and Territories have or are developing field Pest Management Information Systems which can be used for operational monitoring and the other form, performance monitoring (Fordham 1991).

Performance monitoring and evaluation

In this case the aim is to determine how well a management program is achieving desired production or conservation outcomes. The management objective should be evaluated based on previously established performance criteria and criteria for failure (subsection 5.2). Sometimes an index such as pest density may be suitable provided the relationship between it and the resource to be protected is known.

Evaluation should be used not only to prove the effectiveness of an option or strategy but also to improve it. That is, evaluation may show that new objectives and performance indicators need to be defined.

5.6 Conclusion

Integrated pest management based on the principles and strategic approach outlined in this section can greatly improve pest management in Australia. Cost-effective management of pest damage first requires the problem to be clearly defined in terms of damage. Much pest management has concentrated on the pest rather than the damage, and has been aimed at reducing pest density to as low as possible and, hopefully, eradicating the pest. However, except for special circumstances such as off-shore islands, no well-established pest on any mainland has ever been eradicated. Sustained management to achieve clearly identified management objectives should be the basis of most pest management. This approach requires quantification of the linkages between pest density and the costs and benefits of control. For most pests this is poorly known. Large-scale experiments based on studying the management system show promise for establishing the linkages.

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APPENDIX A

STRUCTURE AND TERMS OF REFERENCE OF THE VERTEBRATE PESTS COMMITTEE

VPC reports to SCARM and through it to ACANZ. ACANZ coordinates Australian and New Zealand interests in agriculture at the national level, and comprises the New Zealand, Commonwealth, State and Territory ministers for agriculture.

VPC's terms of reference are:

- to undertake a continuing review of established vertebrate pests in Australia with particular reference to their control or eradication, as necessary, and measures for the exclusion of potential pests from overseas, and report to SCARM thereon;
- to examine and report to SCARM on the research, training, administration and control arrangements necessary for the control, eradication or exclusion of vertebrate pests;
- to foster the coordination of vertebrate pest control activities throughout Australia; and
- to deal with specific matters referred to it by SCARM.

Membership

ACT Parks and Conservation Service,
Australian Capital Territory

Agriculture Protection Board, Western
Australia

Animal and Plant Control Commission,
South Australia

Australian National Parks and Wildlife
Service

Conservation Commission of the Northern
Territory

CSIRO Division of Wildlife and Ecology

New South Wales Agriculture

Department of Lands, Queensland

Department of Primary Industries and
Energy, Commonwealth

Department of Primary Industry and
Fisheries, Tasmania

Ministry of Agriculture and Fisheries, New
Zealand

Department of Conservation and Natural
Resources, Victoria

APPENDIX B

MEMBERSHIP AND TERMS OF REFERENCE OF THE VERTEBRATE PESTS COMMITTEE WORKING GROUP

- Vertebrate Pests Committee, two representatives:
 - Kevin Heinrich, Chief, Animal and Plant Control Commission, South Australia, Chair of the Working Group
 - Neil Hogstrom, Chief Executive Officer, Agriculture Protection Board, Western Australia
- Standing Committee on Conservation of the Australian and New Zealand Environment Conservation Council, one representative:
 - Gerry Maynes, Australian National Parks and Wildlife Service
- National Farmers' Federation, one representative:
 - Don Pfitzner, immediate past-president of the United Farmers' and Stock Owners' Association of South Australia
- Australian Conservation Foundation, one representative:
 - Jim Hone, Senior Lecturer, University of Canberra
- Bureau of Resource Sciences, one representative:
 - Mike Braysher, Project Manager

TERMS OF REFERENCE

1. Oversee the development of national guidelines for the coordinated management of vertebrate pests, including:
 - development of the principles and strategic context for the management of vertebrate pests, including links with national conservation and primary production initiatives;
 - critical review of the impact of major pests, both harmful and beneficial;
 - identification and development of technical options including techniques for:
 - evaluating options; and
 - monitoring and evaluating management;
 - identification of information deficiencies and establishment of research priorities;
 - consultation with relevant government and private land management, community and other organisations to seek endorsement of the process, objectives and proposed outcomes of the project; and
 - to seek endorsement by these organisations of the national guidelines.
2. Provide a progress report to the Vertebrate Pests Committee every six months.

APPENDIX C

RELEVANT AUSTRALIAN VERTEBRATE PEST LEGISLATION

COMMONWEALTH

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Australian National Parks and Wildlife Service	<i>National Parks and Wildlife Act 1975</i>	Commonwealth National Parks proclaimed under this Act. Service is required to develop management plans which include control of pest impact.	
Department of Primary Industries and Energy —Australian Quarantine and Inspection Service	<i>Quarantine Act 1908</i>	Relates mainly to primary production especially exotic pests and diseases. Provides power to prohibit certain imports. Power to enter, search, seize and dispose.	Australian National Parks and Wildlife Service
Australian National Parks and Wildlife Service	<i>Wildlife Protection (Regulation of Imports and Exports) Act 1982</i>	Regulates import of species which pose a threat to the natural environment. Also regulates export of native flora and fauna. Power to enter, search, seize and dispose.	Australian Quarantine and Inspection Service

AUSTRALIAN CAPITAL TERRITORY

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Department of the Environment, Land and Planning — Parks and Conservation Branch	<i>Rabbit Destruction Act 1919</i>	Declaration of rabbit-infested areas. Power to erect barrier fences. Duty of owners and occupiers to destroy rabbits and noxious animals. Power to enter and search.	ACT Veterinary Officer ACT Forests
Parks and Conservation Branch	<i>Nature Conservation Act 1980</i>	Permits and licences to kill, take and sell animals. Regulates the keeping, import and export of animals, including exotics. Access to reserved area may be prohibited or restricted. Power to enter and search occupied land.	ACT Parks and Conservation Service ACT Veterinary Officer AQIS Veterinary Officer Australian Federal Police Australian Federal Police Stock Squad
Environment Protection Service	<i>Pesticides Act 1989</i>	Registration of agricultural chemicals and poisons.	Parks and Conservation Branch

NEW SOUTH WALES

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
NSW Agriculture — Agriculture Protection Service	<i>Rural Lands Protection Act 1989</i>	Feral pigs, wild dogs, rabbits declared noxious, required to be continually suppressed. Control officers have right of entry, to conduct necessary control work, and harbour destruction.	Animal Health Division of NSW Agriculture NSW National Parks and Wildlife Service
Rural Lands Protection Boards			Forestry Commission and other government land management authorities
Department of Conservation and Land Management	<i>Crown Lands Act 1989</i>	Right of entry onto Public Lands. Regulates protection of leased crown land, including stocking rates and pest animal management.	Rural Lands Protection Board
NSW National Parks and Wildlife Service	<i>National Parks and Wildlife Act 1974</i>	Protection of native flora and fauna — permit required from NPWS to control native fauna.	
NSW Agriculture	<i>Pesticides Act 1978</i>	Regulates registration and use of poisons. RLPBs and authorised personnel of agriculture only have authority to use/mix 1080 poison baits. Restrictions of the use of meat baits in NSW.	Rural Lands Protection Boards National Parks and Wildlife Service Forestry Commission Water Board personnel and Soil Conservation Service
Aboriginal Lands Council	<i>Aboriginal Land Rights Act 1983</i>	Access to Aboriginal land.	
NSW Police Force	<i>Firearms and Dangerous Weapons Act 1985</i>	Licensing of shooters. Carriage of firearms.	
NSW Agriculture	<i>Stock Diseases Act 1923 (reprinted 1982)</i>	Quarantine areas and restrictions, powers of inspectors, etc. Right to enter and search. Social disease declarations.	RLPB veterinary officers and Animal Health inspectors

NEW SOUTH WALES (CONTINUED)

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Department of Conservation and Land Management	<i>Enclosed Lands Protection Act 1901–1964</i>	Lawful approval to enter onto private property and deviate from a gazetted road.	Department of Conservation and Land Management, National Parks
Wild Dog Destruction Board	<i>Wild Dog Destruction Act 1923</i>	Board responsible for the construction and maintenance of the NSW Wild Dog Fence.	
NSW Agriculture	<i>Prevention of Cruelty to Animals Act 1979</i>		
			Royal Society for the Prevention of Cruelty to Animals

NORTHERN TERRITORY

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Conservation Commission of the Northern Territory	<i>Territory Parks and Wildlife Conservation Act 1988</i>	Declares animals that are pests or prohibited entrants. Permits may be issued for possession or import of exotic animals. Authority to declare pest control areas and issue notices to landholders to control pests.	Wildlife Management Unit of Conservation Commission of the Northern Territory
Department of Health and Community Services	<i>Poisons and Dangerous Drugs Act 1987</i>	Regulates control and supply of poisons including pesticides used in pest management.	Department of Primary Industry and Fisheries
Northern Territory Police	<i>Prevention of Cruelty to Animals Act 1980</i>	Exempts from the Act control of pest animals provided humane methods are used.	
Department of Primary Industry and Fisheries	<i>Stock Diseases Act 1956–1989</i>	Provides for control of stock including exotic pests.	Conservation Commission of the Northern Territory
Department of Lands and Housing — Pastoral Board	<i>Pastoral Land Act 1992</i>	Regulates appropriate use of pastoral land with emphasis on a cooperative approach through property plans. Power to require pest management.	Conservation Commission of the Northern Territory Department of Primary Industry and Fisheries

QUEENSLAND

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Department of Lands — Lands Protection Branch	<i>Rural Lands Protection Act 1985–1990</i>	Control of declared animals on public land. Occupier responsibility to control declared animals and plants. Establishment and maintenance of animal-proof fencing. Authority to use poisons, set traps, etc. Authority for officers to enter and search.	Rural Lands Protection Board Queensland National Parks and Wildlife Service Queensland Department of Primary Industries Local government councils
Department of Primary Industries	<i>Land Act 1962–1985</i>	Leasehold conditions require control of declared animals and plants.	
Department of Primary Industries — Standards Branch	<i>Agricultural Chemicals Distribution Control Act 1966–1983</i> <i>Agriculture Standards Act 1952–1981</i>	Controls use of chemicals, and registration, use and sale of agricultural pesticides.	
Department of Environment and Heritage — National Parks and Wildlife Service	<i>Fauna Conservation Act (1989) Amendment</i> <i>National Parks and Wildlife Act 1975–1984</i>	Legislative control over entry, movement and keeping of exotic animal species. Undertake control on own land.	
Department of Health — Drugs and Poisons Branch	<i>Health Act — Poison Regulations 1973</i>	Licensing and regulation of vertebrate pesticides and operators.	
Department of Local Government	<i>Animals Protection Act</i>	Prohibit cruelty and regulate animal experimentation; welfare aspects.	Royal Society for the Prevention of Cruelty to Animals

SOUTH AUSTRALIA

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Animal and Plant Control Commission	<i>Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986</i>	Authorised officers have powers to enter, search, etc. Owner/occupier of land responsible for control of proclaimed animals. Training of persons authorised to handle 1080. Regulation of the keeping, import and export of exotic animals.	South Australian Department of Primary Industries Animal and Plant Control Boards
SA National Parks and Wildlife Service	<i>National Parks and Wildlife Act 1972</i>	Permits to take protected animals. Hunting permits/open seasons. Required to manage pests on reserved land.	
SA Department of Primary Industries	<i>Agricultural Chemicals Act 1955</i>	Registration of agricultural chemicals.	Animal and Plant Control Commission
SA Department of Labour	<i>Dangerous Substances Act 1979</i>	Regulations for transport, storage and use of dangerous substances.	Animal and Plant Control Commission
Dog Fence Board (in Department of Environment and Land Management)	<i>Dog Fence Act 1946</i>	Requires effective maintenance of the Dog Fence by lessees. Direct use of traps and poison in vicinity of Fence.	Animal and Plant Control Commission
Department of Environment and Land Management	<i>Dog Control Act 1979</i>	Regulates poison use for dogs. Authorised persons can destroy stray dogs that cannot be caught.	Animal and Plant Control Commission
Attorney-General's Department	<i>Fences Act 1975</i>	Neighbours must share costs of rabbit and dog-proof fences in prescribed circumstances. Sets responsibilities for notification of intentions to construct other boundary fences.	Animal and Plant Control Commission
Department of Environment and Land Management RSPCA	<i>Prevention of Cruelty to Animals Act 1985</i>	Provides for the prevention of cruelty and ill-treatment of animals. Prohibits the use of traps in municipalities.	Animal and Plant Control Commission
Department of Primary Industries — Animal Health Services	<i>Deer Keepers Act 1987</i>	Permit issued by APCC is prerequisite for registration of a deer farm.	Animal and Plant Control Commission
SA Local Government Association — Councils	<i>Local Government Act 1934</i>	Provides for protection of native vegetation on roadsides and reserves.	Animal and Plant Control Commission

SOUTH AUSTRALIA (CONTINUED)

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Department of Public and Consumer Affairs	<i>Land Brokers and Valuers Act 1973</i>	Vendor or agent required to reveal any encumbrances relating to vertebrate pests immediately prior to sale of land (these include notices or unpaid charges).	Animal and Plant Control Commission
Country Fire Service	<i>Country Fire Act 1990</i>	Imposes restrictions on disposal of potential harbour for rabbits. Knowledge of local animal and plant control board officers used during emergencies.	
Department of Environment and Land Management — Pastoral Board	<i>Pastoral Land Management and Conservation Act 1989</i>	Controls use of land in arid areas. Limits amount of stock (including feral animals) that can be carried.	Animal and Plant Control Commission Soil Conservation District Boards
Department of Primary Industries — Soil and Water Conservation	<i>Soil Conservation and Land Care Act 1989</i>	Provides for the conservation of soil and land resources. Conditions relating to this legislation are included in permits to keep exotic animals.	
Health Commission	<i>Controlled Substances Act 1984</i>	Regulates possession and use of poisons and licences pesticide operators.	Animal and Plant Control Commission
Department of Environment and Land Management	<i>Native Vegetation Act 1991</i>	Desirability of retaining native remnant vegetation. Imposes constraints on control measures to achieve reasonable rabbit control.	Animal and Plant Control Commission

TASMANIA

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Department of Primary Industry and Fisheries — Animal Health Branch	<i>Vermine Destruction Act 1950</i>	Duty of occupiers to destroy and suppress vermin (rabbits). Power to enter land and destroy vermin. Suppression of vermin on Crown Land.	Department of Primary Industry and Fisheries Municipal councils
Department of Parks, Wildlife and Heritage	<i>National Parks and Wildlife Act 1970</i>	Rabbit-proof fencing of reserved Crown Land. Issue of permits and licences to take native animal pests. Prohibition on introduction of certain animals. Powers of entry, search, seizure and arrest.	
Health Department of Tasmania	<i>Poisons Act 1971</i>	For the use of 1080.	
Tasmanian Police	<i>Police Offences Act 1935</i>	Laying of poison on public land. Display of notices if poison laid. Use of steel-jawed traps.	

VICTORIA

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Department of Conservation and Natural Resources — Land Catchment and Protection Branch	<i>Vermin and Noxious Weeds Act 1958</i> <i>Vermin and Noxious Weeds Regulations 1992</i>	Responsibility for destruction of vermin on Crown Lands. Requirement for land occupier to destroy vermin. Power to enter and conduct control work and harbour destruction. Provides conditions for keeping domestic rabbits and dingoes.	
Department of Conservation and Natural Resources — Flora and Fauna Branch	<i>Wildlife Act 1975</i>	Permits to take, sell, keep or destroy wildlife. Licences for trapping, deer farms, etc. Authority to use prohibited equipment. Control of pest wildlife. Power of officers to enter, search and control.	
Department of Conservation and Natural Resources — National Parks and Public Lands Branch	<i>National Parks Act 1975</i>	Responsibility for destruction of 'exotic' fauna in national parks.	
Attorney-General's Department	<i>Fences Act 1986</i>	Sets out rights and obligations of landowners with regard to the construction, maintenance and effectiveness of fences.	Victorian Department of Agriculture (in an advisory capacity)
Attorney-General's Department	<i>Wire Netting Act 1958</i>	Provides for financial assistance to landholders with regard to the construction, maintenance and effectiveness of fences.	Victorian Department of Agriculture (in an advisory capacity)
Department of Agriculture	<i>Agricultural Chemicals Act 1958</i>	Registration of poisoned baits. Setting of standards.	Department of Conservation and Natural Resources
Department of Health and Community Services	<i>Health Act 1958</i>	Use of 1080, licensing of private pest control operators.	
Department of Health and Community Services	<i>Drugs, Poisons and Controlled Substances Act 1981</i>	Specifies restrictions on laying of baits. Licensing of poison depots.	Department of Conservation and Natural Resources
Department of Agriculture	<i>Prevention of Cruelty to Animals Act 1985</i>	Specifies conditions for the use of steel-framed leghold traps.	RSPCA

VICTORIA (CONTINUED)

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Department of Health and Community Services	<i>Drugs, Poisons and Controlled Substances Regulations 1985</i>	Specifies conditions on persons laying poison baits on and in roads, channels, sewers, watercourses.	Department of Conservation and Natural Resources
Department of Health and Community Services	<i>Dangerous Goods (Transport) Regulations 1987</i>	Determines the standard safe methods for the transport of dangerous substances.	Department of Conservation and Natural Resources
Department of Health and Community Services	<i>Dangerous Goods (Storage and Handling) Regulations 1989</i>	Provides standards and procedures for the storage and safe handling of dangerous substances.	Department of Conservation and Natural Resources
Department of Conservation and Natural Resources — Flora and Fauna Branch	<i>Flora and Fauna Guarantee Act 1988</i>	Provides for the listing of 'potentially threatening processes' e.g. fox predation. Directs management action to prevent or overcome the problem.	
Department of Conservation and Natural Resources — Natural Resource Systems Branch	<i>Vermin and Noxious Weeds Regulations 1982</i>	Provides for conditions for the keeping of rabbits and the payments of bonuses for wild dog scalps.	

WESTERN AUSTRALIA

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Agriculture Protection Board	<i>Agriculture Protection Board Act 1950</i>	Power for constitution of Board and regulation of powers, functions and duties.	Department of Agriculture Department of Conservation and Land Management
	<i>Agriculture and Related Resources Protection Act 1976</i>	Provides for the management of pest plants and animals, for the prohibition and regulation of the introduction and spread of certain plants, and the introduction, spread and keeping of certain animals.	Local government WA Farmers Federation Pastoralists and Graziers Association
Department of Conservation and Land Management	<i>Conservation and Land Management Act 1984</i>	Provides for use, protection and management of public lands, water, flora and fauna, constitution of a Lands and Forest Commission and a National Parks and Nature Conservation Authority.	
Department of Conservation and Land Management	<i>Wildlife Conservation Act 1950</i>	Provides for the conservation and protection of wildlife. Includes management programs for capture, breeding, keeping and import/export of fauna. Prohibits some imports and use of illegal means and devices for taking fauna.	Agriculture Protection Board
Western Australian Health Department	<i>Health Act 1911 (Pesticide Regulations)</i>	Regulates the controls on pesticides via the Pesticides Regulations. Labelling, packaging, storage, registration, use hazards and use of special pesticides, e.g. 1080, are addressed.	Agriculture Protection Board
Western Australian Health Department	<i>Poisons Act 1964</i>	Regulates and controls the possession, sale, and use of poisons, etc., including many pesticides used in pest control. Poisons are assigned to one or more of eight 'Poison Schedules' according to hazard, toxicity or use.	Agriculture Protection Board
Biological Control Authority of WA (Department of Agriculture)	<i>Biological Control Act 1986</i>	Provides for biological control of pests in Western Australia in conformity with uniform Australian legislation.	Agriculture Protection Board

WESTERN AUSTRALIA (CONTINUED)

Agency or department primarily responsible for Act	Acts	Relevance of Act	Related authorities or agencies
Western Australian Department of Agriculture — National Soil Conservation and Landcare district committees	<i>Soil and Land Conservation Act 1945</i>	Conservation of soil and land resources, and the mitigation of the effects of erosion, salinity and flooding. May include management of land degradation caused by feral and other pest animals and by weeds. Powers include prohibition of animals on, and removal of plants from, any soil conservation reserve.	Agriculture Protection Board
Department of Land Administration	<i>Land Act 1933</i>	Relates to Crown Land. Power to undertake pest control.	
Police Department	<i>Firearms Act 1973</i>	Provides for the control and regulation of firearms and ammunition, and the licensing of persons possessing, using, dealing with or manufacturing firearms and ammunition.	Agriculture Protection Board
Mines Department	<i>Mining Act 1978</i>	Defines responsibility for pest control on mining tenements.	
RSPCA	<i>Prevention of Cruelty to Animals Act 1920</i>	Provides for the prevention of cruelty and ill-treatment of all animals. Includes controls on use/placement of certain traps and snares.	Agriculture Protection Board Local government authorities
Local government	<i>Dog Act 1976</i>	Relates to the control, registration, ownership and keeping of dogs, and the obligations and rights of persons keeping dogs. Includes action that may be taken involving livestock attacks, and for protection of livestock.	RSPCA
Department of Land Administration — Bush Fires Board	<i>Bush Fires Act 1954</i>	Purpose is to diminish the dangers resulting from bush fires and to prevent, control and extinguish fires. Act has power to limit or prohibit movement and use of certain machinery or land in some circumstances and to co-opt resources from several organisations in emergencies.	
Mines Department	<i>Explosives and Dangerous Goods Act 1961</i>	Regulates the classification, marking, storage, carriage and sale of explosives and dangerous goods. Includes transport of many pesticides. Power includes use of pesticides in certain circumstances.	Agriculture Protection Board

APPENDIX D

OUTLINE FOR THE DEVELOPMENT OF SPECIES GUIDELINES

This is a general outline. It may need to be modified for particular species.

(i) **Summary**

(ii) **Recommendations**

1. **Background**

Brief background on why the guidelines were developed.

2. **History** (Brief summary)

Brief history of the introduction of the pest to Australia and its spread. Distribution and abundance.

3. **Biology**

General biology including diseases and other mortality factors. Concentration should be on those aspects relevant to managing the pest.

4. **Impact**

Critical review of the harmful and beneficial impacts:

- economic
- environmental

Describes the impact of the pest, including its affects on agriculture, nature conservation, water catchment and traditional land. To include an assessment of the commercial value of the pest.

5. **Past and current organisation and management**

Overview of past and current management, including legislation, management approach, training and extension and management techniques (summary only).

Includes a section on lessons from past and current management successes and failures.

6. **Attitudes of groups that influence management**

Assess social attitudes of groups and other users and how they influence management, including animal welfare, the attitudes of traditional owners, public perception of pest, commercial use of the pest and changing nature of the rural community.

7. **Management techniques including those for monitoring and evaluation**

Identify and critically assess the techniques for assessing and managing damage, and for monitoring and evaluating the management program. Technical details to be represented as an appendix.

8. **Strategies for managing impact**

Outline the process for developing appropriate strategies, including identification and evaluation of best option(s), with details of objectives, performance indicators, criteria for failure and monitoring and evaluation. Use examples or case studies to illustrate where appropriate.

9. **Process for implementing control**

Describe the process for implementing the management strategy, including the role of government and involvement of Landcare and other community groups. Factors that need to be considered include hobby farms, financial constraints to effective management, landholder attitude, commercial interests, externalities, knowledge transfer, non-target impacts and animal welfare considerations.

Cover occupational health and safety for workers, animal welfare and other implications.

10. Deficiencies in legislation, knowledge and techniques

Outline legislative changes, research and other studies that are required to enhance the national guidelines:

- biology (distribution and abundance, physiology, behaviour, etc.);
- techniques and strategies for management;
- costs and benefits of management;
- non-target impacts, e.g. non-target species at risk from control action;
- animal welfare issues;
- exotic diseases implications;
- legislative deficiencies;
- extension and training needs; and
- monitoring and evaluation issues.

How should these deficiencies be addressed and by whom?

THE FOLLOWING IS A LIST OF MEMBER ORGANISATIONS OF THE VERTEBRATE PESTS
COMMITTEE AND CONTACTS FOR MORE INFORMATION ON PEST ANIMALS

Executive Officer
Wildlife Division
Conservation Commission of the Northern Territory
PO BOX 496
PALMERSTON NT 5787

The Director
Agricultural Production & Natural Resources Branch
Bureau of Resource Sciences
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Chief
Animal & Plant Control Commission
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Unit Manager
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Department of Conservation & Natural Resources
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Chief
Division of Wildlife & Ecology
CSIRO
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LYNEHAM ACT 2602

Executive Director
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Chief Executive Officer
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Baron-Hay Court
SOUTH PERTH WA 6151

Director
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Australian National Parks & Wildlife Service
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CANBERRA CITY ACT 2601

Senior Research Officer
Vertebrate Pests
Department of Primary Industry & Fisheries
PO BOX 180
KINGS MEADOWS TAS 7249

Director
Rabbit & Land Management Programme
Ministry of Agriculture & Fisheries
PO BOX 8640
Riccarton
CHRISTCHURCH NEW ZEALAND

Pests such as rabbits, foxes and feral goats cause extensive damage to primary production and Australia's natural environment. We need 'best practice' management with a more coordinated and strategic approach.

This book is the first in a series providing best possible, humane, scientifically based guidelines for pest management. It contains the principles and strategic approach which are the basis for a series of guidelines for managing feral horses, rabbits, foxes, feral goats and feral pigs. It emphasises the management of pest damage rather than the pest itself. Pests are treated as one element of a whole system approach to land management.

This book is a valuable reference and planning guide for pest managers, policy makers and others interested in better control of the damage caused by Australia's major pests.



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