Solutions for achieving humane vertebrate pest cont rol

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Contents

Background to the seminar

The RSPCA Australia Scientific Seminars provide a forum for the dissemination of information on topical animal welfare issues to a wide audience. The Seminars are designed to cover a broad spectrum of opinion, encourage audience participation, and have a reputation for provoking lively and constructive debate.

The 2003 Seminar, Solutions for achieving humane vertebrate pest control, sought to establish common ground between stakeholder groups and stimulate thought and discussion on practical innovative strategies for achieving humane control of vertebrate pest species.

Session outlines

1 Community needs and expectations in pest animal control: identifying shared goals

The first session of the Seminar invited representatives of animal welfare, land-holder, and conservation groups and government agencies to describe and address the concerns of their constituents over the control of vertebrate pests, discuss their priorities in terms of the impact and use of control measures and identify shared goals that can be used to form the basis of an integrated approach to pest management that has the support of the general community. Talks also examined community attitudes to pest control and the role of government agencies in addressing public concerns.

2 Ethics of controlling vertebrate pests

This session put pest animal control in a broad ethical context by discussing issues such as: What ethical decisions are involved in pest-animal control, and how should these influence our actions? How do different approaches affect individual animals, and the overall population over the long-term? Are current control strategies bypassing ethics and if so, how can this be addressed?

3 Re-examining current strategies

This session discussed the efficacy and relative humaneness of current control methods and addressed questions such as: What makes some strategies effective while others fail? How important is an integrated approach in terms of achieving successful outcomes?

4 Developing innovative and practical solutions to pest-animal control

How can we best move forward to achieving humane solutions to pest animal control? This session examined novel, practical approaches for pest animal control and improvements that can be made to current pest control techniques, as well as identifying longer-term research goals and future strategies.

Integrating animal welfare into vertebrate pest management

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Summary

Animal welfare has barely rated a mention in the history of Australian vertebrate pest control, but in recent years a number of publications have cited humanness or welfare as factors for consideration in the management of vertebrate pests. Unfortunately, when it comes to current practices, there is little evidence to suggest that animal welfare is being given any serious attention.

To begin the process of incorporating animal welfare issues into the planning and management of pest control, we need to first recognise that, regardless of the impact they cause, pest animals require the same level of consideration for their welfare as animals in other contexts. In terms of the numbers of animals killed, and the cruelty of the methods used, vertebrate pest management is probably the biggest animal welfare issue in Australia. Animal welfare organisations have a key role in working to overcome this. RSPCA Australia works to prevent cruelty to animals by actively promoting their care and protection in all areas. Sometimes this involves the RSPCA itself killing animals, such as the euthanasia of thousands of unwanted cats and dogs every year. The RSPCA is clearly not opposed to the selective killing of animals, including vertebrate pests, provided that such control is justified and carried out in the most humane way possible.

Humane killing infers death without pain, suffering or distress perceptible to the animal. To achieve this the method of killing must induce instant insensibility and the animal must remain unconscious until death supervenes. While a clear definition of a humane death is widely accepted, it is also common to use the term humane in a relative sense, in terms of causing more or less pain, suffering or distress. Every step towards minimising pain suffering or distress is a step towards achieving humane vertebrate pest control. There are six guiding principles that underpin the RSPCA's policy on the control of vertebrate pests, which apply equally whether the pest animals are native or introduced. These can be summarised under the following headings: (1) justification for control; (2) lethal or non-lethal control; (3) probability of success; (4) coordinated and strategic approach; (5) target-specificity; and (6) humaneness. A pragmatic approach to humane killing applies the rule that death should always be as pain and distress-free as possible. Unfortunately what is possible depends on the techniques that are available. The RSPCA has concerns over the humaneness of methods used for the control of all major pest animal species. In particular, the use of steel-jawed leg-hold traps, inhumane poisons and baiting strategies, and inhumane burrow clearing and fumigation techniques have been highlighted as issues that require urgent attention.

The aim of the 2003 RSPCA Australia Scientific Seminar is to examine how we can bridge the current gap between considering animal welfare and integrating animal welfare into the planning and implementation of vertebrate pest management. A number of steps are required to progress this aim. The assessment of the humaneness of control techniques, strategies and programs must be regarded as a fundamental component of vertebrate pest management. Control strategies must be designed to minimise the number of animals subjected to ongoing control, and when more humane refinements or replacements to existing methods are developed, it must be a requirement that these are adopted in preference to existing methods. It is time that these issues were given the consideration, attention and action they deserve.

Introduction

Animal welfare does not get a high billing in Australia's long and pain-filled history of vertebrate pest management. In fact it barely rates a mention. But have things changed in recent years? A number of publications from the last 10 years or so have cited animal welfare or humaneness as factors influencing vertebrate pest management (Box 1). This has particularly been the case in publications aimed at influencing national strategies. At the Commonwealth level, the Bureau of Resource Sciences (BRS) series Managing Vertebrate Pests cites considering animal welfare as one of the principles on which to base vertebrate pest management (Braysher 1993; Saunders et al 1995). Threat Abatement Plans (TAPs) for feral cats, goats, rabbits and the European red fox published by Environment Australia all list as a key objective 'encouraging the development and use of innovative and humane control methods' (Environment Australia 1999a, 1999b, 1999c, 199d).

Box 1 Statements on considering animal welfare in vertebrate pest management

'*There is an increasing community expectation that all animals, including pests, will be humanely treated.*' (Braysher 1993)

'*Consideration of animal welfare issues should be an integral part of any feral animal program*' (Saunders et al 1995)

'*Increasingly, animal welfare considerations have influenced the focus of pest control research and the manner in which it is conducted*' (Eason & O'Connor 1999)

Is this an accurate reflection of the acceptance of assessing humaneness in the management of vertebrate pests, or is lip service merely being paid to animal welfare while the underlying practices remain unchanged? It would be heartening to believe the former, but it seems that in practice the latter is far closer to truth. When it comes to management principles, research directives and on-the ground strategies, there is little evidence to suggest that animal welfare issues are being given any serious consideration. For example:

- At the Commonwealth level, the BRS (Braysher 1993) advocates a strategic approach to pest management, but does not include assessing the humaneness of techniques as a stage in this process. Current funding for research into the development and use of innovative and humane control methods as advocated in the national Threat Abatement Plans is extremely limited and there is currently no specific allocation of resources to meet this objective.
- At the State level, the Queensland Government Pest Animal Strategy for 2002-2006 lists 8 management principles for pest animals. None of these include animal welfare. Indeed, while one of these principles is 'improvement of pest management practices', this refers only to the effectiveness of control and does not refer to improving the humaneness of control techniques. None of the 113 strategic actions listed in the document mention animal welfare. While the document lists 'addressing animal welfare concerns' as one of the significant challenges faced by stakeholders, it does nothing to educate or encourage stakeholders to take up this challenge.
- On-the-ground control plans have yet to include animal welfare as an essential consideration in their decision making process. The Cooperative Wild dog/Fox Control Plan (Brindabella and Wee Jasper Valleys) is an excellent example of a coordinated strategic approach to wild dog and fox control that involves all stakeholders in a long-term control program (Anon 2002). Yet there is no record in the report of this plan of animal welfare issues being considered in its

development. Whether or not it would have had an effect on the final outcome, it is important that the issue of humaneness is given adequate consideration.

These few examples illustrate the current gap between considering animal welfare in the theory of vertebrate pest management, and integrating it into the planning and implementation of control strategies.

Bridging the gap – the first step

Our practices concerning pest animal control have not had their roots in the conservation of native ecosystems, but initially as an instinctive reaction to protecting our land and our livelihoods. When property is damaged, crops destroyed or livestock killed or maimed, we naturally feel that 'something must be done'. Perhaps the most extreme example is the case of attacks on livestock where it is hard not to have an emotive response to the injuries caused, for example, to sheep, lambs and calves through predation by wild dogs. The animals concerned are often perceived as acting with deliberate cruelty and our immediate response is often one of retribution.

It should be expected, however, that we can go beyond such instinctive reactions and develop rational and considered responses to the imbalances in natural systems that we are faced with. Because most vertebrate pests have been introduced to this country, they are often portrayed as invading villains, when, of course, they are merely doing what animals do. Control strategies must avoid using inappropriate moral interpretations that suggest any type of control can be justified as a form of punishment. It should be recognised that pest animals require the same level of consideration for their welfare as that given to animals in other contexts. The problems that pest animals cause are reason enough to consider their control a serious issue without resorting to marketing images that distort the ethical context and confuse the appropriate motivations for control.

The role of animal welfare organisations

What role do animal welfare organisations, particularly the RSPCA, have to play in vertebrate pest management? In terms of the numbers of animals killed, and the cruelty of the methods used, the control of vertebrate pests is probably the biggest animal welfare issue in Australia. The RSPCA's role is summed up in its mission statement: 'to prevent cruelty to animals by actively promoting their care and protection'. The RSPCA works to promote the welfare of companion animals, farm animals, research animals, animals used in sport and entertainment, animals being transported or killed, as well as wildlife including native and introduced animals.

The RSPCA is itself responsible for killing tens of thousands of animals every year, in the name of animal welfare. Over the past 5 years over 700,000 animals have been received by the RSPCA across Australia (Table 1). In this period the RSPCA has killed a total of 150,000 dogs and 180,000 cats. We have also rehomed almost 200,000 dogs and 90,000 cats. All of these dogs and cats were desexed (sterilised) prior to being rehomed.

How can an organisation dedicated to caring for and protecting animals be responsible for the death of so many? The answer is simply because to do anything else would be cruel. The rejection rates of dogs and cats by humans cannot be dealt with solely through rehoming. Only through a constant program of encouraging desexing and adoption of shelter animals, and the selective euthanasia of unwanted animals, can numbers be controlled.

It is clear from these stark figures that the RSPCA does not hold a position against the selective killing of animals, provided that there is justification for such killing. The RSPCA is not opposed to the lethal control of vertebrate pest animals. But there is a clear and important distinction between the euthanasia of unwanted animals and many of the methods currently employed to control vertebrate pests. This distinction is not to do with whether pest animals should be killed, but how they should be killed – ie it must be done humanely. The RSPCA is opposed to any method of killing that has the potential for cruelty: a concern that applies to most of the current techniques used to kill vertebrate pests.

Table 1 Comparison of animals received by the RSPCA in Australia 1997-2002

	1998	1999	2000	2001	2002	Total
Total animals received	160,128	153,495	138,607	134,670	132,054	718,954
Dogs received	80,776	72,360	67,204	64,471	61,692	346,503
reclaimed/rehomed/ other	37,503	38,464	40,865	38,560	38,084	193,476
Euthanased	36,037	33,896	26,339	25,911	23,608	145,791
Cats received	59,028	59,006	50,485	51,598	49,754	269,871
reclaimed/rehomed/ other	14,874	16,486	19,283	18,697	18,745	88,085
Euthanased	43,375	42,520	31,202	32,901	31,009	181,007

What is humane killing?

The word humane is often used in conversations concerning animal welfare without being properly defined. The Macquarie Dictionary defines humane as: 'characterised by tenderness or compassion for the suffering or distressed', while inhumane is defined as 'lacking humanity or kindness'. This definition is not especially helpful when it comes to defining the humane treatment of animals. The Penguin Dictionary is more useful as it provides a further definition pertaining to the treatment of animals: 'causing the minimum pain possible' (although this definition does not include suffering or distress). Its definition of inhumane is similar to the Macquarie: 'lacking in kindness or compassion'.

There is general agreement of the ideal criteria for humane killing. The Australian Veterinary Association describes humane killing as 'by the rapid production of insensibility causing minimal distress to the animal' (AVA 1997). The Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART) states that the method used must 'either kill the animals very rapidly or instantaneously render the animal unconscious so that death ensure before consciousness is regained' (Reilly 1993). RSPCA Australia policy on humane killing states that to achieve a humane death, 'an animal must be killed instantly or instantaneously rendered insensible to pain until death supervenes'. Other organisations and publications have similar definitions or policies.

When such clear definitions of humane killing are provided, it is worth examining whether it is appropriate to use the term humane in a relative sense, ie can some practices be described as more

humane (less inhumane) than others? Both words can be described in both absolute and relative terms, depending on the criteria used to define them. The humaneness of a killing method can be measured either by the absence of pain, suffering or distress experienced by the animal, or by the relative level of compassion and kindness exhibited by humans. Conversely, inhumaneness can be measured by the absence of compassion or kindness or the relative level of pain, suffering or distress. While scientists have developed objective ways of measuring pain, suffering and distress in animals, it is a much harder task to objectively assess kindness and compassion. Consequently, when we talk of relative humaneness we tend to mean causing more or less pain, suffering or distress.

The concept of relative humaneness/inhumaneness is important because of the impact it has on practice. It is easy to abandon all hope of achieving humane techniques for vertebrate pest management if it is seen as an unattainable and unrealistic goal, since so many current techniques fall far short of this mark. But every step towards minimising the pain, suffering and distress involved is a step towards achieving humane management. This concept is known as 'refinement' in terms of the 'Three Rs' (replacement, reduction and refinement) which are widely used to progress animal welfare where animals are used for scientific research purposes (Russell & Burch 1959). In this context, refinement refers to any development leading to a decrease in the incidence or severity of inhumane procedures applied to animals. This concept is equally applicable to vertebrate pest management.

The 2000 Report of the American Veterinary Medical Association (AVMA) Panel on Euthanasia provides some good practical wording to describe a humane death that could serve as a benchmark for humane vertebrate pest management:

> 'Death should be as painless and distress-free as possible. Euthanasia techniques should result in a rapid loss of consciousness followed by cardiac or respiratory arrest and the ultimate loss of brain function. In addition, the technique should minimise anxiety experienced by the animal prior to loss of consciousness. The panel recognised that the absence of pain and distress cannot always be achieved. This report attempts to balance the ideal of minimal pain and distress with the reality of the many environments in which euthanasia is performed.'

This statement concentrates on the factors that should influence choice of killing method at a particular point in time. A further point needs to be made, that where current killing methods do not result in a death free of pain and distress, every effort should be made to develop a method that does. We cannot go on accepting 19th century killing methods just because there is thought to be no alternative to their use.

RSPCA Australia policy

RSPCA Australia policies and position statements are publicly available through the RSPCA Australia website www.rspca.org.au. The policy statements are adopted on the unanimous vote of the RSPCA National Council, following consultation with State and Territory RSPCA councils.

The existing policy statements on wildlife issues are currently being reviewed. The review process includes consultation with State and Territory RSPCAs and input from scientists with relevant experience through the RSPCA Australia Scientific Advisory Panel. The objective is to form a set of statements that convey the RSPCA policy on wildlife issues in a consistent and concise manner. The revised wildlife section is still in draft form as it has yet to be formally adopted by the RSPCA

National Council, so what is presented here is not the wording of the policies themselves but an overview of the guiding principles that underlie them.

At the core of the RSPCA's policies on wildlife issues is the understanding that animal welfare issues must be integrated into a wider framework of environmental management (see Box 2 for definitions of terms). The polices of the RSPCA regarding wildlife issues take into account the importance of the conservation of ecosystems in a series of general statements on animal welfare and the environment. These statements are made out of recognition that the state of an ecosystem directly affects the diversity of populations, the likely survival of animal species and the welfare of individual animals within it. However, it is also important that the policies and practices of conservationists, land managers and other stakeholders recognise animal welfare as a key issue.

Box 2 Definitions of terms in RSPCA policy on wildlife issues

Ecosystem - a community of organisms together with its environment, functioning as a unit.

Feral animals - introduced domesticated animals that have reverted to the wild state.

Introduced animals - any non-native (exotic) animals living and reproducing in the wild. For management purposes this may also include native animals when they occur outside their normal geographical distribution.

Native animals - animals that are indigenous to Australia.

Wildlife and *wild animals* - used interchangeably to refer to animals (both native and introduced) living and reproducing in the wild

The RSPCA approach to vertebrate pest management – guiding principles

1 Justification for control

The presence of pest animals in a given location is not sufficient justification for killing them or affecting their welfare in other potentially negative ways. An objective assessment must first be made concerning the impact that population is having. Potential impacts include:

- disease risk
- agricultural impacts (livestock predation, crop damage, competition for resources, damage or infrastructure)
- environmental impacts (on ecosystems and individual populations of native fauna and flora)
- social impacts (eg problem animals such as crocodiles).

RSPCA Australia policy recognises that both native and introduced animals can have a deleterious impact on natural ecosystems, agricultural production and may pose a disease risk. In certain circumstances it is necessary to reduce these populations. It is vital that assessment of such impacts is not carried out in a cursory or arbitrary manner, ie the fact that a particular species has been shown have an adverse impact in one area does not necessarily justify its killing in another. Unfortunately the designation of particular species as 'pest animals' encourages this type of blanket approach to control. It also encourages the vilification of particular animals, which all too often is taken as a justification for cruelty. The need for control must be assessed on a case-by-case basis.

2 Lethal or non-lethal control

Lethal control methods should only be sanctioned where no effective, humane, non-lethal alternative method of control is available. For example in some cases, such as the protection of small isolated populations of endangered native fauna or flora, exclusion of pest animals is the most efficient method of minimising their impact. The control method does not involve killing the animal but prevents it from causing the problem.

Non-lethal methods such as exclusion fencing or the use of chemical deterrents are generally regarded as humane. Some other methods, such as the Finlayson trough that excludes kangaroos from water points through the use of electric shocks, are regarded as inhumane. In such cases, humane lethal control may be the preferred option to non-lethal methods.

3 Probability of success

Any measures taken to reduce or otherwise control pest animals must have a high probability of success in reducing the adverse impact of the target animals. Obviously there will be stages in the development of new techniques, or in the application of existing ones in new ways, where it is difficult to predict how successful a technique will be. However, once a technique has been adopted and has a known efficacy, it should only be applied when there is a high probability of success.

4 Coordinated and strategic control

Much has been said about the need for strategic and coordinated control of vertebrate pests, however there is still a strong feeling, from within the RSPCA and from many people involved in the management of vertebrate pests, that we have a long way to go before this is the reality on the ground. RSPCA Australia holds the view that all control programs should be carried out under the supervision of the appropriate government authorities as part of an approved management program. Integrated control strategies (using different techniques or managing more than one species concurrently) should be used where appropriate to maximise their success. Most importantly, control strategies should be designed to ensure that any reduction of target populations is maintained in the long term to minimise the ongoing number of animals subjected to control. It is also important that control programs and the success of control techniques are effectively monitored and audited with the resulting data made available to the public to help shape future control.

5 Target specificity

Control programs should be target-specific, both in terms of avoiding impacts on other species or on individuals of a sub-group of the same species (such as domestic cats, dogs or rabbits). Target-specificity is important not only to avoid adverse conservation impacts (such as the killing of threatened native animals), but also to ensure that animals are not killed without justification.

6 Humaneness

RSPCA Australia is opposed to inhumane methods of controlling wild animal populations. This applies equally to native and to introduced animals. Any measures taken to reduce or eradicate specific populations of introduced animals must recognise that these animals require the same level of consideration for their welfare as that given to domestic and native animals.

What does this policy mean in practical terms? The RSPCA is opposed to the killing of animals where there is the potential for cruelty. The goal is a humane death. To make progress towards this goal, the following principle should always apply when making decisions on the choice of pest animal control: death should be as painless and distress-free as possible (after AVMA 2000). What is 'possible' depends on the techniques that are available, but the decision should always be to use the most humane approach consistent with achieving the required goal.

Unfortunately, most present pest management techniques are far from achieving the goal of a humane death. But rather than treating this as an excuse for inaction, deficiencies in current techniques should be addressed through innovative research and development into improving the humaneness of existing methods, replacing current techniques with humane alternatives, and the rapid uptake of novel techniques in the field. Research and development of humane alternative control methods should be regarded a priority area for research funding and promotion under government control programs.

Incorporating these guiding principles into management strategies

The concept of a strategic approach to pest animal management has been much promoted over the past decade to improve the coordination and effectiveness of management programs. The BRS series Managing Vertebrate Pests (Braysher 1993) sets out a series of stages as a framework for strategic pest animal management starting with the definition of the problems, through the design of the strategy, its implementation, and feedback into the process from evaluation of the outcomes. Table 2 summarises these stages and illustrates how the guiding principles outlined above can be integrated into this process.

Table 2 Standard strategic approach to pest animal management with suggestions for the integration of animal welfare principles

Strategic approach[a]	Animal welfare principles
1 Define the problem Define the problem in terms of harmful impact Collect necessary data/information Identify the scope of the problem	← Justification for control
2 Determine management objectives Determine the objectives and timeframe Set performance indicators and criteria for failure	← Probability of success
3 Identify and evaluate management options Choose the most appropriate solution (eradication, one-off control, sustained control etc)	← Lethal or non-lethal control
4 Determine management strategy Identify appropriate control techniques	← Humaneness and target specificity of techniques
5 Implement control program Inclusive and cooperative approach	← Coordinated and strategic control
6 Monitor and evaluate the outcome Operational monitoring and performance monitoring	← Justification for control
7 Modify management plans Modify plans or objectives based on evaluation	← Humaneness and target specificity of techniques

[a] After Braysher (1993).

Priority issues of humaneness

The range and extent of animal welfare problems in vertebrate pest management is so great that it is difficult to determine what are the most urgent of these to address. However a quick survey of RSPCAs across the country brought together a list of species and issues that are regarded as priority areas in need of action (Table 3). This list is by no means extensive but provides an indication of the issues of most current concern to the RSPCA.

Table 3 Priority issues of humaneness in vertebrate pest control – the RSPCA perspective

Species	Issues of humaneness
Rabbits	• Use of biological controls, ie myxomatosis, RCD • Use of rabbit traps (now banned in some States) • Use of warren ripping/fumigation with chloropicrin
Foxes/wild dogs	• Use of 1080 • Use of steel-jawed leghold traps • Lack of coordination and consistency in control by property owners
Mice	• Problems with aerial baiting during plagues • Use of poisons such as strychnine and anticoagulants
Cats	• Use of 1080 • Lack of consistency and coordination of control • (Emotive issue with many cat lovers)
Goats	• Welfare problems of mustering and live export
Native animals	• Reactionary nature of control of native animals in agricultural areas • Use of inhumane poisons • Welfare problems with control and relocation of native animals such as koalas and flying foxes • Lack of control over non-commercial killing of kangaroos

In addition to highlighting the main problems in the control of particular species, a number of the methods used warrant specific mention because of their potential for cruelty:

- Steel-jawed leghold traps: RSPCA Australia believes that jawed leg-hold traps should be banned from use as they are inherently cruel. The use of body-grip traps can also cause suffering if the animal attempts to escape or is restrained without access to food or water.
- Poison baits: RSPCA Australia is opposed to the use of inhumane poisons and to baiting strategies that are not target-specific. While not specifically named, this includes most of the more commonly used poisons such as anticoagulants and zinc phosphide. The RSPCA believes that the available evidence indicates that, in general, the effect of 1080 on animals is not humane and is opposed to its continued use for the control of populations of introduced or native species.
- Burrow clearing and destruction: RSPCA Australia is opposed to the use of inhumane burrow clearing or destruction techniques, including fumigation using chloropicrin, or the ripping of burrows without prior clearing using humane control methods.

The RSPCA supports research into fertility control methods to regulate both introduced and native wildlife populations, where these methods are known to be humane.

Bridging the gap – the way forward

The aim of this Seminar is to examine how we can bridge the current gap between considering animal welfare in the theoretical context of vertebrate pest management and integrating practical actions into the planning and implementation of management strategies. An assessment of the humaneness of control methods is regarded as a fundamental stage in the development of such strategies.

The issues presented above underline the extent of the problems faced in attempting to achieve humane vertebrate pest management. The challenge now is to begin to address these problems. There are a number of key principles that can serve to shape this process:

- Animal welfare considerations should be an essential and integral part of the evaluation of current and new techniques, strategies and programs for vertebrate pest management.
- The research and development of humane alternative control methods should be regarded as a priority area for research funding and promotion by government.
- Control strategies should ensure that any reduction of target populations is maintained in the long term to minimise the number of animals subjected to control. Integrated control techniques should be used where appropriate to maximise the success of control programs.
- When refinements to existing techniques, or new techniques that have been developed, have been demonstrated to be efficacious and cause less pain, suffering or distress to animals, then the use of these techniques in preference to others should be mandatory.

It is time that these issues were given the consideration, attention and action that they deserve.

References

Anon (2002) Cooperative wild dog/fox control plan (Brindabella and Wee Jasper valleys). http://www.npws.nsw.gov.au/wildlife/pests/wild_dogs/brindabella_plan.html

Australian Veterinary Association (1997) Guidelines for humane slaughter and euthanasia. In: J Cornwall ed. Member's Directory and Policy Compendium. Veritage Press, Lisarow NSW.

AVMA (2000) Report of the AVMA Panel on Euthanasia. Journal of the American Veterinary Medical Association 218(5):669-696.

Braysher M (1993) Managing vertebrate pests: principles and strategies. Bureau of Resource Sciences, Canberra, 58pp

Eason C & O'Connor C (1999) Wildlife toxicology issues in possum control: a comparison of sodium monoflouroacetate (1080) and brodifacoum. Proceedings of the Manaaki Whenua Conference, Wellington, New Zealand, April 1999.

Environment Australia (1999a) Threat abatement plan for competition and land degradation by feral goats. Environment Australia, Canberra, 39pp.

Environment Australia (1999b) Threat abatement plan for competition and land degradation by feral rabbits. Environment Australia, Canberra, 46pp.

Environment Australia (1999c) Threat abatement plan for predation by the European red fox. Environment Australia, Canberra, 33pp.

Environment Australia (1999d) Threat abatement plan for predation by feral cats. Environment Australia, Canberra, 46pp.

Queensland Government (2002) Queensland Pest Animal Strategy 2002-2006. http://www.nrm.qld.gov.au/pests/strategies/qld_strategies.html

Reilly JS (1993) Euthanasia of animals used for scientific purposes. ANZCCART, Glen Osmond SA.

Russell WMS & Burch RL (1959). The principles of humane experimental technique. Methuen, London, 238pp.

Saunders G et al (1995) Managing vertebrate pests: foxes. Bureau of Resource Sciences, Canberra 141pp.

A landholder's perspective on vertebrate pest control

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Summary

When considering the humane control of vertebrate pests there are many aspects to consider. The aspects to consider today from the landholder's perspective are:

- Landholders
  - What is your perception of a landholder?
  - Who is a landholder?
  - What are the responsibilities of a landholder?
- Vertebrate pests
  - What is your perception of a vertebrate pest and vertebrate pest control?
  - What are vertebrate pests?
  - Why do we control them, what are their impacts?
  - What steps are taken to humanely control vertebrate pests?
  - What impediments are there to the humane control of vertebrate pests?
  - How do you achieve humane control of vertebrate pests?

Introduction

In the general information on today's seminar it states that 'The 2003 Seminar on the topic 'Solutions for achieving the humane vertebrate pest control', will seek to establish common ground between stakeholder groups and stimulate thought and discussion on practical innovative strategies for achieving humane control of vertebrate pest species'. This implies that, currently, the control methods are inhumane.

Containment of any species is not a comfortable concept; death of any species is an even less comfortable concept. So what is possible? Are we talking and debating from a realistic approach of what are the most humane and workable methods available at this time? Or are we hoping for a soft option? Unfortunately there isn't one. Containment or death are the two alternatives in vertebrate 'pest' control.

Currently there are humane control methods being used to contain and despatch vertebrate pest animals. And if we are serious about addressing the issues surrounding humane control of vertebrate pests then we need to deal with all pest species, whether introduced or native.

What is your perception of a landholder?

What do you see? The who, how, what, where, when and why of landholding. Hold that image. Now, I invite you into my space. My space as a landholder. Let me tell you who I am. I am a landholder. I am a passionate agriculturalist. I am up to my armpits in the grit of my industry. I have attended enough workshops, seminars and senate enquiries; sat on enough boards and council meetings at a local and State level to know that there is a wealth of information and research

available which is not read nor given due consideration by people holding strong preconceived perceptions on how everything could be done better. I agree with them on only one thing, there is always room for improvement. That is where I come from. I am very keen on solid workable solutions to real problems.

I am only one landholder; no two landholders are the same.

Who is a landholder?

We are not all farmers or graziers. We are an engineer, teacher, arborist, second-hand building material merchant, retailer, hairdresser, vigneron; we are retirees, nurses, painters, writers, students, tourist operators, tree plantation owners, NPWS, NSW SF, DLWC, volunteer fire fighters, and that is just covering the landholders in Wee Jasper. Australia-wide, landholders are a diverse collection of people and beliefs. We all are obligated to control pest species.

Does that fit your perception of a landholder? Can you expand your perception of a landholder?

What are the responsibilities of a landholder?

Regardless of who you are or why you own land, landholders have responsibilities. There are legal requirements, including (in New South Wales) the:

- Rural Lands Protection Act – legally binds landholders to suppress and destroy declared pest species.
- Local Government Act
- Environmental Planning and Assessment Act
- Prevention of Cruelty to Animals Act
- Native Vegetation Conservation Act
- Enclosed Lands Act
- Occupational Health and Safety Act
- Threatened Species Conservation Act
- National Parks and Wildlife Act
- Catchment Management Act
- Noxious Weeds Act
- Rural Fires Act
- Soil Conservation Act
- Stock Diseases Act
- Water Act
- Western Lands Act
- Federally - Environment Protection and Biodiversity Conservation Act

The landholder cares for their land day-by-day, season-by-season, bound by these Acts but driven by their own set of values.

What is your perception of vertebrate pests and their control?

Now once again cast your mind over to an image. This time, your perception of a feral animal. What do you see? What is your image? How is that animal living? What are its habits? How much do you really know about that animal? How much more is there to know? Is any sort of containment or death of a pest animal acceptable to you? Have we got it right? To start at the beginning what makes an animal a pest animal?

What are vertebrate pests ?

Simply, vertebrate pests are animals that cause a negative impact to an unacceptable level. It may or may not be a population, or large number of animals, it can also be a singular animal. That animal species will not necessarily always be a pest animal, in a different situation it may live in harmony with its total environment. A pest animal can be an introduced species such as a rabbit or fox. It can also be a native animal such as a kangaroo or wombat. Vertebrate pests would also include but are not restricted to: rabbits, feral pigs, wild dogs, feral goats, feral deer, feral cats, wild horses, foxes, mice, rats, feral stock (cattle and sheep), and birds such as, starlings, sparrows and Indian mynahs. And as previously discussed, native animals such as kangaroos, ducks, flying foxes, crows, galahs, silver eyes etc.

Why do we control vertebrate pests, what are their impacts?

We control vertebrate pests because of their impact on the environment, their impact on human health, their impact on the viability of a business, or their impact on the welfare of another animal, when that impact is at an unacceptable level. Here are a few random examples showing how these impacts manifest.

Environment

Probably the easiest example is the rabbit degradation on the environment, their continuous burrowing and veracious appetite, along with prolific breeding cause massive erosion and loss of plant species.

Human health

The fox, wild dog and wallaby have all been proven hosts in the hydatid cycle, hydatids being a human life threatening infestation. The Canberra region has one of the highest hydatid infestations in the world. Bats such as flying foxes carry the Lyssa virus (closely related to rabies), Hendra virus and Menangle virus. Feral pigs can carry several endemic diseases and parasites of importance to human health, such as leptospirosis, brucellosis, tuberculosis, Murray Valley encephalitis etc.

Business Viability

The viability of a business can be at risk when pest animals, such as kangaroos in the pastoral zones, eat the available stock food and decimates fencing. With improved pastures and watering points, kangaroo populations have grown since 1770. The damage caused by marauding feral pigs in a wheat growing enterprise severely impacts on its viability.

Animal Welfare

The impact on the welfare of another animal is one of the most visibly disturbing. The wild dog attacks on agricultural livestock are a very sobering example. Another is the predation by feral pigs on lambs and lambing ewes. Animal-to-animal impact is totally merciless. The predator's aim is to dominate. Whether for play or for a food source, the eventual outcome is usually death, although it is seldom swift.

What steps are taken to humanely control vertebrate pests?

There are fundamental procedures in controlling vertebrate pests, which automatically put in place humane steps. Humane being to minimise the duration and type of stress and the degree of pain inflicted. These fundamentals hinge on the fact that the landholder will favour a fast, successful and economic method. A plethora of organisations, committees and councils at a State, national and international level, are in place to oversee that humane methods are used in pest control. These include (in New South Wales):

- Royal Society for the Prevention of Cruelty to Animals (RSPCA) NSW.
- The Sub-Committee on Animal Welfare that reports to the Animal Health Committee and ultimately to the Primary Industries Ministerial Council.
- The National Consultative Committee for Animal Welfare that includes representatives of Federal, State and Territory Governments, RSPCA, National Farmers Federation, Australian Veterinary Association, and Animals Australia.
- The Vertebrate Pest Committee that reports to the Land and Water Biodiversity Committee and ultimately to the Natural Resource Ministerial Council and to Primary Industries Ministerial Council.
- NSW Pest Animal Council has 14 agencies/organisations represented and reports to the Minister for Agriculture.
- Animal Welfare Advisory Councils exist in most States to provide advice to respective Governments.
- NSW Animal Welfare League.
- NSW Animal Research Review Panel, a statutory body under the NSW Animal Research Act, overseeing all animal research in NSW from an animal ethics perspective. In NSW there are some 70 Animal Care and Ethics Committees reporting back to the Panel. These do consider the impact of procedures on all animals during the research to establish approved control methods. The Australian code of practice for are and use of animals for scientific purposes specifically includes feral animals.
- The National Registration Authority applies a rigorous approach to the registration of chemicals and any associated investigations.
- The Office International des Epizooties (OIE) exists under the World Trade Organisation and sets standards for surveillance and disease control. This also has an impact by requiring vertebrate pest control in some circumstances.

In all situations all over the world, there exist a few people who will always require legislation and or regulation to make them do the right thing. However, I do firmly believe that if the culture of

minimising suffering is promoted by workable economic methods, we will always be using the most humane methods available at the time.

What impediments are there to the humane control of vertebrate pests?

The biggest impediment to humane control of 'pest' animals is ignorance. The second is perception. The more you know about an animal's behaviour – why the animal goes the places it goes, eats the food it eats, reacts to situations the way it does, the more humanely it can be controlled. Two examples armed with this knowledge that spring to mind, are a dog trapper and professional kangaroo shooter. Rarely will these trap or shoot a non-target species because their judgements made during the pest control procedure are honed by knowledge not perception.

The extensive research knowledge available needs to be constantly referred to in pest control method, decision making. Continuing research needs to be funded to make sure workable options are identified.

On perceptions, there has been many a letter written to Ministers complaining about the perceived situation only to find that the best available methods were being used. Value judgements are made and are dependant on your environment, your circumstances regardless of where we are – farm, National Park, or city. We make value judgements all based around our shelter, our water and our food. How often do we place our requirements of food, water and shelter onto an animal?

Perceptions never disclose the full facts. A classic example on perception is one I held myself. Many of you may think, as I did, that a far more humane method of protecting stock from fox and dog attacks is with Maremma dogs rather than 1080 poison or traps. As you are probably aware the Maremma dogs mark their territory very regularly, warding off most pest animals, and hopefully killing those who traverse their territory to damage stock.

We have run Maremma dogs for many years now, and yes they have been successful in limiting predation on lambs and kids. However, their treatment of swamp wallabies, eastern greys and wallaroos is far from humane. The dogs will run their prey and when it suits, they will kill. Animal to animal this is comfortably within their set of values, this is orderly.

How do you achieve humane control of vertebrate pests?

To have workable, humane control of vertebrate pests, we must make decisions on all the facts not part fact or part perception or a combination of both. All the facts must be carefully considered.

Most importantly, before a method of control or dispatch is taken away, an alternate method that has been proven to be more humane, proven as economic and proven as workable in the field, must be endorsed by the user as well as the raft of bureaucracies. Occupational health and safety (OH&S) is also an important item on the agenda here. The operator's health and safety must remain a priority.

Do not take away a method because it is unpalatable from a human perspective. The D class gun license is required in some areas for an OH&S responsible despatch. A semi-automatic rifle is essential if shooting to despatch pigs in heavy lignum bush country. However, due to emotive public issues it is becoming increasingly difficult to obtain and maintain this license.

Humane control is a balance between the pragmatic decision to despatch a pest, and the ethical and moral decision on the method to be used. Another ethical and moral decision, which would offer humane balance, exists in the current dilemma in the Western Division of NSW. The drought has left kangaroos weak from hunger and thirst and long suffering in extreme conditions. This is a case where it is important to minimise the duration and type of stress on a pest. Currently skin-only culling of pest kangaroos is not permitted and it is not economic to cull for meat. Surely this is a case for humane action.

A successful example of minimising the type of stress has been the change from the steel jawed trap to the rubber jawed trap. While there was initial concern about the ability of the rubber-jawed trap to securely hold a wild dog, when properly trialed and fact rather than perception became the subject matter, there was no longer a problem and this more humane method was adopted.

Throughout NSW the Rural Lands Protection Board system now operates under a strategic pest animal management plan with a common structure. This structure is based on a good consultative process to maximise cooperation between all landholders and stakeholders, making humane pest animal control more efficient in time and dollars. Collaborative programs on a regular basis are a common occurrence.

Today landholders are extremely busy, we are short on time and like every other business every dollar is stretched. If an approved method of containment or despatch is not workable or economic in time and dollars, inevitably it will be compromised.

The majority of people would much rather be involved in animal husbandry, sewing crops, land restoration or strategic management activities than despatching pest animals. It is important to note that this is done only when it is an absolute necessity. The speedier the process the better. This is to the advantage of both operator and pest animal.

So when considering humane methods do not make the task more onerous than it already is. Keep methods simple and cost effective. Do not take away a method before an alternate method has been proven economic and workable in the field, to the satisfaction of all stakeholders.

In closing I will reiterate that I do firmly believe, if the culture of minimising suffering is promoted by workable, economic methods we will always be using the most humane methods available at the time. And ask you:

- Are you aware of the incredible complexity facing the landholder? Have you been able to distil from this the essence of what it is to be a landholder?
- Has this information altered your perceptions of vertebrate pest control?

Vertebrate pests—a conservation perspective

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Summary

Conservation organisations by definition are primarily concerned with the conservation of the world we inherit for the benefit of present and future generations. Humans are agents of influence within the local and global ecosystems of which we are a part. Doing nothing in terms of wildlife management is not a choice but a decision.

Vertebrate pest management is a subset of this management responsibility. Nature conservation groups predominantly approach this from an ecological perspective. Respect for life across the whole spectrum of species is a consideration. Management intervention for biodiversity objectives has inherent dilemmas, as for example reducing predation of native birds and small mammals by cats – domestic and feral.

A number of the problem species were deliberately introduced into Australia by colonists, have since acclimatised and 'run wild'. Feral goats, pigs, buffalo, horses and deer for example were introduced first for food and work; the fox for recreational hunting; and others, like the cat, as part of the nostalgia for home, as companion animals and/or use in controlling other pests. Some came in as hitchhikers – such as the ship rat and house mouse while a few, like the cane toad, were imported for biological control of other pests.

Simultaneously, landscape modification for northern hemisphere style agriculture has destabilised existing ecological patterns. For some native animals – the larger macropods, galahs, sulphur crested cockatoos, corellas, and flying foxes to name a few – the changes have expanded preferred habitat and/or created new food opportunities leading to conflict with predominantly monoculture primary production interests.

The challenges implicit in reconciling the urgent need for pro-active vertebrate pest control in the face of declining biodiversity with humane, safe and cost-effective management techniques have been articulated by the conservation movement through policy, submissions, advocacy and involvement with government and non-government agencies and groups involved with natural resource and protected area management.

Interaction with government agencies includes involvement in advisory committees and task forces addressing species of particular concern to agriculture. Methodological concerns over risks of impact on non-target species extend to use/misuse of poisons and genetically engineered agents for disease and sterilisation.

Specific examples are drawn from experience in NSW regarding feral horses, kangaroos and flying foxes. Top priority issues vary in different regions around Australia. The currently available tools for eliminating/minimising pest impacts are far from perfect. Modification of land management techniques and non-lethal methods offer significant opportunities. Preventative action is preferable. Ongoing research, including into sterilisation techniques, is essential. Conservation groups generally

are unable to resource this directly but may participate in identifying critical policy questions and data gaps.

Agreement on common ground with influential bodies such as the RSPCA respecting ecological and social/ethical as well as economic objectives is overdue. It is suggested that key points for conservation include acceptance of eradication as a long-term objective in some instances, and immediate implementation of best available practice in terms of humane but effective control where the viability of native fauna and flora is at risk.

General overview

Conservation organisations by definition are primarily concerned with the conservation of the world we inherit for the benefit of present and future generations. A predominantly anthropomorphic approach prevails for some acknowledgment that humans are just one species existing at this moment in time in earth's history within the broader universe takes precedence.

Humans are agents of influence within the local and global ecosystems of which we are a part; and thus share responsibility for safeguarding our natural heritage for present and future generations. Doing nothing in terms of wildlife management is therefore not an option.

Ecological issues

Nature conservation groups predominantly approach relationship with other animals from an ecological perspective. Australia, a continent long isolated from other lands masses, supports a range of special and unique plant and animal communities. The extent to which humans contributed to the demise of some of our now extinct megafauna is unresolved. Nature red in tooth and claw is accepted as an element in the overall scene.

The changes since Europeans came, cleared and introduced new ways of life along with plants and animals has caused huge disruption within a very short space of time to the established variety and pattern of plant, animal – and human - communities previously spread across the continent. This continent, until recently blanketed by native vegetation, evolved over time, subject to natural extremes of flood and drought, is now fragmented into islands of natural habitat in a sea of lands modified by grazing, clearing and alien plantings, chemical applications, modification of natural water flows and more, to suit our human needs and wants. We contribute to and are in turn affected by global influences natural and human induced, most notably climate change.

The broader conservation movement seeks to reduce the adverse repercussions of contemporary human activity. A fundamental concern is to ensure our life support systems do not collapse.

Appropriate intervention to retain as much as we can of the natural variety species – our biodiversity – is increasingly recognised as urgent. The well-documented shrinking distribution of many of our woodland birds is just one indicator of another wave of widespread extinction of native species.

Along with accelerating exploitation of our natural resources has been the impact of deliberate introductions into Australia of many plants and animals, which have since acclimatised and 'run wild'. The World Wide Fund for Nature, in their January 2003 Position Paper 'Weeds and pests: eradicating the invasive threat', list some 20 species of mammals, 25 species of birds, one amphibian and 19 species of freshwater fish as 'animal pests', highlighting European rabbit, European fox, cat,

pig, goat, donkey, camel, water buffalo, mosquito fish, Northern Pacific seastar, European carp and cane toad as the vertebrate pests causing major problems.

Background: native and introduced species

The boom or bust climatic cycles over much of Australia are a natural contemporary feature. Following one of the occasional inland flood seasons that filled the normally dry Lake Eyre for example, there is an explosion of vegetation cover and the subsequent rapid expansion of plant and seed eaters like the native 'plague rat' (Rattus villosissimus) which so pestered some of the early explorers: this is followed by a build up of raptors and ground dwelling carnivores and subsequent by drawn-out decline with literally mounds of drying fish as the teeming salt lakes again dry out. The big wets and hot dry seasons of Northern Australia; the alpine and subalpine areas of Victoria, NSW and ACT: all manifest natural extremes of weather each year, compounded by the longer and less well defined climatic cycles and trends, on which the current global warming phase impinges. Over thousands of years the flora and fauna has adapted to these extremes with a range of special strategies. However the natural stresses are significantly compounded by the recent and rapid fragmentation of habitat, curtailing opportunities for altitudinal and lateral shifts.

Accepting that human influence across a human modified landscape is unavoidable; management of species that become pests is part of this influence, involving a range of approaches from exclusion to population control through to elimination.

The prime focus on vertebrate pest management has been driven by the detrimental impacts on a primary industry driven by market pressure to deliver minimum standard regular supplies in a way that is not readily compatible with the fluctuations of the natural world. Any native or introduced species that seriously threatens human wellbeing and prosperity soon features on the 'vertebrate pests' list.

The larger native macropods have contributed to 'total grazing pressure', reaching unnaturally inflated numbers facilitated by extensive installation of stock watering points, which may be compounded by removal of the dingo as well as all the lovely improved pasture and grain crops. It has also been suggested that commercial harvesting, far from serving as a pest control measure, may increase population numbers through selective take of large males rather than females. Possums, fruit bats, dingos, cockatoos, even the now extinct thylacine are all examples of native vertebrate species that could be categorised as pests in so far as they impinge on human productive endeavour and wellbeing.

Non-native vertebrate pests

Many of the vertebrate pests of today were introduced for what seemed like good reason in their day. The hard-hoofed omnivorous feral goats and pigs were introduced to provide food for the future, with no understanding of the potential impacts on existing native animals and the vegetation on which they depended, let alone on agriculture. The fox, first brought in for recreational hunting, is now one of the most successful of predators: and despite all the problems it has caused on the mainland has only recently and illegally been secreted into Tasmania to the horror of all who care for the native wildlife on which it so successfully preys. Buffalo, horses and deer were introduced first for food, work and sport, the cat, as a companion animal and also for 'vermin' control. Some came in as hitchhikers – such as the ship rat and house mouse while a few, like the cane toad, were

imported for biological control of other pests. Colonists nostalgic for the wildlife of northern Europe brought others in under officially approved 'acclimatisation' schemes.

Absence of natural disease/disease vectors and predators are a feature of the introduced species, facilitating population explosions when coinciding with favourable seasonal conditions. This compounds the destabilising influence of other changes across the landscape on natural ecosystems and habitats established over the many thousands of years of previous evolution.

Many of these introduced species are also a serious threat to native fauna and flora. Only this week we have read in the Sydney Morning Herald about the amazing Lord Howe Island stick insect, teetering on the brink of survival following escape of ship rats. The cat and fox also have a lot to answer for: while yet others such as hard-hoofed feral goats, deer, horses and pigs contribute to soil erosion, affect drainage patterns and wetland integrity, as well as compete for food and for shelter. The carp has become known as the rabbit of the inland waterways.

Our precious network of national parks and reserves are increasingly islands in a sea of change, many pitifully small and the majority on the land deemed least productive and so least suitable for agriculture. It is critical that these areas be managed to minimise further destabilising impact, and defended from the impact of the invading hordes!

Major themes

The major themes of animal welfare in vertebrate pest control from a conservation viewpoint require ecological as well as social and economic understanding of the impacts across the continent. Prime considerations should address the need to protect and retain the diversity of ecosystems and habitats and the populations that these sustain. At the same time, it is essential to seek management strategies that minimise collateral environmental damage. A well-resourced scientifically grounded research base is required to facilitate this understanding and in pursuit of more effective but less detrimental strategies. Accountability is critical: the conservation movement has been at the forefront in seeking effective community participation, backed up by access to legal processes. These points are illustrated through a series of 'Catch 22' case studies.

'Catch 22' examples

Hedgehogs in the Hebrides

An offshore example illustrates the dilemma in managing change when a native species is deliberately introduced outside its existing range for a benevolent purpose.

Hedgehogs were introduced into the Outer Hebrides in 1974, apparently to help reduce slugs and snails in local gardens. In the absence of natural predators the population soared and wader breeding plunged as hedgehogs moved on to take eggs.

Study of translocation options indicate significant animal welfare concerns with a projected 25% mortality; fencing off bird breeding areas is costly, possibly ineffective; population control through sterilisation of the hedgehogs not a short-term option. Meanwhile numbers continue to increase and waders to decline due to a standoff as hedgehog lovers oppose killing. What is the solution?

Wild dogs versus dingo survival

Wild dogs in and around the fringes of national parks are a serious menace to domestic stock – and have been known to threaten humans. In the few larger rugged protected areas, such as Kosciuszko National Park, the mountain dingo still hangs on, but its future is precarious. Widespread aerial baiting with 1080 is a threat to the true dingo and other species. However skilled 'doggers' can target the offending animal, baiting and shooting within a 5 km buffer zone with occasional use of frequently monitored soft-jawed traps where problem individual dogs are identified. This is not a perfect solution – is this nevertheless the best option available in the circumstances?

Kangaroos versus park values (Hattah Lakes, Victoria)

The Western grey kangaroo population built up to almost ten times estimated natural numbers due to a mix of factors including historical land use change and then in the face of vehement objection to killing of kangaroos. The overall grazing pressure from the kangaroos plus rabbits and some goats was severely damaging the vegetation including some rare and threatened local plant species and exacerbating soil erosion. Eventually a major cull was accepted as inevitable, and numbers were reduced from nearly 50/ha to between 5 and 7/ha, populations are now monitored twice yearly and additional culling occurs under a 'restoring the balance' plan with strictly observed protocols based on ecological and humanitarian principles. The vegetation has recovered dramatically. Is this a good model for other situations?

Koalas on Kangaroo Island

The exploding koala population on Kangaroo Island, South Australia, stems from deliberate introduction of animals from the mainland. Disease and food shortages are the only limits to population control in the absence of natural predation. Relocation has been suggested rather than killing. However, apart from the stress to the individuals concerned and the impact on existing populations in any translocated area, it is important not to mix gene stock for the reason that 'local provenance' for seeds is used when regenerating natural vegetation.

Feral animals in national parks

Feral animals generally should have no place in those limited areas we have reserved for the conservation of our natural landscapes, flora and fauna. Control programs apply for such introduced animals as pigs, goats, cats and foxes, with shooting, trapping and some baiting: the aim is to ensure strict well-monitored protocols. Public outcry has however led to a political stalemate such that feral horse populations have boomed unchecked in some parks in NSW, to the detriment of the natural environment. Vocal opposition to deer culling post the 1994 fires in Royal National Park severely affected revegetation. The situation has finally moved forward with extensive public consultation and adoption of a Deer Management Plan. Is this the way to go?

Cats versus native animal prey

Cats are natural carnivores, and very successful hunters of small birds and mammals. Feral cats are now established across most of Australia. Moves to curtail the night hunting of the domestic 'companion animal' cat are at last being accepted. Shooting feral cats is accepted but insufficient to address the problem long-term. Yet one known cat-specific disease which might serve to dramatically reduce numbers in the wild has not been released as it would be difficult to ensure the domestic moggy does not also succumb. What is the best solution?

Fruit bats versus horticulture

Recently the Humane Society International brought a case against the Minister for the Environment for failing to comply with the requirements of the Environment Protection and Biodiversity Conservation Act in relation to fruit bat control on a large Queensland horticultural property. Native fruit bats have lost much of their original rainforest habitat and food supply but have adapted to feeding on a range of new plantings introduced by horticultural ventures. Electrified netting that effectively fries any intruder has been employed. Conservation groups such as the Kuringai Bat Society are working for ecologically sustainable alternatives that include costly orchard netting, alternative food supplies and secured maternal roosting sites rather than widespread extermination of a naturally very mobile group to an extent that could push some of the species to extinction.

Mouse plagues

The introduced Mus domesticus from Europe can build up into serious plague numbers across the wheat belt under suitable climatic conditions, costing millions in lost productivity. Research into options for controlling mouse plagues is being undertaken by CSIRO, one possibility being a genetically manipulated virus strain that causes sterility. Sterilisation appeals as a pre-emptive measure limiting population numbers rather than death of living individuals: however genetic engineering of this sort is opposed on principle by some. A recent detailed appraisal under the 'GenHaz' system was impressive, ranging from implications on related species in Asia, some rare if the disease spread via contaminated wheat, to practical considerations of feasibility. Development of such an option is lengthy and costly. How much is society prepared to pay to address problems arising from the mistakes of past generations?

Foxes in Tasmania

Until recently Tasmania has been fox-free, and hence a haven for many animals threatened by predation and competition on the mainland. A targeted program aimed at elimination is now in place though possibly hampered by sufficient resources and drivers. The Tasmanian Conservation Trust, which has long strenuously opposed the use of 1080 because of the impact on non-target native wildlife and the unpleasant death for the individual. However, after protracted discussion, it is now accepted that 1080 is an essential tool in these exception circumstances on the basis of best practice buried baiting techniques, thus minimising likelihood of non-target species such as quoll and possums picking up the bait. 1080 has been widely used in that State, as a cheap (subsidised) option.

Discussion

These 'Catch 22' examples illustrate the challenges in managing vertebrate pests so as to deliver ecological outcomes that are acceptable, humane and sustainable.

Preventative measures – retention of native vegetation, of native forests, opposition to introduction of alien plants and animals – and application of the 'precautionary principle' should take precedence.

Fixing up the damage is harder, more costly, and often harder to 'sell'. Advocacy for improved care of the landscape, solar energy and improved pest control techniques are all areas where conservationists have constructively contributed.

Animal welfare concerns are an element of best practice wildlife management rather than an overwhelming concern for each and every individual animal to an extent that overrides the viability and natural variety of native animal populations and communities.

Pro-active advocacy for pest control in the face of declining biodiversity with humane, safe and cost-effective management techniques is a facet of this responsibility. This advocacy ranges from lobbying for legislative changes through to catchment and local planning and implementation strategies. Preventative action to reduce new introductions is have been articulated by the conservation movement through policy, submissions, advocacy and involvement with government and non-government agencies and groups involved with natural resource and protected area management.

Interaction with government agencies includes involvement in advisory committees and task forces addressing species of particular concern to agriculture. Methodological concerns over risks of impact on non-target species extend to use/misuse of poisons and genetically engineered agents for disease and sterilisation.

Top priority issues vary in different regions around Australia. The currently available tools for eliminating/minimising pest impacts are far from perfect. Modification of land management techniques and non-lethal methods offer significant opportunities. Preventative action is preferable. Ongoing research, including into sterilisation techniques, is essential. Conservation groups generally are unable to resource this directly but may participate in identifying critical policy questions and data gaps.

Agreement on common ground with influential bodies such as the RSPCA respecting ecological and social/ethical as well as economic objectives is overdue.

Conclusion

- Time is running out for our native wildlife.
- Intervention is inescapable.
- Humane pest control is a component when prevention fails.
- Essential considerations for best practice must include:
    - minimisation of ecological disruption;
    - minimisation of collateral environmental damage;
    - minimisation of suffering of target and non-target species;
    - resources for research and implementation;
    - accountability.
- Non-lethal methods (sterilisation, re-location) not necessarily applicable.
- Delay is an unacceptable option when the environment is at risk.

Disclaimer: In preparing this paper I have sought information not only from the conservation groups with which I am most closely associated but also from some of the other State, national and international groups whose activities have bearing on vertebrate animal survival. However, the paper is my responsibility alone.

The NRA's role in the regulation of vertebrate pest control agents

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Summary

The National Registration Authority for Agricultural and Veterinary Chemicals (NRA) is responsible for the evaluation and registration of agricultural and veterinary chemicals in Australia. Before any agricultural or veterinary product can be supplied, it must be either registered or permitted by the NRA. The framework within which the NRA must act (including its limitations and obligations) are defined within the NRA's key governing legislation, the Agricultural and Veterinary Chemicals Code Act 1994 (the Agvet Code). This legislation is the result of agreement between the Commonwealth and the States, and any changes to it require Commonwealth/State agreement.

The aim of this presentation is to outline the role of the NRA in the regulation of invertebrate pest control agents; to discuss the criteria the NRA must (and can only) take into account when it is assessing these products, and to consider possible future directions.

Vertebrate pest control agents fall within the definition of an 'agricultural chemical product' contained in the Agvet Code. Species that are controlled by the use of these agents (for example rabbits, feral pigs, wild dogs) have been formally declared to be pests under the Rural Lands Protection Act 1998. The NRA therefore regulates invertebrate pest control agents as agricultural chemicals. Section 14 of the Agvet Code defines the matters the NRA must take into account when it is considering whether to register an agricultural chemical product. These matters do not refer specifically to animal welfare but include requirements that, when used according to recommendations for its use, a product will be effective and:

- would not be an undue hazard to the safety of people exposed to it during its handling or people using anything containing its residues;
- would not be likely to have an effect that is harmful to human beings;
- would not be likely to have an unintended effect that is harmful to animals, plants or things or to the environment; and
- would not unduly prejudice trade between Australia and places outside Australia.

The presentation will explore these criteria in relation to the registration of vertebrate pest control agents, with a particular emphasis on how they relate to the issue of animal welfare, and the importance of defining clear science-based requirements to underpin them. It will also draw on experiences with the registration and recent review of agents such as 1080 and pindone.

Aim

The aim of this paper is to describe the overall regulatory framework for agvet chemicals in Australia, to outline the role of the NRA in the regulation of invertebrate pest control agents, to discuss the criteria the NRA must (and can only) take into account when it is assessing these products, and to consider possible future directions.

Regulatory framework

Within Australia's National Registration Scheme, the NRA is responsible for the evaluation and registration of agricultural and veterinary chemicals in Australia. Before any agvet product can be supplied in this country, it must be either registered or permitted by the NRA. The framework within which the NRA must act (including its limitations and obligations) is defined in the NRA's key governing legislation, the Agricultural and Veterinary Chemicals Code (the Agvet Code).

While the NRA is responsible for registration of all agvet chemicals, and for their regulation up to the point of retain supply, the State/Territories are responsible for control of use of the products – that is, ensuring that products are used in accordance with their registered particulars. In this context, it is also noted that the NRA is also not involved in the design and conduct of programs to control vertebrate pests, these again being the domain of various State agencies.

The NRA's governing legislation is the result of agreement between the Commonwealth and the States/Territories, and any changes to it require Commonwealth/State agreement. The NRA must act in accordance with the requirements specified in the legislation, and responsibility for progressing any proposed changes to it rest with the Department of Agriculture, Fisheries and Forestry, in consultation with the States/Territories. Ultimately any changes have to be agreed and passed through Commonwealth Parliament.

In determining whether to register an agvet chemical product, and in prescribing the conditions for its use, the NRA seeks expert advice from a range of agencies, including the Therapeutic Goods Administration (human health issues), Environment Australia (environmental assessment), the National Occupational Health and Safety Commission (operator exposure), and the States (product efficacy).

Registration criteria

Section 14 of the Agvet Codes defines the matters the NRA must take into account when it is considering whether to register an agricultural chemical product. These matters are quite extensive and very specific and include requirements that, when used according to recommendations for its use, a product:

- would not be an undue hazard to the safety of people exposed to it during its handling or people using anything containing its residues;
- would not be likely to have an effect that is harmful to human beings;
- would not be likely to have an unintended effect that is harmful to animals, plants or things or to the environment; and
- would not unduly prejudice trade between Australia and places outside Australia.

Section 14 also requires 'that the use of the product in accordance with the recommendations for its use that the NRA proposes to approve would be effective according to the criteria determined by the NRA for the product'. It is important to note that, while the NRA must be satisfied that the section 14 criteria have been met before granting a registration, it is also obliged to register a product if it is satisfied they have been met.

In addition to its role in considering applications for registering agvet chemical products, the NRA carries out a number of post-registration activities. These include a compliance program aimed at

ensuring that only products that are registered and meet registration requirements are supplied in Australia, an Adverse Experience Reporting Program, and a program of review of existing chemicals (the chemical review program). The chemical review program evaluates products that have been registered for some time to determine whether, in light of experience with their use, new information about their associated risks, and changing scientific and regulatory standards, they continue to meet requirements for registration. Outcomes of chemical reviews can range from reaffirmation of the registration, cancellation of registration, or some variation or restriction as to how the chemicals are used.

Vertebrate pest control agents

Vertebrate pest control agents fall within the definition of an 'agricultural chemical product' in the Agvet Codes. Species that are controlled by these agents (such as rabbits, feral pigs, wild dogs) have been formally declared to be pests under the Rural Lands Protection Act 1998. The NRA therefore regulates vertebrate pest control agents as agricultural chemical products. Although it may be stating the obvious, other means of controlling vertebrate pests, for example traps, do not fall within the definition of an agricultural chemical product and are not regulated by the NRA.

How then, can animal welfare considerations be addressed within this framework? To enable it to fully assess applications for registrations of agvet products to determine whether the Section 14 criteria of the Agvet Codes are met, the NRA establishes extensive requirements for the data and information it needs to assess, and these are
published in the Ag and Vet Requirements Manuals. Applicants for registration are required to submit data that meets these requirements.

In considering, for example, applications to register veterinary medicines, the NRA requires substantial data to demonstrate that the products will work (are efficacious) as claimed. The NRA expects that the research and trials that are conducted to generate this information are done in accordance with the appropriate animal ethics legislation, and this is overseen by State-based animal ethics committees. Key guidance in this regard is provided by the Australian code of practice for the care and use of animals for scientific purposes, which also refers (section 5.10) to studies involving feral animals.

The Agvet Codes do not specifically refer to any obligation to consider animal welfare issues as part of the decision to register agricultural chemical products. However, it could be argued that the existing section 14 provisions regarding efficacy provide scope for the NRA to include animal welfare considerations as part of its assessment. Vertebrate pest control agents are designed to control animal populations and the primary aim of the assessment of their efficacy must be how well they achieve the intended control. However, the humaneness of the control is a factor that might also legitimately be assessed in the efficacy evaluation. Accordingly, the NRA could be considered to have scope to evaluate animal welfare issues when assessing the efficacy of vertebrate pest control agents, even though it is not compelled to do so by legislation. In its initial assessment of rabbit calicivirus (RCV), for example, the NRA considered animal welfare issues as part of the overall efficacy evaluation, and, has signalled its intention to take them into account as part of the current review of the registration of sodium monofluoroacetate (1080).

The challenge, however, in evaluating animal welfare issues related to vertebrate pest control agents, is the lack of objective, science-based criteria on which to base these assessments. Such criteria are essential if there is to be sound, defensible consideration of animal welfare in registration decisions involving these products. Currently, there is an extensive range of views on what animal welfare is

and the extent to which it can and should be considered, but a lack of consensus on objective standards that should be applied to its consideration. Any contribution that the current debate can contribute to the development of such objective standards and requirements is to be encouraged.

The role of the Vertebrate Pests Committee in improving the humaneness of pest animal control

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Background

The Vertebrate Pests Committee (VPC) comprises one member from each Australian State/Territory, and New Zealand, with each member representing the interests associated with conservation, sustainable use and management of Australia's land, water, and biological resources. CSIRO, Bureau of Rural Sciences, Environment Australia and Biosecurity Australia also provide one member each.

Members are required to provide professional and technical expertise and have the necessary authority to speak/act on behalf of their jurisdiction. Many issues require a whole-of-government approach from each jurisdiction. Mechanisms used to achieve this range from inter-agency communication through to more formal processes like the NSW Pest Animal Council.

The VPC also interacts with other Government organisations. The Coalition of Australian Governments (COAG) is the overarching structure for formulating coordinated national policy. Beneath COAG, a number of committees have some involvement in vertebrate pest management and include:

- Natural Resource Management Ministerial Council (NRMMC)
- Natural Resource Management Standing Committee (NRMSC)
- Land and Water Biodiversity Committee (LWBC)
- Vertebrate Pests Committee
- Primary Industries Ministerial Council (PIMC)
- Primary Industries Standing Committee (PISC)

The VPC approach to vertebrate pest management

Australia's most important vertebrate pests are introduced species, many of which were intentionally released by Acclimatisation Societies, reflecting an earlier and different set of social views, values and priorities.

Vertebrate pests cause serious economic, environmental, animal welfare and social impacts including:

- kill and maim livestock causing financial and emotional impacts on farmers;
- kill, maim and compete with native fauna threatening the survival of some populations of native species;
- destroy/damage horticulture, broadacre crops and pasture;
- alter and degrade the environment, botanical composition and/or ecological balance thus eroding biodiversity and environmental sustainability;

- financial loss through management costs and opportunity cost of resources diverted to pest management;
- social impacts (droppings, damage to buildings and infrastructure, noise pollution, ecotourism).

Impacts can be particularly severe where canids are involved with just a few animals capable of causing enormous damage.

There is a broad range of attitudes and philosophical positions within the community on pest animal management, animal welfare, animal rights, conservation, environmental protection and human safety. These all bear directly on vertebrate pest management, creating considerable complexity and potential for conflict. It is within this climate that the VPC has the unenviable task of trying to resolve the need to reduce vertebrate pest impacts while recognising the many other concerns such as animal welfare.

It may be useful to acknowledge the many attitudes and philosophical positions that exist on just the animal welfare/animal rights aspect of vertebrate pest management. In general terms, these range from:

- It is unacceptable to interfere with or utilise wild animals in any way. We brought exotic species here, and have no right to try to remove them regardless of how much damage is being caused. It is not even acceptable to interfere with the social interactions of animals (eg removing some rabbits from an area has a psychological/sociological impact on remaining rabbits in a warren complex); to
- Compromises need to be made between animal welfare and the need to reduce pest animal impact. In any case many control techniques are no less humane than natural mortality factors such as predation, disease and drought; to
- Reducing impact is paramount. Animal welfare should not be a deciding factor. In any case, pest animals do not belong here; they cause damage; they are not 'useful' animals and should therefore not be subject to the same welfare considerations as 'useful' animals.

Society's expectations regarding vertebrate pest management are formally enshrined through various State and federal legislation and include obligations to control vertebrate pests, conserve threatened species and ecological communities, prevent cruelty to animals, ensure the appropriate use of pesticides and protect the safety of people. Vertebrate pest management policies need to balance these diverse obligations in order to provide feasible and achievable outcomes. In most jurisdictions responsibility for meeting these obligations rests with individual landholders and land managers.

The VPC therefore reflects the broad community consensus that vertebrate pest impacts need to be minimised for the benefit of society, using methods that reflect available resources, technology and community views and values. The VPC has also developed guidelines to prevent the introduction or escape of additional pest species It also promotes continual improvement in our management of vertebrate pests.

The legislative framework outlined above does not allow any of the obligations to be ignored, much less rejected. Doing nothing about the impacts of vertebrate pests is not an option. At the same time vertebrate pest management is becoming increasingly complex. Success in achieving an appropriate balance across this broad range of legislative objectives will inevitably require greater communication, collaboration and cooperation between those with interests in, and responsibilities

for, the delivery of each obligation. This seminar provides an excellent opportunity to foster this interaction.

Most of the legislation affecting vertebrate pest management operates at the State/Territory level. For this reason, the VPC does not have formal strategies covering occupational health and safety (OH&S), pesticide use or animal welfare. Instead, it participates in relevant forums and provides advice and leadership on specific issues as needed. A recent example is the VPC input into the revised Model code of practice for the welfare of feral livestock.

While not explicitly stated, the VPC's approach and terms of reference are consistent with agreed principles of ecologically sustainable development and this includes the aim of ensuring the use of humane control techniques. For example, animal welfare implications of VPC decisions are considered and, if necessary, referred to the VPC's animal welfare working group.

The VPC also provides recommendations on important vertebrate pest management issues such as the use of 1080. The VPC has recently conducted a comprehensive review and provided input to the current National Registration Authority review of 1080. The VPC recently endorsed national vertebrate pest competency standards

The VPC's overall approach can be summarised as promoting the adoption of best practice management (BPM) principles and practices. The Bureau of Rural Sciences vertebrate pest management guidelines published over the last decade and the Threat Abatement Plans produced by Environment Australia were developed in conjunction with State and Territory agencies through the VPC. They represent overarching guides on BPM and research directions for a wide range of issues including animal welfare.

Some outcomes from a BPM approach include:

- Identifying the damage caused by the pest then removing or minimising this effect rather than necessarily targeting the pest itself.
- Strategic control in order to maintain pest populations below the levels at which they cause significant damage and avoid the need to control large numbers of animals by preventing populations from exceeding these damage thresholds. Examples of strategic control programs include Western shield (WA), Bounce back (SA), Out-fox the fox and Southwest rabbit control program (NSW).

Features that are usually reflected in a strategic approach include:

- regionally based activities;
- prioritising effort and resources appropriately;
- commitment to deliver a sustained effort;
- adaptive management;
- taking tactical advantage of seasonal or other opportunities as they arise (eg drought, RCD);
- implement monitoring, recording and reporting systems;
- continual improvement in ability to minimise non-target impacts.

The concept of BPM involves continual modification and improvement to programs and this trend is clearly evident in Australian vertebrate pest management at both research and operational levels, particularly over the last 5-10 years. One specific obstacle is the relatively small market for

vertebrate pest control products and a general reluctance of private companies to fund development of new toxins/baits for such small markets. This is compounded by the cost and time of complying with NRA registration requirements. There is also likely to be community opposition to some new VPM approaches like GMOs, particularly self-propagating viruses. This may hinder the introduction of fertility control, which is often touted as the panacea to animal welfare concerns associated with lethal control techniques. These factors mean that the protection of environmental and agricultural resources will be heavily dependent on existing techniques – albeit with improvements – for some time.

There are relatively few Australian scientists in the vertebrate pest arena. They collaborate closely, both directly and through the Pest Animal Cooperative Research Centre and other institutions. Funding bodies like BRS also facilitate coordination of research effort.

While it monitors research in each jurisdiction, the VPC has no resources and so cannot fund its own research. However, the VPC strongly supports research to develop new or improved control techniques and better understanding of vertebrate pest biology and ecology. Research being conducted by VPC member agencies shows that they are serious about improving animal welfare in a tangible way, for example:

- carbon monoxide fumigator to substitute for chloropicrin;
- investigation of analgesics for fox/wild dog 1080 baits;
- investigation of trap tag devices (incorporating analgesic, sedative or faster-acting toxin) for wild dog traps;
- cyanide ejectors for canid control;
- fencing designs to keep predators away from livestock or fauna;
- repellents;
- investigation of alternate toxins to 1080 for feral pigs and discouraging the use of yellow phosphorous;
- research into improved use of existing strategies to reduce the need for recurrent killing of large pest populations and further reduce non-target risks;
- immunocontraception.

The VPC is also aware that the complexity inherent in vertebrate pest management renders the prospect of 'magic bullet' solutions most unlikely. Regrettably, it is difficult to easily and adequately explain this complexity to the community.

At the State/Territory level, there is an increasing focus on fostering the professionalism of front line vertebrate pest control practitioners. This includes an emphasis on training (national VPM competency standards mentioned earlier) and opportunities to attend conferences to present and discuss their work. Over the last few years, the emphasis on capacity building has also been broadened to include geographical information and database systems to improve planning, recording and reporting. The property event management system (PEMS) currently being developed nationally is expected to provide a substantial boost to this capacity.

In many ways front-line vertebrate pest management staff are the 'unsung heroes' of natural resource management. They carry many responsibilities and are often criticised, yet the capacity of front line staff will become increasingly important in delivering better outcomes on vertebrate pest management issues like animal welfare. For example, the growing professionalism among front line

practitioners is helping to change community attitudes and gain acceptance for phasing out of practices like steel jaw traps (already banned in some jurisdictions) and fumigants.

Conclusion

The VPC has the difficult task of identifying feasible and achievable vertebrate pest management outcomes, which balance society's expectations and legislated obligations in this area with a climate of broader community expectations and legislated obligations on issues such as animal welfare.

Factors such as the availability of funds, resources and increasing complexity of regulations continue to limit progress, but the VPC is nevertheless contributing to improvements in animal welfare outcomes associated with vertebrate pest management.

The VPC also recognises that achieving genuine progress will inevitably require greater communication, collaboration and cooperation between those with interests in, and responsibilities for, the delivery of each of these obligations.

Assessing public attitudes to vertebrate pest control

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Summary

At present, we do not have a good understanding about how individual attitudes and priorities regarding vertebrate pest control influence community behaviour, particularly community expressions in the form of acting as opinion leaders, writing letters to editors, signing petitions, demonstrating, lobbying, etc.

Public attitudes to vertebrate pest control can be regarded as a mixture of general attitudes and behaviour-specific attitudes. General attitudes are those which are collected by surveys and which are reported in terms of relative frequency of occurrence. They reflect people's opinions but, because they are based on variable sources of information and may not be a product of experience, may not be especially salient for an individual, are not specifically directed to a particular behaviour and may not be expressed in a specific behaviour, for example, opposition or support for pest control strategies. It is useful to distinguish these public opinions from personal, behaviourally-directed attitudes that an individual holds, which are derived from experience. Such attitudes are not general but are directed towards specific behaviours, for example publicly opposing vertebrate pest control or voting for a particular legislative change. Understanding this distinction and the differential effects of the two is important in predicting their effects on public response to specific pest control instances and the relevance of education and regulation. Behavioural attitudes are direct predictors of behaviour and are relevant to, for example, proactive individual acts. General attitudes, on the other hand, are expressed in survey results and influence politicians and regulatory bodies and lead to changes in policy and regulations.

At present, there is a substantial amount of information available on public attitudes towards animal welfare, human use and management of wildlife and public attitudes towards various methods of wildlife control. It can be difficult to identify an appropriate response to these public attitudes because their relationship to relevant behaviours is not known. For example, a recent Rural Industries Research and Development Corporation (RIRDC) report showed that many people concurrently held the opinions that kangaroos were a pest to graziers and should be controlled while at the same time believing that they should be protected because they are unique to Australia. It is clearly necessary to understand how these attitudes relate to pest control practices. People may hold a strong attitude towards a particular object but, because that attitude is not particularly relevant to their behavior, do not behave in a way that is consistent with that attitude. A clear example of this from the animal welfare literature is that the majority of people have a negative attitude towards caged hens but their choice behavior when purchasing eggs does not reflect this.

Appropriate, sustainable and effective vertebrate pest control requires an informed decision process based on an understanding of community views about specific aspects of control and the importance of these for individuals in conjunction with appropriate consultation and education processes. In particular, those attitudes which are specifically relevant to particular control practices, the factual underpinnings of these attitudes and their behavioural consequences need to be understood.

Assessing public attitudes to vertebrate pest control

The impact of public perceptions relating to welfare issues is becoming a major force in determining commercial and government controls on the uses of animals. This has already become evident in the intensive animal industries. In addition to regulatory and legislative action, in 1996 one supermarket chain in the UK adopted the Freedom Food label of the Royal Society for Prevention of Cruelty to Animals and marketed eggs laid by hens in barn systems (Anonymous, 1996). This development was apparently a response by the supermarket to pressure from their customers. Recent examples in the USA demonstrate the impact of such pressure: a number of fast food restaurants in the USA are insisting on specific changes in livestock slaughter practices and in housing and management practices for laying hens. Indeed such responses by processors and retailers, rather than government legislation, may be more influential in the future in changing livestock production in many countries (Hemsworth, 2000). Also, in response to community concerns about the environment the North Carolina Legislature has imposed a moratorium on new hog farms.

In the area of vertebrate pest control, the signs are that public perceptions will have a similar impact. The recent culling of kangaroos at Seymour is a recent example of the public outcry and associated wide media coverage that can occur if responsible agencies fail to understand community attitudes or fail to address them.

An understanding of relevant attitudes and their effects on behaviour of the public can provide a basis for Government in formulating animal welfare policy in relation to public education (eg targeting negative and unsound attitudes), industry policy (eg changing Codes of Practice) or science policy (eg directing science research and extension).

At present, we do not have a good understanding about how individual attitudes and priorities regarding vertebrate pest control influence community behaviour, particularly community expressions in the form of acting as opinion leaders, writing letters to editors, signing petitions, demonstrating, lobbying, etc. Although we have a good intuitive understanding of what attitudes are, it is worth being fairly precise about the term because of the important role we give attitudes when attempting to understand people's intentions and their behaviour.

Eagly and Chaiken (1993) defined attitude as 'a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour'. There are three key features to this definition: (1) the idea that attitudes are directed at an entity or thing, (2) the idea that attitude is a tendency or disposition and (3) that attitude expresses some positive or negative evaluation. It is important to realise that attitudes cannot be observed directly, we infer peoples' attitudes from what they say and do.

Characterising an attitude object is not simple. We may have attitudes towards people, animals, inanimate objects or even ideas. For example, we may have an attitude towards a political ideology, a religion, an individual, a race, a species of animal or a particular animal. As we shall see later in this chapter, to get some insight into expected behaviour, it is very important to be quite specific about the particular attitude object of interest.

The notion of attitude as a tendency reflects the view held by psychologists that our attitudes tend to direct our behaviour or, at least, our intended behaviour (eg Ajzen and Fishbein, 1980). The evaluative nature of attitudes is what distinguishes them from other kinds of verbal expression. A statement which either explicitly or implicitly characterises something as good or bad, liked or disliked or even something to be enjoyed or not enjoyed, expresses an evaluation of that object and,

therefore, reflects the underlying attitude. Attitudes are, therefore, favourable or unfavourable; they reflect a tendency for or against, like or dislike, etc. More specifically, the beliefs that people hold, when combined with their evaluations of those beliefs lead to the formation of attitudes. Intentions and actions then follow from these attitudes.

Ajzen and Fishbein proposed the theory of reasoned action to account for the relationship between attitudes and behaviours. The theory of reasoned action relies on attitudes towards specific behaviours rather than objects for prediction of acts. The immediate cause of intended behaviour is a person's attitude toward the behaviour in combination with the person's subjective norms with respect to the behaviour. A person's subjective norms refers to the extent to which a person believes that relevant other people would approve of the behaviour and the extent to which the person feels willing to comply with other people's expectations. One important feature of this part of the theory is that the object of the attitude is not some general person (or animal) but a behaviour.

Public attitudes to vertebrate pest control can be regarded as a mixture of general attitudes and behaviour-specific attitudes. General attitudes are those which are collected by surveys, are targeted towards issues rather than behaviours and which are reported in terms of relative frequency of occurrence. They reflect people's opinions but, because they are based on variable sources of information and may not be a product of experience, may not be especially salient for an individual, are not specifically directed to a particular behaviour and may not be expressed in a specific behaviour, for example, opposition or support for pest control strategies. It is useful to distinguish these public opinions from personal, behaviourally-directed attitudes that an individual holds, which are derived from experience. Such attitudes are not general but are directed towards specific behaviours, for example publicly opposing vertebrate pest control or voting for a particular legislative change. Understanding this distinction and the differential effects of the two is important in predicting their effects on public response to specific pest control instances and the relevance of education and regulation. Behavioural attitudes are direct predictors of behaviour and are relevant to, for example, proactive individual acts. General attitudes, on the other hand, are expressed in survey results and influence politicians and regulatory bodies and lead to changes in policy and regulations.

At present, there is a substantial amount of information available on public attitudes towards animal welfare, human use and management of wildlife and public attitudes towards various methods of wildlife control. For example, Wilkinson and Fitzgerald (1997) surveyed public opinion in New Zealand about rabbits, rabbit control and the use of rabbit calicivirus. The survey was done subsequent to the escape of calicivirus from Kangaroo Island in Australia prior to its planned release. The usual survey methods were applied-eleven focus groups were conducted involving the major stake holders (primary producers, government agencies, primary sector agencies, forestry producers, animal welfare organisations, environmental and conservation organizations, the urban public and the rural public. This was followed by a telephone survey involving 2,528 contacts with 1,127 completed interviews. In general, there was wide acceptance that feral rabbits damaged the environment and were a threat to farm production. But at the same time, they also thought of rabbits as cute and furry and also 'a useful resource that could generate significant economic benefits if exploited appropriately' (p276). This is consistent with a recent RIRDC report (1998) which showed that many people concurrently held the opinions that kangaroos were a pest to graziers and should be controlled while at the same time believing that they should be protected because they are unique to Australia.

Wilkinson and Fitzgerald (1997) also found that public attitudes towards various methods of killing rabbits were quite broadly distributed. Although some methods were considered more acceptable

(for example shooting) than other methods (for example aerial use of 1080 poisoned bait), substantial numbers of people were for and against each method.

In Australia, Johnston and Marks (1997) conducted a survey on public attitudes to vertebrate pest management. While a majority of the people sampled supported some use of biological controls (58%) only a minority were prepared to accept collateral death of non-target native wildlife (39%) or non-target domestic pets (38%). Most people (63%) believed that pest animals were being adequately controlled. With respect to method of control, there was a wide variation in which methods were acceptable and this variation was species specific. For example shooting was considered appropriate for kangaroos by 44% of the sample but was only considered appropriate for wild rabbits by 18% of the sample. Clearly there is some complexity in the specific attitudes and the underlying beliefs associated with vertebrate pest control.

Although a comprehensive application of the Ajzen and Fishbein (1980) model to vertebrate pest management has not been carried out, Manfredo, Vaske and Wittman (1998) did a study on the role of normative beliefs about wildlife management practices. Consistent with the Ajzen and Fishbein (1980) theory, they found that normative beliefs about wildlife management were influenced by situational specifics and wildlife value orientations. For example, the destroying of beavers or coyotes was generally considered unacceptable when these animals were in the open, in a residential area, even in a resident's own yard, but was considered to be acceptable if the animal was carrying disease. Importantly, these context effects were apparent in people who were anti wildlife use as well as those who were pro wildlife use. They concluded that an understanding of why people hold particular normative beliefs will result in better communication with the public and permit better resolution of differences. As yet there are no studies which also measure appropriately targeted behavioral attitudes towards vertebrate pest control.

It is clearly necessary to understand how these attitudes relate to pest control practices. People may hold a strong attitude towards a particular object but, because that attitude is not particularly relevant to their behavior, do not behave in a way that is consistent with that attitude. A clear example of this from the animal welfare literature is that the majority of people have a negative attitude towards caged hens but their choice behavior when purchasing eggs does not reflect this. (Bennett, 1998) reported that willingness to pay extra for free range eggs correlated only 0.28 with concern about animal welfare. Other issues including price and quality were more important considerations for consumers. There is a need to establish not only people's attitudes towards vertebrate pest management but also their priorities with regard to those concerns. While a person may consider a domesticated rabbit as a warm and lovable animal, that same person when considering rabbits in the context of environmental and crop damage may be quite prepared to accept some form of control. When considering the various forms of control that same person will have clear preferences. Therefore an assessment of attitudes towards control of vertebrate pests needs to be situationally specific, method specific and in the context of the individuals' priorities.

A way of considering the relevant attitudinal variables and their consequences in terms of community response is given in Figure 1. In this model, those attitudes which are specific to the particular target species as well as generic attitudes towards vertebrate pest control are included. In addition, the knowledge base from which these attitudes have developed or which form the context for those attitudes is included. Finally, the range of community responses which may occur as a result of these attitudes is included. An analysis of the interrelationships amongst these variables provides a method for identifying the way in which community to responses are formed. The actual distribution of those attitudes which prove to be important in determining community responses will then provide a basis for decision-making by those responsible for vertebrate pest management.

It can be difficult to identify an appropriate response by government agencies to these public attitudes because their relationship to relevant behaviours is not known. Also, Individuals or groups that are seen to have some kind of vested interests may be viewed by the public with some suspicion. Scientists were viewed somewhat skeptically following the early and inadvertent release of rabbit calicivirus in South Australia. Some groups do hold specific and prescriptive views about the processes that should be adopted in regard to vertebrate pest control. For example, Animal Liberation (1999) has been highly critical of the lack of community consultation involved in kangaroo culling and has recommended that 'a new, unbiased and genuinely consultative committee…. be set up to advise the ACT government on kangaroo management issues. A moratorium should be called on all kangaroo culling at least until existing data on the environmental impact (of) removing kangaroos, and the actual effectiveness of the culling programs has been objectively analysed.'

As indicated earlier, an understanding of relevant attitudes can have at least three outcomes: public education, formulating industry policy and directing science research and extension. In regard to public education, Wilkinson and Fitzgerald (1997) issued a caution about public communication strategies that have the objective of providing information about vertebrate pest control. Any communication which contains a hint of deception or public manipulation is likely to increase the risk of public rejection of any particular control strategy. Appropriate, sustainable and effective vertebrate pest control requires an informed decision process based on an understanding of community views about specific aspects of control and the importance of these for individuals in conjunction with appropriate consultation and education processes. A similar point can be made about the formulation of public policy. All stakeholders need to be satisfied that the information upon which policies are based is factual and dispassionate. The proposal put forward by Animal Liberation is a way of ensuring that the stakeholders do have input into the process. In addition, appropriately planned scientific study which addresses the complex factors which underpin public attitudes to vertebrate pest management can provide a factual and dispassionate basis for informing the decision making process.

References

Ajzen I, & Fishbein M (1980) Understanding attitudes and predicting social behaviour. Englewood Cliffs, New Jersey: Prentice-Hall.

Animal Liberation (ACT) (1999) Kangaroo culling in Australia and the ACT. Retrieved February 10, 2003, from http://bohm.anu.edu.au/Clubs/animalliberation/kangaroo.htm.

Anonymous (1996) Freedom barn match cage eggs on price. Poultry World, August, p 2.

Bennett RM (1998) Measuring public support for animal welfare legislation: A case study of cage egg production. Animal Welfare 7: 1-10

Eagly AH & Chaiken S (1993) The Psychology of Attitudes. Orlando, Florida: Harcourt Brace Jovanovitch.

Hemsworth PH (2000) Pastoral farming of animals in 2020. In Mellor D, Fisher F and Sutherland G (Ed) Proceedings of the joint Animal Welfare Advisory Committee and the Australian and New Zealand Council for the Care of Animals in Research and Teaching Conference p 12-19 Wellington, New Zealand.

Johnston MJ & Marks CA (1997) Attitudinal survey on vertebrate pest management in Victoria. Agriculture Victoria, Department of Natural Resources and Environment. Report Series Number 3.

Manfredo MJ, Vaske JJ & Wittmann K (1998) Normative beliefs about wildlife management actions. Society and Natural Resources 11: 649-662

Rural Industries Research and Development Corporation (1998) Improving consumer perceptions of kangaroo products. Retrieved February 10, 2003, from http://www.ridc.gov.au/pub/shortreps/improve.html.

Wilkinson R & Fitzgerald G (1997) Public perceptions of biological control of rabbits in New Zealand: Some ethical and practical issues. Agriculture and Human Values 14: 273-282

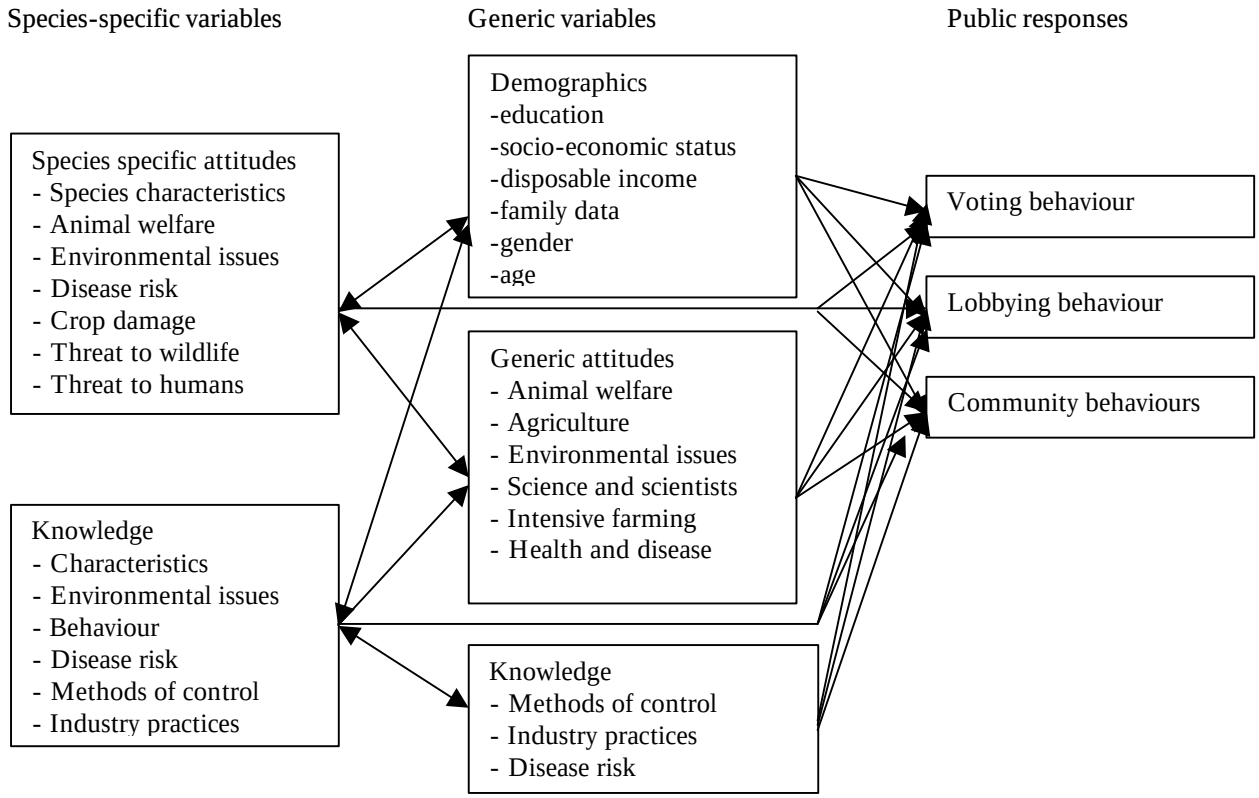

Figure 1 Possible relationships between species-specific and generic antecedent variables and community behaviours regarding vertebrate pest control.

Killing pest animals—some ethical issues

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Key Concepts

The key concepts dealt with include the following:

- To be conducted, a pest control programme must be necessary and it must be justified.
- The necessity of intervention at all, and the necessity of killing as part of control, as opposed to, or in addition to non-lethal control, must be evaluated.
- Justification is only available if all of the negative impacts (harms) of pest control are minimised and all of the positive impacts (benefits) are maximised as far as can be feasibly achieved.
- All harms caused by pest control methods to people, animals and the environment must be minimised.
- In all cases, the most humane control method possible must be used, we must seek ways to improve the humaneness of existing methods, and we must find new methods that are both more humane and sufficiently cost-effective to be useable.
- The benefits include the direct positive outcomes of successfully minimising the harms done by the target-species to people, animals and the environment.
- There are six major principles that guide the design and execution of ethically sound vertebrate pest control programmes. (1) The anticipated benefits and harms of any pest control programme must be clear. (2) Control must only be undertaken if the benefits are realistically achievable. (3) Methods that most effectively achieve the benefits must be used. (4) Methods must be used in the most effective way. (5) Whether or not the benefits were achieved must be evaluated at the end of any programme. (6) Follow-up steps must be taken to ensure that the benefits are maintained once initial control has ceased.

Introduction

We have been asked to provide some ethical perspectives on the killing of vertebrate pests and, in particular, to provide some ethical guidelines to be applied to pest control programmes. Before doing so, however, it will be helpful to reiterate some distinctions made by Mellor and Stafford (1999).

Ethics, etiquette and moralising

Ethics deals with principles by which our proposals or actions may be judged as good or bad, right or wrong. The primary concern of ethics is not to decide whether particular proposals or actions are right or wrong, rather it is to analyse different ways such decisions can be made. Thus, an ethical analysis can help us to understand the principles upon which our value judgements depend, thereby helping us to become more confident about our judgements when they are challenged (Mellor 1998).

Etiquette is concerned with conventional and accepted standards and practices in certain professions and situations. In this usage, for instance, formal codes (eg RSNZ 2003) deal mainly with professional etiquette by providing guidance on or rules for acceptable behaviour. Although they are in fact based on ethical principles, the principles are usually not analysed explicitly or in depth. So such codes outline what should or should not be done, but they do not examine why.

Moralising refers to expressing or conveying truths or counsel regarding truths. Moralising is commonly thought of as telling people what they should do or think. It is typified at one extreme by the expostulations of puritanical fundamentalists of any religion or group and at the other by benign but directed parental advice to children.

It is helpful to be clear about the above distinctions because just as ethicists who adopt a moralistic tone soon lose credibility and are ignored, groups or professions captured by an overzealous moralising spirit can easily erect barriers between themselves and those they are trying to influence. Accordingly, we prefer to engage in ethical reasoning, not moralising.

Responsibilities to animals

Value judgements are clearly involved when we make decisions about the acceptability or otherwise of the different ways we interact with animals, and these value judgements engage us in ethics (eg Fraser et al 1997; Fisher 1998; Mellor 1998; Sandoe et al 1999). There is a long tradition of ethical thinking in relation to animals. This has brought us today to a commonly held view which we shall make the starting point of this paper:

- animal management or use by people is acceptable provided that such management or use is humane (Banner et al 1995; Fisher 1998).

Additional, related maxims are as follows:

- vertebrate animals are sentient, they can suffer and it matters to them how they are treated;
- people are responsible for animals in their care or control, or which they seek to affect;
- people should not harm animals unless it is absolutely necessary;
- if there are less painful or distressing ways of treating animals they should be used; and
- some harms should be prohibited, regardless of their benefits (modified from Fisher 1998).

Killing versus pain and suffering

Many methods of killing vertebrate pests undoubtedly cause pain and suffering, and most (some would say all) involve an act of violence, the degree of which depends on whether and how firearms, traps, poisons, bludgeons, dogs and/or other approaches are used. Nevertheless, it is important to note that not all such killing methods actually produce significant pain and suffering. Properly applied, several can cause instantaneous unconsciousness or death and are therefore humane.

Necessity of and justification for pest control

For a pest control programme to be conducted it must be both necessary and justified. Regarding the necessity to undertake control, the questions to ask are: Is it unavoidable? Can we use other approaches? Some argue that we should not interfere as it has usually been our interference and

lack of understanding which have led to the animals become pests in the first place. Others argue that as we have usually caused the problems and have better knowledge now, we have an obligation to correct the problems.

Justification for implementing control measures is usually in terms of removing or avoiding the harms that the pests cause. Such harms generally occur in five major areas (Cowan and Tyndale-Biscoe 1997):

- environmental degradation (eg soil erosion);
- endangerment of native plants and animals (eg by overgrazing, introduction of alien plant seeds, competition for food, predation);
- loss of primary production (eg by overgrazing and competition for food);
- loss of livestock production through disease (eg tuberculosis);
- damage to private property and human health (eg damage to structures and electrical wiring, and transmission of diseases).

However, a key ethical question confronting us is whether or not the harms the pests cause represent sufficient reason to expose them to the negative consequences of control programmes. Related questions include the following:

- What harms are done by the pests?
- How serious are those harms?
- Are they serious enough to require control?
- What suffering is caused by the different control methods?
- How can that suffering be balanced against the harms done by the pests?
- How can that suffering be avoided or minimised?
- Does designating an animal as a pest, for any reason, free us to engage in control programmes no matter what suffering the programmes cause?

Minimising pain and suffering and maximising benefits

Much of our use or treatment of animals is justified according to the Utilitarian ethical precept of doing the most good for the least harm, which in practice involves conducting harm-benefit analyses. What this means in the context of vertebrate pest control is that all the anticipated harms (eg to people, animals and the environment) of a pest control programme must be minimised and all of the expected benefits must be maximised, so that the separation between the sum of the harms and the sum of the benefits is the greatest that can be feasibly achieved (Battye 1994, 1998). This ethical principle clearly has application to the assessment and improvement of vertebrate pest control methods and to the management of control programmes, as briefly outlined below, and as discussed in detail in a paper entitled 'Animal welfare and ethical issues relevant to the humane control of vertebrate pests' by Littin et al (unpublished).

Assessment, development and use of humane control methods

To be ethically credible, we must take active steps to minimise any animal suffering that results from the application of vertebrate pest control methods. The suffering caused reflects the

humaneness of the chosen methods. Accordingly we have an ethical responsibility to maximise the humaneness of control methods and this can be done in at least three ways.

1 The relative humaneness of all current methods must be assessed in the practical circumstance of their use and the most humane methods that are useable in any given situation must be employed. This step, conscientiously taken, should lead to an immediate reduction in animal suffering.

2 Active attempts must be made to improve the humaneness of all current methods. not excluded by step 1, that cause significant suffering. This step should lead to welfare benefits in the medium term.

3 An active research programme to develop new more humane methods must be implemented, bearing in mind that such new methods also need to be sufficiently cost-effective to be useable. This step should achieve improvements in the long term.

Clearly, we are ethically obliged to retain an ongoing commitment to these steps, and this requires practical backing by regulation, legislation and financial support.

Principles guiding ethically sound vertebrate pest control programmes

There are six major principles to guide the design and execution of ethically sound vertebrate pest control programmes.

1 The aims or benefits, and the harms, of each control programme must be clear. This is so that the expected benefits can be maximised and any anticipated harms minimised. Clearly, a sound understanding of the impacts of the pest is required in each case and it must be decided whether the aim is to reduce or avoid the impact of the pest, or to eradicate the pest. The harms to be minimised include any suffering caused to target and non-target animals.

2 Control must only be undertaken if the aims can in fact be achieved. To do otherwise is unacceptable. Thus, the certainty of benefit needs to be assessed (Hickling 1994) and even if the harms (eg to animals) are low, control should not be undertaken if the certainty of benefit is low.

3 The methods that most effectively achieve the aims of the control programme must be used. This means that the methods must be appropriate for the species and the situation, so the choice will depend on which methods can best achieve the aims with the target-species in their particular locations.

4 The chosen methods must be applied in the best possible way. This is achieved by good quality control applied to, for example, the manufacture, selection, operation, placement, maintenance and effective use of devices, poisons and other components of each control method.

5 Whether or not each control programme actually achieves its precise aims must be assessed. As programmes do not always achieve their aims, such assessment allows methods to be changed to those that are more likely to be successful if a programme is extended or in future programmes. They also allow lessons to be learnt and that knowledge to be shared. Note that the index of a

successful control programme should be a reduction in the negative impacts of pests, not merely a reduction in the number of pests.

6 Once the desired aims or benefits have been achieved, steps must be taken to maintain the beneficial state. If that is not done, the control programme and any suffering it causes would be purposeless.

Striving for a 'gold standard' by 'incremental improvement'

It is encouraging to know that an increasing amount of research and other activities are being directed towards developing more humane pest control methods and programme strategies. Nevertheless, there is scope for more as the 'gold standard' in animal welfare terms of methods that cause no suffering is not yet achievable in most cases. However, in the pest control arena, as in other areas (Mellor and Stafford 2001), we can achieve 'incremental improvements' towards that 'gold standard' by undertaking a careful harm-benefit analysis, by following the three steps outlined here regarding the assessment, development and use of humane pest control methods and by adhering rigorously to the six principles guiding the operation of ethically sound control programmes.

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References

Banner M, Bulfield G, Clark S, Gormally L, Hignett P, Kimball H, Milburn C, Moffitt J (1995) Report of the Committee to Consider the Ethical Implications of Emerging Technologies in the Breeding of Farm Animals. Ministry of Agriculture, Fisheries and Food (MAFF), London, England.

Battye J (1994) Ethics and animal welfare - where do we go from here? In: Baker RM, Mellor DJ, Nicol AN (eds). Animals Welfare in the Twenty-First Century: Ethical, Educational and Scientific Challenges, pp 3–10. ANZCCART, Glen Osmond, South Australia.

Battye J (1998) Ethical issues and animal use in science. In: Mellor D, Fisher M, Sutherland G (eds). Ethical Approaches to Animal-Based Science, pp 11–18. ANZCCART, Wellington, New Zealand.

Cowan PE, Tyndale-Biscoe CH (1997) Australian and New Zealand mammal species considered to be pests or problems. Reproductive Fertility and Development 9: 27–36

Fisher M (1998) Intersections between ethics and science in the promotion of animal welfare. In: Mellor DJ, Fisher M and Sutherland G (eds) Ethical Approaches to Animal-Based Science, pp 33-37. Australian and New Zealand Council for the Care of Animals in Research and Teaching, Wellington, New Zealand.

Fraser D, Weary DM, Pajor EA and Milligan BN (1997) A scientific conception of animal welfare that reflects ethical concerns. Animal Welfare 6: 187-205

Hickling GJ (1994) Animal welfare and vertebrate pest management : compromise or conflict? In: Baker RM, Mellor DJ, Nicol AM (eds). Animal Welfare in the Twenty-First Century : Ethical, Educational and Scientific Challenges, pp 119–124. ANZCCART, Glen Osmond, Australia.

Littin KE, Mellor DJ, Warburton B, Eason CT Animal welfare and ethical issues relevant to the humane control of vertebrate pests (submitted to the New Zealand Veterinary Journal).

Mellor DJ (1998) How can animal-based scientists demonstrate ethical integrity? In: Mellor D, Fisher M, Sutherland G (eds). Ethical Approaches to Animal-Based Science, pp 19-31. ANZCCART, Wellington, New Zealand.

Mellor DJ, Stafford KJ (1999) A "gold standard" or "incremental improvement" as ethical strategies for enhancing animal welfare. Proceedings of 16th Annual Seminar of the Society of Dairy Cattle Veterinarians of the NZVA, Foundation for Continuing Veterinary Education, Massey University, No. 192: 153-161.

Mellor DJ, Stafford KJ (2001) Integrating practical, regulatory and ethical strategies for enhancing farm animal welfare. Australian Veterinary Journal 79: 762–768

RSNZ (2003) Royal Society of New Zealand Code of Professional Standards and Ethics, http://www.rsnz.org/directory/code_ethics.php.

Sandoe P, Neilsen BL, Christensen LG, Sorensen P (1999) Staying good while playing God – the ethics of breeding farm animals. Animal Welfare 8: 313-328

Case studies of control strategies—the Tasmanian story

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Summary

Tasmania has had an increase in the numbers of native mammals which, along with introduced animals, cause agricultural and forest plantation damage. Current control techniques include poisoning with a range of toxins, shooting, live trapping and fencing.

The use of poisons in particular to control native species has resulted in public opposition of practices used. The acceptability of any particular technique appears to be based on the observers subjective assessment or other preconceived ideas. Death from 1080 poison for example is widely regarded as being inhumane, while anticoagulant poisons in the form of rodenticides are widely used without comment but taking longer to kill an animal may be less humane. Fencing is promoted as an acceptable control technique but often separates animals from their primary feed source and results in starvation until the population is reduced to a new carrying capacity.

The introduction of foxes into the State has introduced a further control problem. Current control practices from other States including 1080 poisoning have been adopted with wide public acceptance.

If progress in pest control is to occur there is a need for objective assessment of the humaneness or cruelty of all techniques used.

Introduction

Tasmania is unusual in Australia in that pest species have been restricted until recently to herbivorous mammals and birds, with little control of carnivores required on mainland Tasmania until the introduction of foxes a couple of years ago. Also, past clearing practices have resulted in significant areas of bush being left providing cover for native animals. Photo 1 shows the retained vegetation in an area of the central north, one of the earliest settled parts of the State. As a result of this and lack of foxes, Tasmania has high populations of the smaller macropods and bandicoots, but three species Bennett's wallaby (Macropus rufogriseus), Tasmanian pademelon (Thylogale billardierii) and the Common Brushtail possum (Trichosurus vulpecula) have increased to such numbers that they are significant pests of agriculture and forestry. Figure 1 shows the results of recent annual population monitoring done by the Department of Primary Industries, Water and Environment (DPIWE) using standardised spotlight surveys along approximately1300 Km of roads throughout Tasmania (Hocking pers comm)

Control Techniques

The first Australian use of the poison 1080 occurred in Tasmania in the early 1950s, replacing strychnine and phosphorus as a rabbit control agent, and by the late 1950s it was recognised that establishment of tree seedlings could be improved by poisoning wallabies and possums (Cremer 1960).

Photo 1 Central north of Tasmania showing retained vegetation

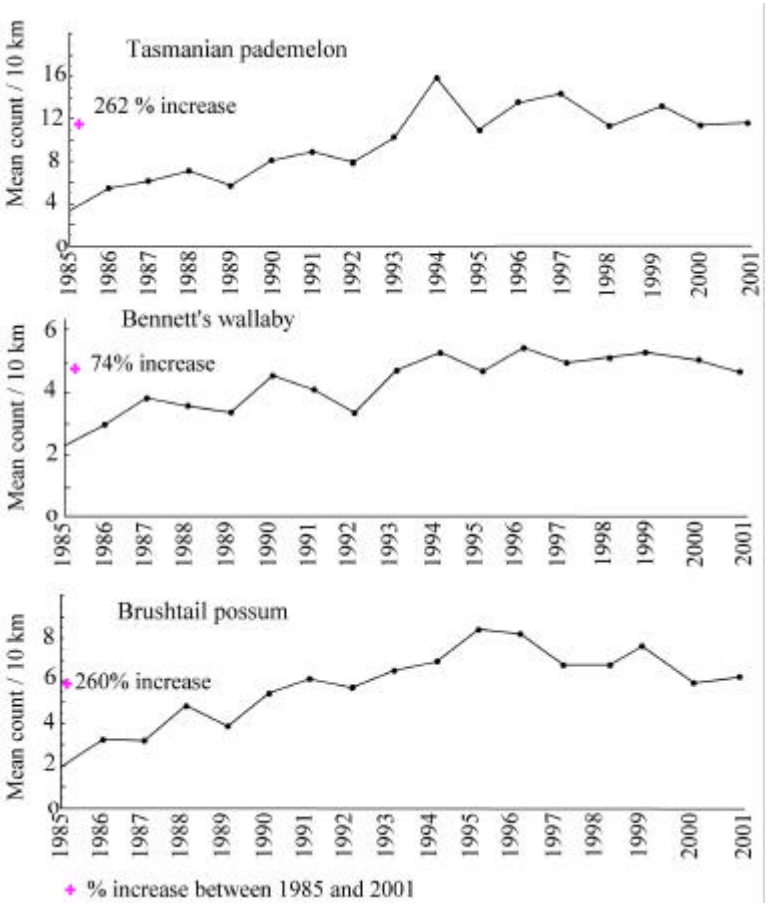

Figure 1 Population trends 1985–2001 (Hocking pers com)

Poisoning

The poisons which can be used for any vertebrate species are listed in Schedule 1 of the Tasmanian Animal Welfare Regulations (1993) (See Table 1). These can be varied only by recommendation of the State Animal Welfare Advisory Committee to the relevant Minister.

The Animal Welfare Act (1993) also bans the use of snares and leghold traps unless an exemption has been granted by the Minister.

Any control of protected wildlife has to be carried out under a issued under the Nature Conservation Act (2002) by the Nature Conservation Branch of DPIWE. Poisoning is further restricted by a Code of Practice enforceable under the Nature Conservation Act (2002)

Current control techniques for pest animals include:

- 1080 used to control rabbits, possum and wallabies. In 2000/2001, 9.5 Kg of 1080 was used in Tasmania of an estimated 150 Kg used throughout the country. The use of this material, particularly for control of native species is controversial. Many of the arguments in favour of banning the use of 1080 revolve around its humaneness which is assessed subjectively.
- Pindone, an anticoagulant is used for rabbit control in urban areas. It is not used in rural areas because of the potential risk to native carnivores through secondary poisoning. Although anticoagulants are widely used in rodent control they are not seen as particularly humane (Mason and Littin 2003).
- Alphachloralose is used primarily as a bird control agent and was introduced to replace strychnine following research in the mid 1980s (Statham and Medlock 1987). It is thought to be humane as it acts as a narcotic (Mason and Littin 2003).
- Small amounts of Aluminium phosphide are used for rabbit fumigation.

Biocontrol

Rabbit haemorrhagic disease and myxomatosis are endemic in the rabbit population and cause significant deaths if the circumstances are favourable. On the basis of the New Zealand experience myxomatosis would probably not be allowed into Australia if it were proposed as a new introduction.

Shooting

Both recreational and professional shooters are used in pest control, but in many areas access and terrain limit the effectiveness. Paid professional shooters, as distinct from commercial harvesters, are becoming an increasingly important part of forestry pest animal control.

An Animal Welfare Standard for wallaby hunting is currently being developed by the Tasmanian Animal Welfare Advisory Committee for approval under the Animal Welfare Act (1993).

Table 1 Control of prescribed animals with prescribed substances (Animal Welfare Regulations 1993 Schedule 1)

Animal	Substance
Bennett's wallaby (Macropus rufogriseus)	(a) Sodium monofluoroacetate
Brush possum (Trichosurus vulpecula)	(a) Sodium monofluoroacetate
Cat (Felis catus)	(a) Sodium monofluoroacetate (b) Cyanide (c) Alphachloralose
Dog (Canis familiaris)	(a) Sodium monofluoroacetate (b) Strychnine (c) Cyanide
Fox (Vulpes vulpes)	(a) Sodium monofluoroacetate (b) Strychnine (c) Cyanide
Goat (Capra hircus)	(a) Sodium monofluoroacetate
Hare (Lepus capensis)	(a) Sodium monofluoroacetate
House mouse (Mus musculus)	(a) Sodium monofluoroacetate (b) Metallic phosphides (c) Methyl bromide (d) Any rodenticide approved by the NRA and specified in Schedule 5 or Schedule 6 to the Poisons List Order 2001
Pademelon (Thylogale billardierii)	(a) Sodium monofluoroacetate
Pig (Sus scrofa)	(a) Sodium monofluoroacetate
Rabbit (Oryctolagus cuniculus)	(a) Sodium monofluoroacetate (b) Pindone (c) Alphachloralose (d) Metallic phosphides
Brown rat (Rattus norvegicus)	(a) Metallic phosphides (b) Methyl bromide (c) Any rodenticide approved by the NRA and specified in Schedule 5 or Schedule 6 to the Poisons List Order 2001 (d) Cholecalciferol (e) Sodium monofluoroacetate
Ship rat (Rattus rattus)	(a) Metallic phosphides (b) Methyl bromide (c) Any rodenticide approved by the NRA and specified in Schedule 5 or Schedule 6 to the Poisons List Order 2001 (d) Cholecalciferol (e) Sodium monofluoroacetate
Starling (Sturnus vulgaris)	(a) Alphachloralose (b) Fenthion (c) 4-aminopyrridine
Any other bird not referred to in Item 14	(a) Alphachloralose
All mammals	(a) Alphachloralose
All fish	(a) Rotenone

Trapping

Trapping of possums in cage traps is a developing industry, with carcasses being processed and exported. This industry is carried out under a Code of Practice enforceable under the Animal Welfare Act (1993).

A trapping and shooting program for feral cats on Macquarie Island may have resulted in eradication of the species.

Fencing

Fencing is being used as a long-term control measure in areas where it is suitable, primarily in agricultural situations with high value crops. Extensive research in the DPIWE has demonstrated the feasibility and economic value of fencing for wallaby control, and of course rabbit fencing has been proven for many years. There is still no really effective fencing for possum control in broad acre farming.

As a technique fencing appears to be one of the most humane methods of pest control, however there are two effects which cause problems. Firstly the effect on non-target species. Electric fencing can have disastrous effects on species like echidnas (Photo 2) and any fencing can restrict movement of native species. Secondly, the target species, rabbits or wallaby, rely on pasture areas for feed to support the numbers present. Fencing prevents access to the feeding areas and significant proportions of a population will die of starvation until the numbers adjust to the lower feed availability.

Photo 2 Echidna dead in electric fence

Other research

Other control techniques which have been trialed in Tasmania with Government and industry funding include repellents, ultrasonic devices tree guards, more resistant seedlings and alternate crops, with little success as yet.

Research is also underway in the development of predictors for potential pest damage, particularly in forest plantations. If the areas which are at significant risk can be identified the amount of control can be minimised.

Public opinion

In general 1080 is seen as unacceptable on the basis of its cruelty to target species, perceived effects on non-target animals or secondary effects on dogs, native carnivores and birds of prey. There seems to be a difference in acceptability of this poison depending on the species targeted. In Tasmania there are rarely complaints about rabbit control, but there are about wallaby control. Even RSPCA policy appears to differentiate between the two (Anon 2002), with 1080 being acceptable for introduced species but not for native animals, despite the fact that symptoms of poisoning are similar. Are these arguments therefore based on humaneness, or a more general view of the acceptability of killing native animals?

Native carnivores are more tolerant of 1080 than herbivores. They can feed on poisoned carcasses without being affected and are therefore not at significant risk (Statham 1983). Dogs of course are at risk and the movement of poisoned animals from a poisoning area combined with poor dog control results in death of a number of dogs each year. Irrespective of any issues of humaneness, the death of dogs, particularly pets is a powerful public argument against the use of 1080 poison in particular.

The addition of analgesic materials to reduce the symptoms of 1080 poisoning in carnivores (eg Marks et al. 2000) would probably not resolve the problem of the effect on dogs poisoned as a result of scavenging carcasses

Bait placement and dying of bait to minimise attractiveness to birds are used to minimise the effects on non targes species. Despite the fact that individuals of some species, eg Tasmanian bettong, are at risk from 1080 poisoning (Statham 1983), evidence from collections of carcasses after poison operations indicate few non target animals are found (de Little pers. com.).

Foxes in Tasmania

A small number of foxes were introduced to the State as cubs, raised and released in possibly 3 areas, the central north, east coast and south. The aim of the current control program is eradication with shooting and 1080 poisoning in buried meat baits being the predominant techniques. Research prior to 1080 baiting for foxes has concentrated on bait take by non target species, particularly the other carnivores.

Public acceptance of the program is very high, even with 1080 usage as the presence of foxes is seen as a greater threat than the use of poison. There has been no real thought to the humaneness of the technique, partly as it is an accepted control method in other States and partly because of the seriousness of the threat to the environment and agriculture if foxes establish in the State

Discussion

The control of damage caused by native and introduced herbivores in Tasmania is necessary for agricultural and forestry production and some environmental revegetation. All current techniques result in some degree of suffering, from at least some distress as a result of poisoning, hunger from fencing and wounding from shooting.

The aim of pest control in Tasmania is changing from killing the maximum number of individuals to minimising the damage caused by pest animals. There are no viable options to changing from the

current practices, but there is less reliance on poisoning with an increase in fencing, professional shooting and combinations of all three.

It is important that any changes based on humaneness of one technique over another be based on some objective measure of humaneness, rather than subjective emotion based perceptions.

References

Anon (2002) Animal Welfare and the Environment, RSPCA Policy and Position Papers.

Cremer KW (1960) Problems of eucalypt regeneration in the Florentine Valley. APPITA 14: 71-78

Marks CA, Busana F, Gigliotti F, Hackman C (2000) Assuring that 1080 toxicosis in the red fox (Vulpes vulpes) is humane: fluoroacetic acid (1080) and drug combinations. Wildlife Research 27: 483-494

Mason G, Littin KE (2003) The humaneness of rodent pest control. Animal Welfare 12: 1-37

Statham HL (1983) Browsing damage in Tasmanian forests and effects of poisoning Tasmanian Forestry Commission, 7.

Statham M, Medlock S (1987) Alphachloralose as a control agent for the Tasmanian native hen (Tribonyx mortierii). In Proceedings of the Australian Vertebrate Pest Control Conference p 284-287

Considering humaneness in implementing and designing control strategies: the Victorian story

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Summary

In Victoria, the Department of Sustainability and Environment (DS&E), and to a lesser extent the Department of Primary Industries (DPI), has considerable control over the manner in which unwanted introduced (and native) animal populations are managed. Regrettably the methods and procedures permitted have been developed without input from animal welfare scientists or broader community animal welfare organisations.

The Victorian Prevention of Cruelty to Animals Act (1986) currently denies its protection to unwanted introduced and native vertebrate animals through an exemption for [6.(10)(d)] '…anything done in accordance with the Catchment and Land Protection Act 1994 or the Wildlife Act 1975;…'. Neither of these Acts provides for the welfare of target or non-target animals. [Similar exemptions from welfare legislation occur in the other States]. The Victorian Animal Welfare Advisory Committee (AWAC) initially recommended (in 2000) to the then Minister for Agriculture that the exemption in POCTA be removed. While supported 'in principle', the Minister suggested instead that an 'ethics committee' be considered in order to provide animal welfare input into those things permitted under the two exempt Acts.

After considerable debate, finally in mid-2002 a Wildlife and Pest Animals Standing Committee (WPASC) was established to provide AWAC with advice on existing Government and other policies and procedures for the management of unwanted wild living animals. In turn the AWAC reports to the Primary Industries Minister to recommend changes to the POCTA or to encourage the Minster for Sustainability and Environment and that Department to alter procedures.

The WPASC is made up of self-selected AWAC members or their representatives and an animal welfare scientist from the Animal Welfare Centre (AWC). In fact the Committee has broad representation with the Victorian Farmers Federation, Australian Veterinary Association, RSPCA (Vic), a representative of the DS&E and the Victorian Bureau of Animal Welfare (DPI), and of course Animal Australia, at all meetings.

Four meetings of the WPASC have been held with a long list of priority issues scheduled (assisted by the outcomes of the 2001/02 Animal Welfare Centre planning process which considered the importance of the issues based on the level of community concern, the scientifically established welfare risk, and the likely number of animals affected). At each meeting the WPASC considers background papers and hears from attending representatives of relevant industries or interests who provide presentations (eg a Vertebrate Pest Research scientist, a Government officer in charge of bird gassing in NW Victoria, and officer from the Chemicals Standard Branch of DS&E, and two game bird farm operators have attended).

The WPASC, among other issues, has considered the DS&E standard conditions of 'Authority to Control Wildlife' (under the Wildlife Act), and the routine methods used by or advised by the DS&E for gassing, trapping, and poisoning animals, and has recommended significant changes to legislation (POCTA) and to DS&E guidelines for their own officers. Several examples will be

provided of these recent findings of the WPASC and consequent recommendations to AWAC (and in turn the Minister for Primary Industries).

Introduction

It is undeniable that the labels given to some animals, an animal's perceived usefulness, or particularly its level of nuisance to humans, often dictates how it is treated. This is then reflected in the laws and the permitted, often very harsh, treatment of animals that find themselves in the wrong place at the wrong time – let's call them 'mislocated' animals.

Until recently in Victoria there had been little ethical scrutiny of the laws and practices relating to these animals, and certainly no consistent community input to decisions made usually at the level of the Department of Sustainability and Environment (DS&E).

Unwanted animals can be hunted, trapped, shot, poisoned, gassed, caught and translocated, or inflicted with a deadly disease, and the methods used have not usually had any input from animal welfare scientists, animal ethics committees, community animal welfare groups, and often are not even monitored for efficacy by agencies permitting them.

What I have been asked to relate to you is the recent establishment of a committee to address this gross deficiency in the current system. This paper will cover:

1 The prevention of cruelty to animals legislation in Victoria, and how it exempts most of these animals from effective protection. I will also indicate that similar legal deficiencies occur in the other States.

2 The reason for the establishment of the Wildlife and Pest Animal Standing Committee of the Animal Welfare Advisory Committee (WPASC), its membership, and current priorities.

3 Some examples of the issues considered by WPASC and the recommendations made.

Legislation deficiencies

The Victorian Prevention of Cruelty to Animals Act (1986) (POCTA) currently denies its protection to unwanted introduced and native vertebrate animals through an exemption.

> '6.(1) This Act does not apply to – ….
> (d) anything done in accordance with the Catchment and Land Protection Act 1994 or the Wildlife Act 1975;…'.

Neither the Catchment and Land Protection Act 1994 (CALP) or the Wildlife Act 1975 provides for the welfare of animals (target or non-target). The CALP Act has as its primary purpose the protection of land and water resources and '(c) to set up a system of controls on noxious weeds and pest animals'. The Wildlife Act has as its purpose the 'protection and conservation of wildlife'. Without any provision for the welfare of individual animals, it is clear the 'protection of wildlife' is meant to apply at the population level.

In addition, the Victorian POCTA does not apply to a practice that is done in accordance with a named Code of Practice, and indeed to show that a Code has been adhered to will provide a defence to cruelty charges under the Act.

In my view this means we have three classes of animal citizens:

1 Those who are deemed animals under the POCTA and are not exempted for any reason – so neglect, excessive confinement, abandonment, injury, deliberate poisoning, invasive surgery with anaesthesia, for example would lead to a prosecution for cruelty for say a cat or a domestic dog.

2 Those animals for which a code of practice has been drawn up, and the suffering permitted will be limited, eg limiting minimum sizes for confinement, advising of monitoring intervals, detailing the ages at which invasive or mutilating practices can occur.

3 Those animals for which there are no community agreed codes, no legislative protection, and no public interest consultation on the methods permitted. This third-grade animal citizen is the one the WPASC is to address. In legislative and real terms these animals are the 'untouchables'.

Similar exemptions from welfare legislation occur in the other States – but my reading of them indicates there is a greater scope for some protection.

Queensland's new Animal Care and Protection Act 2001 has exemptions like all others, and says in Part 6 that an exemption applies to feral or pest animals, but states that a prohibited trap or spur cannot be involved and the exemption to the Act's protection only applies if: (a) the act is done in a way that causes the animal as little pain as is reasonable; and (b) the control complies with any conditions prescribed under a regulation.

In New South Wales the Prevention of Cruelty to Animals Act 1979 also provides '24 Certain defences'

> '(b) in the course of, and for the purpose of:
>
> (i) hunting, shooting, snaring, trapping, catching or capturing the animal, or
>
> (ii) destroying the animal, or preparing the animal for destruction, for the purpose of producing food for human consumption,
>
> in a manner that inflicted no unnecessary pain upon the animal,'

The South Australian Prevention of Cruelty to Animals Regulations, 1986 (Reg. 25) has similar exemption provisions for codes, but requires adherence to the Model Code of Practice for the Welfare of Animals, The Destruction or Capture, Handling and Marketing of Feral Livestock Animals (Australian Agricultural Council Sub-Committee on Animal Welfare) 1991.

Tasmania's Animal Welfare Act 1993 exempts hunting from its cruelty provisions, but says (Sect. 4.(1)) that this exemption is valid only if the practices used in the hunting of animals is 'done in a usual and reasonable manner and without causing excess suffering unless the practices are prohibited by this or any other Act'.

So, in summary, Acts in other States (than Victoria) do not have the absolute carte blanche provided by total exemption of things done under the CALP and the Wildlife Acts as in Victoria, but they similarly say that things done to unwanted animals (wild living animals, introduced or native) can be of a different standard to those done to wanted animals. The existing Codes of Practice relevant to these wild living animals are inadequate, and closer ethical consideration is well overdue.

The WPASC

The Victorian Animal Welfare Advisory Committee (AWAC) worked through 2000 to agree on the major changes needed to the POCTA and to the Domestic (Feral and Nuisance) Animals Act 1994 (DAA). It recommended some 29 changes, with the then Minister for Agriculture, Keith Hamilton, agreeing to about 10 of those. At that time the AWAC recommended that the exemption in POCTA for things done under the CALP and Wildlife Acts be removed.

A clear example of the need to remove that exemption had been provided by the immediate past Minister for Conservation, Mrs Marie Tehan in Kennett's Government, who had allowed permits (under the Wildlife Act) to grain farmers to poison native birds with anything they could lay their hands on – sheep dip, weed killer, insecticides etc. She was dubbed the 'Minister for Poisons' for such a reckless act, but probably thousands of birds fell victim to various farm chemicals while the farmers were protected from cruelty prosecutions due to the exemption in the POCTA. [NB The new ALP Minister removed the ability to issue the poisoning permits soon after taking office.]

While the AWAC advice to remove the exemption was supported 'in principle', the Minister suggested instead that an 'ethics committee' be considered in order to provide animal welfare input into those things permitted under the two exempt Acts. He had understood our argument, but perhaps did not think such a change would go down well with the rural lobby – which at that time through three-rural based independents effectively had the balance of power in Victoria. [Indeed he may well have been right given that an amendment proposed to ban the use of small (rabbit) steel jawed traps ultimately failed in December 2001 due to last-minute farm lobbyists].

I then proposed to the AWAC that they support the establishment of a 'Wild Animal Management Ethics Committee' and provided details of its function, Terms of Reference and its likely membership. At the time the current function of the (now) Department of Primary Industries and the Department of Sustainability and Environment were together in a single department – the (then) Department of Natural Resources and Environment. I naively thought that the two responsible Ministers (Agriculture and Environment) would see an independent committee dealing with this joint responsibility as a positive move. I visualised it would be resourced by the DSE, but I was wrong!

After considerable debate, finally in mid-2002 a Wildlife and Pest Animals Standing Committee (WPASC) was established to provide AWAC with advice on existing government and other policies and procedures for the management of unwanted wild living animals. AWAC of course reports only to the Primary Industries Minister to recommend changes to the POCTA and can only ask that Minister to then encourage the Minster for Sustainability and Environment and that Department to alter procedures.

The WPASC is made up of self-selected AWAC members or their representatives and an animal welfare scientist from the Animal Welfare Centre (AWC). In fact the Committee has broad representation including:

- Victorian Farmers Federation
- Australian Veterinary Association (Victoria)
- RSPCA Victoria
- Department of Sustainability and Environment (Dr Robert Begg)
- Bureau of Animal Welfare (Department of Primary Industries)

- Animal Welfare Centre (scientist Dr John Barnett)
- Animals Australia

Its primary Terms of Reference include (6-7 are not listed):

1 To consider the ethical and welfare implications of wild animal population management strategies, policies, programs and procedures undertaken by or permitted by the Department of Natural Resources and Environment under the Wildlife Act and the Catchment and Land Protection Act.

2 To consider the ethical and welfare implications of specific proposals for the invasive management of wild animal populations in Victoria (including both native and introduced vertebrate animals).

3 To identify gaps and recommend on the development of principles and standard operating procedures for wild animal management activities undertaken by, or permitted by, the Department of Natural Resources and Environment.

4 To recommend on animal welfare requirements and conditions for licences and permits issued by or on behalf of the Department of Natural Resources and Environment [renamed Department of Sustainability and Environment].

5 To provide advice to the Minister for Agriculture, via AWAC, on specific programs and broader strategies and policy initiatives dealing with wild animals.'

Four meetings of the WPASC have been held, with a long list of priority issues scheduled. We determined our priorities with the assistance of the outcomes of the 2001/02 Victorian Animal Welfare Centre (a joint venture of the Victorian Institute of Animal Science, University of Melbourne and Monash University) planning process, which considered the importance of the issues based on:

- the level of perceived community concern;
- the scientifically established welfare risk; and
- the likely number of animals affected.

This has meant that at our first meeting we set topics to be considered over the first 12 months, meeting each second month, the alternate to the AWAC meeting. Our standing committee list was:

- gassing/poisoning introduced vertebrates – chloropicrin, 1080 poison;
- trapping – large leg hold traps (dog traps);
- culling native wildlife on public land – shooting, trapping, gassing;
- recreational hunting of native ducks;
- hunting deer/feral pigs (with dogs);
- game bird farms (private raising and release for shooting on a property);
- bow hunting of deer (permitted under the Wildlife Act);
- culling native wildlife on private land (kangaroos, wombats, cockatoos) under the Wildlife Act (Authority to Control Wildlife conditions);
- wildlife rescue/rehabilitation (and to include drought, fire);
- private keeping of wildlife (under the Wildlife Act);

- recreational fishing;
- wild animal road injuries/deaths;
- wild horses management programs.

At each meeting the WPASC considers background papers and hears from attending representatives of relevant industries or interests who provide presentations, for example, a vertebrate pest research scientist, a government officer in charge of bird gassing in Northwest Victoria, and officer from the Chemicals Standards Branch of DS&E, and two game bird farm operators have attended.

Examples of WPASC work

Several good examples of the work WPASC has undertaken and the recommendations to AWAC (and in turn the Minister for Primary Industries) will provide a better idea of the role it plays. Among other issues, WPASC has considered the DS&E standard conditions of 'Authority to Control Wildlife' (under the Wildlife Act), and the routine methods used by or advised by the DS&E for gassing, trapping, and poisoning animals, and has recommended significant changes to legislation (POCTA) and to DS&E guidelines for their own officers.

1 Steel jawed traps – small and large, different standards

Under the Victorian POCTA, small steel jawed traps, the type used for rabbits, are permitted only if the user abides by a Code of Practice. That Code of Practice was assessed by the AWAC many years ago and requires users to check the traps every 24 hours in order to kill or released trapped animals. This is both an ethical issue to limit the time an animal suffers (inadequate in my view!) and also to give some opportunity for non-target animals (often native animals) to be released where possible. [It should be noted that AWAC has indicated its total opposition to small steel jawed traps].

By contrast, one of the first issues WPASC looked at was the manner in which Government (DS&E) officers [referred to as doggers] undertake the use of large steel jawed traps to capture wild dogs in our high country to ease their impact on sheep in farms abutting national parks. There is no public Code for this activity and the POCTA limits where these traps can be used (the North East high country and the far north west regions), but is silent on how they are to be used. Thus, due to the exemption for activities undertaken under the CALP and Wildlife Acts, the manner in which this is done falls to Departmental policy. That policy has not had the scrutiny of AWAC or any other like body.

So what does the Departmental policy on 'The use of large steel-jawed traps for wild dog control' (1995) say? It does say that officers should promote safer and more effective techniques, including treadle snares, poisoning, exclusion fencing and shooting to private landholders, but allows field officers to use them themselves where they are judged necessary.

When they do use traps, either treadle snares or large steel jawed traps, they only need check them 'within three days of setting and then at least twice every seven days.' I know AWAC well enough to know that this discrepancy between the frequency of checking large and small steel jawed traps would not be seen as justified.

One of the first recommendations of WPASC has been that large steel jawed traps and treadle snares be phased out over the next 12 months, and that all leg hold traps be inspected at least once every 24 hours.

2 Game bird farms - permitted under the Wildlife Act

In recent years in Victoria, a small but ambitious group of game bird farmers have established themselves. They breed thousands of pheasants, partridge and quail in long sheds, then release them for a party of hunters to shoot them with shotguns on the owners property. By the operators' own figures (returns provided to the Department (DNRE) for 2000) almost 5,000 birds are released, and about 20% of the pheasants and partridges are either wounded and escape, or simply disappear, presumably dying of exposure, starvation or predation (Table 1). [NB the figures indicate quail rarely escape the guns]. The game bird properties are licensed under the Wildlife Act's Regulations and became established without any referral to AWAC or other body.

Table 1 Returns to DNRE for release and fate of game birds

Species	Released	Shot	Recovered	Escaped/other death *	%Esc+death
Pheasants	1,983	1451	184	398 (348)	17.5 %
Partridge	1,197	855	87	197 (255)	21.3 %
Quail	1680	1515	163	2	very small%

*The returns were not internally consistent. The adjusted figure (in brackets) is the remainder after those claimed shot and those claimed recovered are deducted from the number of birds the licensees stated they released. The birds claimed to have escaped or died are in the 5th column. It is the adjusted figure that is used to calculate the % of the original birds released. Due to the inaccuracy in the returns, the figures should be taken as estimates only.

Despite the POCTA [Sect. 9. Cruelty (1)] declaring it an offence of cruelty if a person 'wounds, … worries, torments or terrifies an animal', or '…knowingly or negligently does … an act with the result that unnecessary, unreasonable or unjustifiable pain or suffering is caused to an animal'; or '…abandons an animal of a species usually kept in a state of confinement or for a domestic purpose', these game bird farms have been able to operate without even a code of practice and with immunity to the POCTA due to the exemption for things done under the Wildlife Act.

The WPASC have had ongoing communication with members of the game bird farm association, called GECO, and they have written a draft code of practice themselves which the working group has examined. Their representatives addressed the third meeting of WPASC and the deficiencies of their draft code were discussed. AWAC was advised by WPASC after its further detailed consideration that it should maintain its opposition to game bird farm operations, due to its similarity to trap shooting (already banned by POCTA) and due to the wounding and abandonment of some released birds.

The next step for this issue is that the Minister for Primary Industries in Victoria will need to agree to ban this practice under the POCTA, and then due to the current exemption, the Minister for Environment must ensure that the licensing of the game bird farms ceases under the Wildlife Regulations.

Ironically, if the industry group GECO (Game Environment and Conservation Organisation) were successful in having a code of practice endorsed (to marginally improve animal welfare) the practice would be automatically exempt from cruelty provisions under another exemption in the POCTA Act. If this occurred, then the birds would move from being third class animal citizens to second

class – not a huge step forward when these largely domesticated birds emerge from their breeding shed to face the shotguns and dogs.

In summary

The WPASC is a compromise committee; set up because we have not as yet achieved political acceptance to take out the blanket exemption for things done under the CALP Act and the Wildlife Act. However, its activities for the first time bring together animal scientists, community based animal welfare representatives and Government and private land managers to discuss reasonable minimum standards for the treatment of wildlife and introduced unwanted animals. How we introduce and influence those standards may vary for each practice, but for now we are pleased to get a look in to see if we can't curb the horrific excesses and actually reduce animal suffering over time. One thing we trust will assist us is that we are calling on the assistance of experts, including animal welfare scientists, to document the animal welfare and ethical case, to ensure the advice is well-based.

It is an understatement of course, but as a minimum I believe each State and Territory must pay greater attention to setting up a similar ethical review system, and provide it with the resources and power, to properly review how these third class animal citizens are treated.

Assessing the humaneness of pest control methods

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Summary

This paper describes the main methods used for controlling unwanted pest species. They are:

- shooting;
- hunting;
- explosives;
- electrocution;
- traps;
- poisons;
- encouraging disease;
- introduction of predators;
- deterrents and repellents;

The focus is on the ways that these methods go wrong, and on some of the inevitable aspects of suffering they inflict. This does not mean that all methods cause suffering. The least obtrusive method is to keep the pest out of the area that has to be protected. Road grids, keeping the door or gate closed, maintaining fencing and translocating stray animals are used widely and are sometimes the simplest as well as the most humane solutions. However, exclusion is difficult in the case of birds and rodents, and killing methods will no doubt continue to be needed in the future.

Shooting

Shooting an animal in the head at close range is one of the most humane killing methods. The following anecdote by a veterinary practitioner serves as a good example (Rainey 1933):

> 'The best demonstration ever given to me of how a small bullet will cause instantaneous unconsciousness and certain death to a large animal, was on a coco-nut plantation where a large number of cattle suffering from open tuberculosis had to be killed. The planter, a crack shot, stood beside me in the midst of about 100 cattle in a small paddock and asked me to point out the diseased beasts. Using a 0.22 calibre rifle, fitted with a silencer, he rapidly picked off about a dozen beasts with complete accuracy at ranges up to 25 yards one after another, so that each beast fell dead with one tiny bullet in the brain. The report was so deadened by the silencer, and it was all done so quickly and cleanly, that the other cattle did not take alarm. Every bullet had entered the skull just about where the hair curls on the centre of the forehead.'

On other occasions three 0.22 head shots were needed to fell a steer. Accuracy and a short distance between the animal and marksman are critical when using light firearms and shotguns.

The usual intention when hunting and culling large mammals is to shoot the animal in either the head, neck or chest. When the hunter is within 20 m, a head shot is considered appropriate, and between 20 and 40 m, a neck shot is used. Between 40 and 100 m, a chest shot has been recommended (Farm Animal Welfare Council 1985). With a high velocity bullet there is a good

chance that a head shot will concuss the animal, even when it strikes the jaw instead of the skull. With a neck or chest shot the hope is to sever a major blood vessel and cause a rapid death by haemorrhage. However, as Rainey (1933) pointed out when using a Webley long barrel revolver firing a 0.450 bullet aimed at the heart, it was unusual to see cattle drop immediately, and there can be 'a considerable interval of conscious distress before the animal fell'. If the spinal cord is struck without incurring much bleeding, the animal may appear, from a distance, to be shot dead, but it could in fact be paralysed and alive. If the spinal cord is damaged above the fifth cervical vertebra, it is likely that the animal will die from being unable to breathe. Damage to the spinal cord below that point without lethal haemorrhage would result in a slow death.

Most of the information on the effectiveness of shooting during hunting or culling and on the immediacy of the kill is anecdotal. The accuracy of the shooting was assessed during kangaroo culls in Australia by Young and Delforce (1986) and during deer stalking in the UK by Bateson (1997). The majority of kangaroos (88%) were shot in the head, and a minority in the chest. Dealers pay lower prices for kangaroos shot in the body because of damaged skins and bruising to the carcases, and this has been a strong incentive for performing head shots. Lewis et al (1997) recorded shooting efficiency during night-time impala (Aepyceros melampus) culling. 94 % of the animals that were hit were killed instantaneously, and in the 6 % that were wounded the survival time was on average 30 sec. Bateson (1997) reported that when 44 red deer were shot in the chest, the average distance run before they dropped to the ground was 32 metres. Whereas, the average distance run by 45 deer shot in the head or neck was 3 metres. Misadventures sometimes happened as recorded in the following case:

> 'On the 25th April 1996 a stag was shot in the left hand side of the head from close range (approximately 5-10 m) after it had lain down in deep bracken, following a chase of approximately 23 km over four hours. The shot broke the upper, vertical section of the lower jaw. The stag immediately leapt to its feet and ran off into nearby woodland. It was killed with a second shot (from a humane killer) about 10-15 minutes later.'

Overall, 11% of red deer that were shot by stalkers were killed with two or more shots, and 7% of the deer took more than two minutes to die. About 2% of the deer escaped wounded (Bateson 1997).

Shooting feral horses from a helicopter has become a sensitive issue in Australia and New Zealand. Some horses have been shot without being immediately killed, and in a recent case in New Zealand a Kaimanawa pony survived in a disabled state for 10 months. In a helicopter cull conducted in October 2000 by the New South Wales Parks and Wildlife Service, a mare was found with bullet wounds in the shoulder 7 to 10 days after she had been shot. Aerial culling from helicopters is more haphazard than stalking, as both the target and the marksman are moving. Nevertheless, it is strongly defended as a more practical option when there are large numbers of animals that have to be culled in extensive or inhospitable terrain. The ideal solution with helicopter culls is to follow any injured but mobile animals to give them a second shot, and to off-load operators to despatch any injured fallen animals. These precautions are needed because not every animal will be killed with the first shot. An M14 7.62 mm rifle is often preferred for horses (Edwards et al 1997), and when goats are culled from helicopters, a shotgun fitted with a magazine and ¾ choke is sometimes used.

Shotguns are used in Australia and New Zealand for controlling and hunting wallabies. In Tasmania it has been common to find old shotgun pellets in carcasses when they were dressed, and so it is difficult to condone it as a humane method (Anon 1987). Problems also arise when a shotgun is fired at a group of birds flying overhead. The birds aligned with the central cluster of

pellets will usually be fatally injured. Whereas, birds at the perimeter of the volley may be hit with one or two pellets, and they stand a good chance of surviving. Suffering in those survivors is an inevitable welfare problem. In a study of shooting wounds in over 45,000 live trapped waterfowl in Australia, Norman (1976) found that 14 % of ducks had shotgun pellets in their tissues, which were identified radiographically (Table 1). The species of larger duck carried more pellets, and one of the Mountain ducks had 13 pellets. In a similar study in the northern hemisphere, 14 % of Ptarmigans (Lagopus lagopus) that were caught with snares were found to be carrying between one and six birdshot pellets, with a mean of 2.7 pellets per bird (Holmstad 1998).

Table 1 Prevalence of shotgun pellets in live ducks in Australia

Species	Number examined	% with pellets
Mountain duck	400	19.0
Black duck	2544	13.7
Wood duck	696	13.6
Hardhead	351	11.1
Grey teal	38075	9.0
Chestnut teal	3144	6.2
Dusky moorhen	159	0.6
Eastern swamp hen	17	0

Normally when a shotgun pellet lodges in soft tissue without killing an animal, it is gradually surrounded by fibrin which is non-vascularised. This isolates the pellet and usually arrests the inflammatory response. It also stops the pellet from migrating elsewhere in the body or emerging under the skin. Encapsulation with fibrin does not occur in the case of a shotgun pellet lodged in a joint, and this is a particularly serious injury. With lead pellets, the synovial fluid bathing the pellet dissolves some of the metal causing chronic irritation as well as systemic effects from distribution of dissolved lead.

Many countries have changed to using steel shot in place of lead shot. However, there are disadvantages with steel shot. In the USA there are reports of severe inflammatory reactions in non-fatal wounds when the steel pellets corrode (Bartels et al 1991). Tungsten-bismuth-tin, bismuth, tungsten-iron, and tungsten-polymer shot are less prone to inducing an inflammatory response, in comparison with steel.

Bullets damage tissues in three ways:

- laceration and crushing;
- shock waves;
- cavitation.

Low velocity bullets cause crushing and laceration, whereas a high velocity bullet causes the tissue itself to accelerate, and this gives rise to the temporary cavity around the missile tract. The explosive effect produced by the formation and collapse of the temporary cavity can be very damaging. It results in a zone of bruising and tissue disruption from the stretching, shearing and rupture of vessels, nerves and bone. The density of the medium influences the way in which the explosive effect is transmitted. When a bullet strikes a tissue with high specific gravity, there is efficient

transfer of energy to that tissue. This can result in the bone being shattered whilst skin and other soft tissues are only perforated.

When a bullet makes impact with the body there is a massive injury discharge in the adjacent nerves when they are damaged or stretched. This creates a feeling of general or gross disturbance in the body, in addition to the blow of the impact. The nerves that are damaged would normally serve a wide range of sensory functions, including, heat, cold, mechanical sensation, movement and pain perception, and when activated in unison there is often an electric shock-like feeling, along with the feeling of tissue disturbance ('trauma'). If pain receptors in and around the wound are activated, there can be an immediate sense of pain, but this may be diluted or over-ridden by the barrage of impulses from all the other sensory nerves that occurs at the same time. The immediate feelings of trauma are no doubt exaggerated when there is wider tissue disturbance such as from a high velocity or expanding bullet, or a close range shotgun blast.

Neurophysiological studies have shown that the barrage of injury discharges that occur when a nerve is severed lasts for up to 4 seconds. Thereafter the end of the cut nerve is unresponsive to most stimuli (Wall et al 1974). However, when nerves close to the wound are stretched or stimulated without being severed or disabled, there is a period of increased activity, that lasts for minutes. There is usually a sense of trauma or tissue disturbance and paraesthesias at this stage. This nerve activity may or may not provoke pain, depending on circumstances and in particular, whether functional pain receptors are in the field of activation. Typically, when deep structures are injured, the pain may be felt at a site which is alongside rather than within the damaged site. Persistent pain develops subsequently when the pressures associated with haemorrhage, oedema and inflammation develop, and when pain receptor agonists released from the injured tissue accumulate at the wound. In addition, the inflammatory responses will induce hyperalgesia and allodynia. If nerves have been stretched without being severed, there can be chronic causalgia, and this is a particular risk with bullet wounds. If nerves have been severed there can be neuropathic pain.

Neuropathic pain is often chronic. In some species it becomes obvious when there is self-mutilation of the part that has been denervated. The mechanism setting up neuropathic pain is thought to be as follows. The barrage of C-nerve fibre activity at the time of the injury induces a delayed but long-lasting hyperexcitability in dorsal horn interneurones (Seltzer et al 1991). This interferes with the normal effects of descending nociceptive inhibition, allowing continuous activity in pain pathways within the spinal cord, and this may be exaggerated by any afferent activity such as that from a neuroma that has formed at the wound. A similar disorder within the spinal cord contributes to secondary hyperalgesia and allodynia, but in the case of allodynia there is activation of central nociceptive neurones by impulses in non-nociceptive primary afferent neurones (eg Aβ-fibre activity).

The construction of a bullet determines whether it penetrates and passes through an animal as a single object, or whether it breaks-up on entry. Soft-nosed, hollow-nosed, flat-nosed, and bullets with grooves across the tip are prone to breaking up ('expanding bullets'), and so cause more widespread internal injury. The presence of an entry and an exit wound does not imply that the whole bullet has passed through an animal. High velocity soft-jacketed bullets tend to leave behind a trail of casing inside the animal.

Military bullets are fully jacketed and are 'non-expanding' when they penetrate a target. They inflict considerably less internal damage than 'expanding' bullets used in hunting, culling and animal euthanasia. For example in a study on anaesthetised dogs which were shot in the chest at 884 $m.sec^{-1}$, the internal wound volume with an expanding bullet was 917 cc, compared to 24 cc for a

non-expanding bullet with the same velocity (De Muth 1966). Expanding bullets have been shown to lose between 59 and 77 % of their weight in fragments as they break up inside a pig's hind leg (Fackler et al 1984). This dispersal causes considerable tissue damage, with internal bleeding, and raises the chances of inflicting a lethal wound.

There are five types of bullet motion:

- Trajectory motion is the line the bullet takes between the gun and the animal.
- Spin or rotation around the long axis of the bullet, is caused by the rifling of the gun.
- Wobble, in the form of spiralling movement by the tail of the bullet. This tends to be greatest at the beginning and end of the flight of a bullet, and is periodic in between.
- Flip-over occurring when the nose of the bullet makes impact, and the bullet tumbles over itself.
- Fragmentation on penetrating the animal, and dispersal in the tissues.

If a bullet yaws as it impacts an animal, or if it enters during a wobble phase in its flight, or if it flips-over as it enters the body, it tears a bigger hole near the entrance. In these situations, the area of presentation to the skin is larger than the diameter of the bullet, and gyroscopic action reams out a larger internal wound. High velocity bullets are more likely to flip-over and tear out a cavity inside the body. Low velocity bullets pierce the tissue creating a hole that corresponds approximately to the diameter of the bullet.

The immense forces generated by high velocity bullets can cause the following types of damage:

- Muscle can be split along its fascia. Muscle that is ripped from bone does not regain its normal position after collapse of the temporary cavity, and healing can be complicated.
- Hydraulic forces can be set up within blood vessels, which burst veins at some distance from the wound. Arteries, on the other hand, are more elastic and less prone to this type of damage. Radiographs in the cat have shown the femoral artery can be forced aside by the pressure of the temporary cavity without causing it to rupture, whereas the femur in the same vicinity has broken (Harvey et al 1962).
- Nerves may show failure in transmission due to compression or stretching, without any outward signs of physical damage. However, when there has been excessive stretching, the nerve may show kinking, and this is a sign that the inner axon has probably broken whilst the neurilemma and myelin sheath are still intact.
- Sometimes it is found that a gas-filled organ, such as the intestine, is ruptured when a bullet passes through the abdomen without directly entering that particular section of gut. It is the negative pressure effect that causes the organ to burst, through expansion of gas inside the intestine.
- Bone fractures can occur at some distance from the track of the bullet, without direct contact between bone and bullet. Whereas, when a bullet strikes bone, there is usually a comminuted fracture. With high velocity bullets, the bone seems to 'explode' when it receives a direct hit. The bone fragments fly out into the temporary cavity, and, with collapse of the cavity, they are forced back to approximately their former position. The bone fragments act as returning secondary missiles and add to soft tissue damage.

If a wild animal receives a bullet in the abdomen and the gut is perforated, the risk of death from peritonitis is high, but it is not inevitable. A notable exception, reported in human medicine, was the case of a soldier wounded during the Battle of Loos in the First World War, who recovered

without surgery. Subsequently, he was wounded again during the Battle of the Somme, and during surgery his earlier wound, which involved several perforations of the small intestine, was discovered. Leakage from the gut following the first wounding had evidently been constrained by loops of the bowel that developed adhesions to the small intestine (Fraser 1942). Analogous situations have been observed in a dog, and episodic leakage of digesta caused obvious sickness in the animal.

Bullets that pass through layers of wool or dense fur can drag some of the fibre as a cocoon into the wound. This is particularly evident with expanding bullets, whereas round shot and pointed non-expanding bullets tend to split their way through the fleece or coat. Fibre that penetrates in this way inevitably increases the risk of infection.

Tissue will regenerate within the zone of extravasation if it is kept clean. Otherwise, it is prone to harbouring pyogenic bacteria and developing gas gangrene. In its early stages a gangrenous wound can be painful, partly from the pressure created by gases. During this phase, humans feel anxious and distressed, but as the pain eases, the subject starts to feel better. When the toxaemia sets in, vomiting and flushes commence, and there is further swelling at the site of the wound which probably helps to disseminate the bacteria. Intoxication with products from autolysis and with bacterial exotoxin make the patient very ill, and the chances of survival are further reduced if the bacteria invade the bloodstream. Overall, the suffering associated with this condition is greatest during the initial and fulminant stages of the toxaemia. In the later stages the subject is profoundly ill, and seems to submit emotionally to the process.

When a bullet strikes a limb and sets up a haemorrhage which is contained within the limb, there can be a substantial rise in interstitial pressure within the closed fascia. If the raised pressure reduces capillary perfusion, a condition known as Acute Limb Compartment Syndrome may develop. This occurs when there is muscle and nerve ischaemia with muscle infarction, nerve damage, and swelling. It is a very painful condition, even though there is sensory loss in other respects in the affected area. The pain is out of proportion to the apparent injury, and it is present during passive movement of the limb. Compartment Syndrome is not the same condition as Crush Syndrome. Limb Compartment Syndrome results from increased pressure, whereas, Crush Syndrome develops from acidosis, hyperkalaemia, myoglobinuria, shock and acute renal failure. An analogous situation to limb Compartment Syndrome can occur when there is haemorrhage within the abdomen (Abdominal Compartment Syndrome).

When musculoskeletal trauma results in fat emboli lodging in the lung and brain, the emboli can contribute to respiratory distress and central nervous system (CNS) dysfunction. In humans the respiratory signs can be as severe as cyanosis, and typically the CNS signs include confusion, restlessness, irritability, and in severe cases disorientation and stupor (Oh 1978).

When an animal is shot but not killed it can suffer from the disabling effects of the injury, from sickness due to infection of the wound, and from pain created by the wound. The forms of suffering can be itemised as:

1 Animal disabled preventing it from:
   - escaping or avoiding threatening situations;
   - keeping up with the social group;
   - feeding and drinking adequately;
   - performing particular functions because of damage to a specific body region (eg compromised breathing, impaired vision).

2 Pain and discomfort associated with:
- inflammation at the wound (pain from swelling at the wound, pain from the release of algogenic substances at the wound site, primary and secondary hyperalgesia, allodynia);
- medium-term effects of disruption and damage to tissues (muscle soreness and stiffness);
- chronic effects of injury (causalgia, neuropathic pain, centralised pain, myiasis).

3 Chronic psychological effects:
- dissociative and/or anxiety disorders.

Hunting pest species

There are three types of hunting; chase hunting, trapping and stalking. Chase hunting usually depends on out-running the animal enabling close enough access to shoot, concuss or stick it, or for the dogs to kill it. Protagonists of chase hunting often state that the chase is similar to natural predation, and that hunted species are well-adapted to the chase. It is claimed that if the animal was struck by abject fear or panic, its survival would be compromised. Instead, it must rely on stealth, subtle manoeuvres and out-witting the hunting party, and these must require some control over its own emotions. Others argue that the chase is nothing like natural predation. Prolonged pursuit is unusual during natural predation. Normally, predators such as a lions, leopards or wolves depend on catching prey by stalking, ambush or bringing the victim down during a brief pursuit. Whereas, organised hunting parties use the collective strength of the huntsmen, the pack of dogs, or helicopters and open-back trucks to out-compete the animal.

It is inevitable that the opportunities for suffering during chase hunting are considerably greater than during stalking. The stresses and injuries associated with chase hunting can include:

- exertion, fatigue, respiratory distress, exhaustion;
- fear associated with the chase, noise from the hunting party, blocking of escape routes, and during close proximity to humans and dogs;
- injuries experienced during the chase;
- biting by the hunting dogs;
- wounding when shot or stuck.

Pig hunting carries some of the highest risks of hunting trauma, for both the pig and for pig-hunting dogs. The usual aim is to chase the pig to exhaustion, and when it has been bailed-up by the dogs, to either shoot or stick it. Some pig-hunters prefer sticking because there is less risk of shooting a dog, but there is a risk of injury to the dogs from the pig with sticking because the dogs have to restrain the pig. This is often done by two dogs, one on each ear, or by one dog holding each leg plus a fifth dog holding an ear. Some dogs develop a knack of biting the scrotum of the pig during the chase and this has been known to stop the pig in its tracks. Pigs have powerful shoulder muscles and when attacking a dog they throw it in the air and then gore it from underneath with their tusks. Eventration in this way can lead to shock.

The traditional way of hunting wallaby in Tasmania has been to drive the animals from cover with dogs, and then to shoot them with shotguns. On one property as many as 3,000 Rufous and Bennett's wallabies were shot annually. Animals that were not killed outright were either killed by the dogs, re-shot, or had their necks cut. Joeys in the pouch were usually concussed. One of the difficulties with re-shooting is in aiming at the head, neck or chest when the main view of the

receding target is its hindquarters. Night shooting is commonplace for kangaroos, wallabies and rabbits. The animals are shot from a vehicle whilst frozen by a spotlight.

In Australia, snakes near homesteads used to be shot with a snake gun using 16 gauge shot. More commonly, they are left alone, or beaten to death.

Explosives

Explosives are not commonly applied in pest control, but they have been used in the following situations:

- intentional underground gas explosions for fox, rabbit, gopher, prairie dog and ground squirrel control;
- control of unwanted animals that live in colonies, such as flying foxes;
- intentional underwater 'fish blasting'.

When dynamite has been used for controlling flying foxes in Queensland, it was applied alongside their roosts to kill and deter them. Explosives were used for controlling rabbits in Australia by driving the rabbits into their burrows and then blowing up the burrows with carbon disulphide. Carbon disulphide was readily available as an insecticide and it has now been replaced for this purpose by cylinders of propane and oxygen. The methods used for detonating the carbon disulphide vapour had their dangers, and one of the less humane methods was to release a captive rabbit into the burrow with a stick of phosphorus tied to its leg. We do not know a great deal about the effects of underground explosions on the rabbits, as few people have gone to the trouble of digging out the warren to see what might have happened.

Underground animals exposed to a detonation may be injured by:

- direct effects of the air blast;
- being thrown by the blast, and acquiring injuries on impact with rigid objects or during decelerative tumbling;
- flying debris inflicting penetrating and non-penetrating injuries;
- burns from the flash and from hot gases, or combustion of the surroundings;
- inhalation of noxious gases from fire or from the detonation;
- collapse of the tunnel.

Underground explosions tend to be highly directional, and they are potentially very effective against any animal that is in a major tunnel which conveys the blast. Animals in blind side tunnels may be less affected.

There are two components to an explosion. Initially there is a sudden compression wave. This is followed by a longer lasting rarefaction wave. The force of the compression wave is the stronger of the two, but both waves cause tissue injury by spalling, implosion and shear from inertia. In open areas, the compression wave is quickly dissipated, whereas in underground tunnels, the pressure is directional, and animals and loose objects are thrown in that direction. Underwater blasts are not usually directional, but can be very damaging because the shock wave in water maintains its pressure over a considerable range.

The pressure waves from an explosion cause greatest injury in air-containing organs such as the ears, lungs and intestines. The lungs are particularly susceptible. At one time it was thought that lung injury and haemorrhage were due to the compression wave rupturing the air spaces and surrounding tissue within the lungs. However, it was found, from experimental work in rabbits, that haemorrhages often occurred on the outer surface of the lungs at points corresponding to the position of the ribs (Zuckerman 1940). This pattern was common in young animals which had compliant rib cages. Evidently, the lungs are bruised by the impact transmitted against the chest wall. Haemorrhages also developed in the mediastinal face of lungs. The medial lung surface is in fact the part that is most distorted by the pressure wave acting on the rib cage. This situation is analagous to a coin being knocked against a row of other coins, and the end coin flies off. The coins in the middle correspond to air-locked alveoli at the centre of the lung, and they undergo little displacement. Whereas, the furthest least-constrained coin (mediastinal aspect of the lung) is prone to displacement. In the case of the lung, the displacement results in tearing.

Haemorrhage in the lungs can be linked to pains in the chest and impaired ventilatory function. There is expiratory dyspnoea coupled with grunting, shallow breathing, cyanosis, and the haemorrhagic area may be prone to secondary infection (leading to broncho-pneumonia).

Ear injuries can include rupture of the eardrum, middle ossicle displacement, and damage to the cochlea. In cochlear damage, the organ of Corti is often dislocated from its attachment to the basilar membrane. There may also be loss of sensory hair cells, which will impair subsequent hearing. In humans, hearing loss following a blast injury is often accompanied by persistent earache (Phillips and Zajtchuk 1989).

Injury to the intestines is less common than lung and ear injury, except in underwater blasts. Nevertheless, the types of intestinal injury that occur are:

- Transmural perforation.
- Contusion of the intestines.
- Mesenteric laceration.
- Tearing or straining of the mesentery is responsible for stitch-like pain in humans. The mechanisms causing these injuries include:
    - bursting of fluid-filled small bowel loops from the sudden increase in intraluminal pressure created by the blast;
    - compression of intestinal loops against the vertebral column;
    - tangential tears at fixed points.

Rupture of the small intestine is potentially very serious. The contents have a near-neutral pH, a low bacterial count, and contain proteolytic enzymes. This combination is conducive to peritonitis when chyme leaks into the abdominal cavity. If an animal is in abdominal pain following a blast, and if this is accompanied by vomiting, rupture of the tract should be considered a possibility.

In humans, the immediate sensation during a blast wave is severe compression of the chest plus the momentary feeling that 'all the blood was being displaced to my head, making it throb badly' (Anon 1941). In some cases this has been followed by a period of paralysis lasting for half an hour or more, shortly followed by full sensory capacity. In other cases the subjects have been mobile but unable to speak (Gordon 1918). The early behavioural responses, after the blast has subsided are typically confusion, depression or dullness, suppression of normal reflexes, deafness, reduced visual function and reduced taste and smell. Memory changes and psychological changes such as fear and anger

can occur, whereas in others there may be apathy and depression. The behaviour of blast-exposed animals can range from confusion to paralysis. The exact signs depend on the extent and type of damage inflicted on the central nervous system. Haemorrhages can develop in the brain either from impact when thrown by the blast, or from a surge of intravascular pressure to the brain from compression of the thorax and abdomen. At the time of the blast there is a period of apnoea that can last up to a minute, and is followed by fast and shallow breathing. Some cases of apparent paralysis may in fact be due to cardiogenic shock. There is hypotension and severe bradycardia, which in laboratory rats has been shown to develop within about 15 seconds of the blast. These cardiovascular responses are neurally mediated as they have been prevented by bilateral vagotomy plus atropine premedication (Irwin et al 1999). The initial heart rate reduction is caused by the blast pressure acting directly on the carotid sinus, whereas a more prolonged bradycardia occurs as a reflex response to distension of the lungs by haemorrhages and traumatic emphysema. The reduced cardiac activity can be apparent from a weak pulse and distension of the jugular veins.

The medium-term behaviour patterns after a blast can include the following. Subjects who were disoriented immediately after the blast have been known to develop emotionally-induced convulsive seizures when stressed. Rabbits have been seen to hop around aimlessly, horses showed mild paralysis, and cows stopped eating. Signs of brain injury in dogs have included generalised spasms, forced twisting movements of the body, nystagmus, barking whilst in syncope, and loss of orientation. In general, loss of consciousness from the primary blast has been rare.

The greatest risk of concussion is from being struck by a secondary missile. Concussion can take the form of a catatonic state lasting for twelve or more hours after the explosion, during which there is a characteristic physical plasticity and flexibility (Stewart et al 1941). When the body is manipulated into an unusual posture or orientation, it remains in that position until moved again. Subjects suffering from blast injury often display an extreme expiratory dyspnoea. Respiration may be slow and shallow, and pain in the chest may modify the breathing pattern, making it short and panting. Tachypnoea may persist for many hours after the blast, and it tends to be more severe in animals that appear to be only moderately injured. In severely injured mice, monkeys and goats, breathing was instead slow, with expiratory grunting and in some cases a double expiratory movement (Clemedson 1956). When limbs have been blown off, the amputation usually occurred through the shaft of a long bone, rather than through a joint.

Death from blast injuries usually arises from one or more of the following: pulmonary haemorrhage and obstruction to breathing with blood and froth, cardiac insufficiency in combination with pulmonary oedema due to circulatory shock plus obstruction of the pulmonary circulation, or air embolism in the coronary arteries or brain blood vessels. Sometimes blast victims are found dead with no external signs of injury. In such cases, the likely causes of death have been vagally mediated circulatory collapse or air emboli. 'Showers' of air emboli can occur in the carotid artery for up to half an hour after a blast. In surviving subjects there can be transient blindness from air emboli lodging either in vessels of the retina or the visual cortex.

Dynamite is sometimes used to catch fish. Fish with swim bladders are particularly susceptible to blast injuries, and explosives such as dynamite, which produce an abrupt shock wave due to a fast burn time, are more damaging than explosives that burn more slowly. Fish swimming near the surface are more prone to damage than those at lower depths, because their swim bladders are more inflated, and they experience a rapidly changing pressure and rarefaction wave from reflection at the water-air interface. When the swim bladder bursts it opens into the abdominal cavity, and the rarefaction wave can cause sudden intravascular bubble formation which bursts the blood vessel walls.

Electrocution

Electrocution systems have been used at various times for killing pests. In New Zealand a baited electrocution platform was developed for possums (Trichosurus vulpecula). In Australia an electric grid system has been used until recently for flying foxes (Pteropus species) invading lychee orchards. In various countries electrocution is used against rats, and the version that has been promoted in Australasia recently is the Rat Zapper.

The concerns with electrocution systems are that they can cause:

- pain or shock from current flowing through the body before the animal is insensible;
- cardiac pain from the induction of a cardiac arrest before the onset of insensibility.

The feeling created during an electric shock is due to two effects. Firstly, there is the direct activation of nerves near the point of contact, and they conduct a barrage of pulses to the brain. Secondly, there is the violent jerk of the muscle contraction. When animals are electrically stunned in abattoirs the current is applied through the head, and this induces immediate insensibility. Whereas, in most electrocution systems the current does not pass through the head, and unconsciousness occurs when the effects of the cardiac arrest set in. Under this situation cardiac pain could develop from the release of bradykinin.

Trapping

The classification of animal traps is shown in Table 3. All traps can cause injuries, but in general, traps which contain an animal cause less damage than restraining traps. Kill traps that kill quickly cause shorter-lasting distress than live traps. Body-catch traps include the scissor mole trap and the Fenn trap, and, in general, are not humane.

Table 3 Traps used on animals

Live traps	Kill traps
Cage traps	Neck hold traps
Box traps	Neck snares
Nets	Break-back traps
Pitfall traps	Body-catch trap
Leg snares	Crushing devices
Leg hold traps	
Glue boards	

Animals caught in cage and box traps are not likely to experience trauma except when they take extreme measures in trying to escape. Normally foxes either become inactive shortly after capture, or they may pace up and down the box (White et al 1991). Excitement during transport can be controlled by covering the cage with a cloth to exclude light and visual threats. If the caught animal has to be handled or killed at some stage, this is the period when trauma is most likely to occur.

In Australia net guns are sometimes used for catching feral goats. They are less likely to cause injury when used at waterholes in comparison with firing them from helicopters during a chase (Edge et al 1989).

Pitfall traps are sometimes used for catching large game for food or for relocation, and wild rodents for research purposes. In Papua New Guinea sharpened stakes are fitted at the bottom of the pit to impale wild pigs which are used for food. Warren ripping is used in parts of Australia. It is done with a large tine drawn by a vehicle. The intention is to bury them alive but it is not always effective as some rabbits dig their way out.

Foxes can be quite active when caught in leg hold traps. They try to pull against the anchor of the trap, and they dig the ground. Kreeger et al (1990) examined the stress and injury caused by leg hold traps in red foxes. The data shown in Table 4 compares six treatments in terms of blood stress parameters.

Captive foxes were caught in either soft-jawed padded or in unpadded leg hold traps. Blood samples were taken at either two or eight hours after being caught or at 8 hours. In order to bleed the animals, they were shot by a marksman from a distance without being seen by the fox, and then blood was collected by cardiac puncture. Free-ranging foxes were caught in either padded or unpadded leghold traps, and their blood responses were compared with animals that were shot without being trapped, and so they experienced no restraint stress or tissue injury whilst conscious. The results indicated that using padded traps helped to reduce physical exertion and tissue damage as reflected in the lower plasma activities of alkaline phosphatase, gamma glutamyl transpeptidase and aspartate aminotransferase enzymes, and concentration of phosphorus. This was confirmed for gamma glutamyl transpeptidase and aspartate aminotransferase activities in the free-ranging foxes. Phosphorus in the plasma gave an indication of the inorganic phosphate that was released from muscle after ATP had been broken down during exercise. Leaving a fox in a leg hold trap for 8 hours compared with two hours caused greater exertion stress and muscle injury as shown by the higher circulating levels of the muscle enzymes lactate dehydrogenase and creatine kinase. Shooting free-ranging foxes caused less tissue activation and damage in terms of the release of alkaline phosphatase, lactate dehydrogenase, creatine kinase and aspartate aminotransferase into the circulation. The differences in bilirubin concentrations could reflect differences in either liver damage, the breakdown of haem pigment subsequent to bruising, or length of food deprivation. This study showed the advantages of using padded traps and in minimising the period that foxes are held in the traps. Warburton et al (1999) did a similar study in possums. Possums caught in leg hold traps were more stressed, as shown by their serum cortisol concentrations, than possums caught in cage traps. The longer an animal was held in a leg hold trap, the higher its postmortem muscle pH, which indicated that they had lower muscle glycogen levels and experienced greater muscle depletion of energy reserves.

The injuries incurred with leg hold traps in racoons vary from minor soft tissue injury in the case of some animals caught in padded traps, to metacarpal subluxation or phalangeal joint luxation (Proulx et al 1993). Padded Victor leg hold traps caused considerably less damage to possums than unpadded versions of the same trap (Warburton 1992). Lanes-Ace (gin) traps caused substantially more injury than either the padded or unpadded Victor leg hold traps. Wolves are prone to tooth, lip and gum injuries when they fight leg hold traps (van Ballenberghe 1984). They also chew nearby vegetation, and this has been known to result in a stick becoming wedged between the upper molars.

Table 4 Blood parameters in captive and free-ranging foxes that were caught in leg hold traps or shot. Means in a row without a common superscript letter were significantly different at $p<0.05$

Plasma measurement	Captive Foxes			Free-ranging Foxes		
Mean (± se)	Padded trap for 2 h	Padded trap for 8 h	Unpadded trap for 8 h	Shot	Padded trap	Unpadded trap
Bilirubin mg/dl	0.4^{ac} (0.1)	1.0^{b} (0.1)	1.0^{b} (0.1)	0.4^{a} (0.04)	0.7^{c} (0.1)	0.3^{a} (0.1)
Alkaline phospahatase IU/l	50.2^{ab} (3.0)	42.6^{ac} (7.2)	70.9^{d} (4.5)	31.1^{c} (2.0)	58.9^{be} (6.9)	70.9^{de} (2.7)
Gamma-glutamyl transpeptidase IU/l	1.0^{a} (0.01)	2.0^{a} (1.0)	23.4^{b} (3.6)	1.5^{a} (0.3)	1.8^{a} (3.8)	14.2^{c} (2.2)
Lactate dehydrogenase IU/l	416^{a} (11)	1176^{b} (160)	939^{bc} (137)	177^{a} (29)	346^{a} (130)	872^{c} (72)
Phosphorus mg/dl	7.4^{ac} (0.7)	8.8^{ac} (1.1)	11.3^{b} (0.9)	6.9^{a} (0.4)	7.7^{ac} (0.5)	8.9^{c} (0.4)
log creatine kinase IU/l	6.9^{ac} (0.4)	10.8^{b} (0.3)	10.1^{bd} (0.3)	6.6^{a} (0.3)	8.5^{ce} (0.6)	9.1^{de} (0.3)
Aspartate aminotransferase IU/l	224^{ab} (16)	964^{c} (115)	1327^{d} (219)	85^{a} (8)	430^{b} (92)	1076^{c} (143)

When setting leg hold traps it is important to place them away from objects that could be used as a purchase that will allow the animal to escape, and not to place them near undergrowth which will allow the chain or wire to get tangled up. Foxes and rock wallabies, in particular, can put up an impressive fight against a leg hold trap, and entanglement increases the chance of a dislocated leg (Meek et al 1995). Skin lacerations also occur during struggling, and the strength of the trap springs and the point at which the chain or wire is attached to the jaws of the trap influences the amount of swivel and potential injury.

Birdlime was used for catching songbirds in days gone by, and about 100 hundred years ago it was adapted for catching rats in Australia. The modern equivalent is the glue board. These are used mainly for mice in food factories where baited poisons are disallowed. The animal gets stuck to the board and if it is not discovered in time, will eventually die. Another discontinued method used for rats in Australia was to mix caustic soda with molasses, and to smear the sticky mixture on a board near a rat hole. The blend stuck to their feet, causing burns. When they licked their feet they acquired mouth and gastrointestinal tract burns.

Snares are used in communities where the hunter has plenty of time too set and inspect the snares. Wire snares are widely used in Africa. They are cheap, effective, easy to carry, but they have to be placed on an animal trail and this limits the number of target species. They are usually applied as foot snares, but for some species they act as neck snares. When caught by a foot, 'death is gruesome as the animal fights to free itself, often breaking the captured limb, and dies slowly from shock, blood loss, exhaustion, and starvation' (Noss 1998). Wire snares tend to be non-selective, and wasteful because of losses to scavengers and decomposition.

The intention with neck snares is to cause a rapid death by strangulation. It may either compress the trachea causing suffocation, or occlude the carotid arteries causing prompt failure in blood supply to the brain. However it does not always work that way. In a study on 65 wild-caught coyote (Canis latrans), 59 % were caught by the neck, 20 % by the flank, 11 % the front leg and neck, and

10 % the foot. 48 % of the total catch were found alive the morning after the snares were set, but some of these were moribund (Guthery and Beasom 1978). Clearly it does not always produce a quick kill.

Sometimes the cable snare breaks, and the animal escapes. This could be quite common in some species. For example, in one study 11 out of 45 Red Duiker (Cricetomys dorsalis) were found to have previous wire snare injuries, the most serious being an animal missing two feet. When a wire is positioned over an artery it can cause a long-term arterial spasm (Klenerman 1962). Theoretically this vascular injury could contribute to the restricted blood supply to a foot or limb in some escapees. In addition, sudden release of a tourniquet can cause shock, through massive loss of fluid from the circulation through small vessels in the hypoxic limb. In which case, some of those animals may experience acute renal failure.

Snares can be made more species and size selective by affixing a ferrule which limits the smallest size of the noose. Nevertheless, larger non-target animals can be caught, depending on the lure and how the snare is set.

In Papua New Guinea snares are sometimes used for catching wild pigs (Barss and Ennis 1988). They take the form of a noose attached to a sapling. Other hunters use a large log propped with a small stick either over a pig run or over bait scattered on the ground. The intention is that the log will crush the animal.

When kill traps fail to produce a prompt kill there is the risk that the animal will suffer for an extended period. The majority of kill traps operate in one of two ways. They either clamp the neck, or they grip the chest. If the neck is clamped, one would hope that this quickly arrests the flow of blood to the brain through the carotid arteries. The aim with a chest clamp should be to inhibit or stop the pumping action of the heart. The positioning of the animal in the jaws of the trap cannot be predicted, and in some cases the animal may even be concussed by the jaws striking the head. Sometimes animals are caught in a Conibear trap by the body, where the intention has been to catch them by the neck. The Conibear is the most widely used kill trap for fur-bearing species.

Nutman et al (1998) found that only 22 % of brushtail possums (Trichosurus vulpecula) that were caught in a Conibear trap had both carotid arteries occluded by the jaws of the trap. There were two reasons for this poor performance. If there was axial rotation of the neck, the carotids were not aligned with the jaws of the trap, and so one or both of them were not clamped. In addition, in some cases the carotid arteries were displaced laterally around the sides of the vertebral column. It has even been known for a fisher (Martes pennanti) to twist its head while pulling and escape from a Conibear trap, and so a modified Bionic® kill trap has been recommended in its place (Proulx and Barrett 1993). Warburton et al (2000) found that if the jaws of the neck-hold trap were offset from each other, instead of being directly opposed, the neck is stretched into dorsoflexion and this improves the occlusion of the carotid arteries substantially. The time to death was correspondingly reduced. Clearly the way that the jaws of a trap hold the neck is critical, and changes are needed in some designs to improve their humaneness.

Chemical pesticides

The ideal pesticide is an anaesthetic that sends the animal into an irreversible sleep. However, the use of anaesthetics is controlled by the medical and veterinary professions, and none are available for

routine use as pesticides. The nearest compound to an anaesthetic that is used in pest control is the stupefacient α-chloralose. It has a bitter taste, and so its main application is in birds, which in general are less choosey about food flavours. Its weakness is that it sometimes makes a bird drowsy so that it stops eating before it has taken a lethal dose. Death is either from anaesthetic-induced apnoea or from hypothermia, depending on circumstances.

Over the year, strychnine has been the most widely used chemical pesticide. It was discovered in 1817, and at various times it has been the toxicant of choice for crows, moles, wallabies, flying foxes, parrots, rabbits, dingoes, wild dogs, and rodents. It has been used for controlling dingoes along the dog fence and for mouse plagues in Australia, and for gophers and voles in North America. There are anecdotal cases of domestic dogs finding and dying from strychnine-injected eggs or gopher bait. Strychnine inhibits glycine-mediated neurotransmission in the spinal cord and medulla, and this interferes with postsynaptic inhibition at these sites. The signs of strychnine poisoning are as follows. Within 10 minutes to two hours of eating the poison, the animal becomes apprehensive, nervous, tense and stiff. Seizures occur often in response to noise, light or physically touching the animal, and they terminate with extensor rigidity in a 'sawhorse' posture (Murphy 1994). Death is from respiratory failure.

One of the most potent pesticides in use today is 1080 (sodium monofluoracetate). It is widely used in New Zealand for controlling the Australian brushtail possum (Trichosurus vulpecula) and in Australia against red fox. In the past it has been used against wallabies, dingoes, feral pigs and rabbits. In other countries it is considered too toxic to be used except under confined conditions, for example against ship rats. 1080 is a TCA Cycle blocker, affecting brain and heart function. The signs of poisoning in humans include nausea and apprehension, muscle twitching, tremors, cardiac irregularities, convulsions, coma and then death. Wild pigs (Sus scrofa) often have easy access to1080 baits, and death follows within 2 hours to 5 days. In the intervening period there is a lot of vomiting (O'Brien 1988).

Anticoagulants are the most widely used poisons for controlling rodents. The favoured anticoagulant presently is brodifacoum, which was originally developed to combat warfarin-resistant rodents, but has subsequently been used against many agricultural and forest pests throughout the world. It competitively inhibits recycling of vitamin K, leading to depletion of vitamin K-dependent blood clotting factors. Death is from haemorrhaging at injured sites. There are two ways in which it causes suffering. Firstly, they cause a slow death with a relatively long period of signs of sickness. In possums, the signs of sickness last for between 6 and 13 days before death at about 21 days (Littin et al 2002). These signs included abnormal breathing, diarrhoea, shivering and trembling, external bleeding and spasms. Secondly, some haemorrhages can be painful when they swell within confined spaces in tissues (Compartment Syndrome effects).

Cholecalciferol causes sickness and death from hypercalcaemia. It is unpleasant because of the protracted malaise that can accompany excessively high blood calcium levels. The animals are depressed, anorexic, thirsty, and occasionally vomit. They fail to groom themselves, the abdominal wall is tense, sometimes in association with gastric ulcers. Death may follow seizure episodes and is often due to kidney failure through calcium accumulation. In the words of an endocrinologist who took to inducing hypercalcaemia in himself as part of a research study 'I have never felt so ill in all my life'.

One of the newer rodenticides is bromethalin. It is an oxidative phosphorylation uncoupler and starts to have effects within 10 hours. There is ataxia, vomiting, tremors, hyperexcitability, and seizures before death occurs after a period of coma that can last for days. Poisoning with thallium

rodenticides and zinc phosphide cause abdominal pain (Humphreys 1978), and various approaches have been used to inflict death by constipation. In former times plaster of Paris was mixed with flour and sugar in a formulation that was used for controlling sparrows. More recently, a cellulose derivative was marketed as a compound for blocking up the intestines of rats.

Carbon monoxide fumigant cartridges are available for poisoning foxes in their dens. They contain carbon and sodium nitrate, which when ignited by a fuse produces carbon monoxide over a period of 2 to 4 minutes. The recommended procedure is to use this method during the whelping period, when occupancy of the den is likely to be high. Carbon monoxide is poisonous at low concentrations, it is odourless, non-irritating and does not provoke dyspnoea. It kills the animal by hypoxaemia through displacement of oxygen bound to haemoglobin in the blood. This makes it a relatively slow method in comparison with other gases taking, for example, between four and five minutes to induce unconsciousness when it has been used in dog pounds. The dogs often give a howl just before they collapse. Carbon dioxide has been used to fumigate fox dens. It is less expensive and safer than carbon monoxide. It is a potent stimulant of breathlessness, and at low concentrations this could last for several minutes before the loss of consciousness. In the uncontrolled situation of a fox den, it is difficult to guarantee a high concentration and a prompt kill.

Chloropicrin is a soil fumigant that has been used off-label with diesel fumes for fumigating rabbit warrens. It is an intensely irritating lachrymatory agent and should not be used for this purpose. Hydrogen phosphide is more appropriate as a den fumigant. The pesticide which probably causes the least suffering in terms of sickness before death is potassium cyanide (Gregory et al 1998).

Phosphorus is used as a pesticide for controlling cockroaches, rats, pigs and possums, and it is one of the more common agents used for suicide amongst young women in the Middle East (Fahim et al 1990). Many animals show restlessness before a period of subdued activity, disorientation, and coma prior to death. Animals that fail to eat a lethal dose, and animals that lose part of a dose from vomiting, can die at a later stage from liver failure. Normally, when a lethal dose is consumed, death is from myocardial infarction (Pietras et al 1968), and in possums the time to death is about 19 hours. When the stomach is opened postmortem, phosphoric acid fumes are liberated as the contents are exposed to air. The behavioural signs of phosphorus poisoning in pigs can be harrowing, and for this reason its has been recommended that it should be disallowed for pigs.

Rotenone (derris powder) is used for poisoning unwanted fish. Between 1988 and 2000, 110 tonnes were used in North America for this purpose and for quantifying fish populations. Its species-specificity in fish has allowed the retention of game species, whilst unwanted species, such as catfish, have been controlled. It is recognised as an environmental carcinogen for mammals, causing mammary tumours at high concentrations. In animals that survive rotenone poisoning, there can be signs similar to Parkinson's disease due to destruction of dopaminergic neurones in the substantia nigra of the brain. This is also a potential risk with using cyanide as a pesticide.

Disease

The attraction of using a disease for pest control is that, if it is highly contagious, it can be effective against large numbers of animals whilst incurring little effort. In some cases it can also be species specific. Myxomatosis has been used to control rabbits in many countries. The time to death following infection with the myxoma virus varies with the virulence of the strain of virus. It ranges from about 10 days to 50 days. With virulent strains, skin swellings appear over the body after four or five days. Conjunctival swellings emerge on the fifth or sixth day and the eyes are completely

closed a day or two later (Ross 1972). Rabbits that recover from an infection have problems with seeing because their eyes are glued together by a tenacious purulent exudate. Their breathing is also restricted. Rabbit calicivirus has been introduced as an alternative to myomatosis. This virus is thought to cause liver damage which results in the release of clotting factors such as thromboplastin, which sets up a disseminated intravascular coagulopathy (DIC) in the bloodstream. This in turn results in a sudden stroke if the clot lodges in the brain, or cardiac irregularities if there is an infarct in the heart, which should be relatively benign ways to die. This is not always the way the dying process progresses. Sometimes there are signs of sickness including anorexia, rapid respiration, cyanosis, ataxia, paddling movements of the limbs, and finally frenetic behaviour with squealing before death (Chasey 1997). About 20 % of affected rabbits discharge foamy blood from the nostrils. When death is quick following the stroke or cardiac arrest, it should provide a more humane death than that from myxomatosis.

Predation

Non-native predators have been released in many countries in the belief that they will control an unwanted pest species. For example, in New Zealand, ferrets were introduced to control rabbits, even though it was recognised that ferrets have a preference for birds over rabbits. Similarly, in Western Australia, cats were released to keep down rabbit numbers, but this was unsuccessful and feral cats are now regarded as a pest.

Deterrents and repellents

Various high frequency audio animal repellents are available, including the Av-Alarm and Shu roo. They are barely audible to the human ear, but cause an alerting response in many species of animal, and sometimes flight behaviour. Raptor bird calls are available for scaring unwanted birds.

Electric shock equipment is available in a variety of forms for deterring unwanted animals. For example, the Finlayson trough has been used to deter kangaroos in Australia, but it is now illegal in Queensland. An electronic deer repellent is used in North America against white tailed deer that invade gardens. Tunnel vibration equipment is sometimes used to repel moles.

Methiocarb is used as a bird repellent on seeds and seedlings, and polybutene is used as a roost inhibitor. Denatonium benzoate is used as a bitter-tasting repellent in a range of formulations, and pepper products are still used against unwelcome cats and dogs.

Questions

This account raises the following questions:

- Are we comfortable with chest shooting ?
- Should shotguns only be used for close range shooting aimed at the head ?
- Can the back-up procedures used during aerial culling be improved ?
- How serious or common are the inflammatory reactions to steel shot ?
- Can chase hunting be considered a humane method of controlling unwanted wildlife ?
- What happens to rabbits when their warren or burrow is blown up ?
- Should electrocution systems for rats be disallowed ?

- Shat inspection standards should be required when using leghold and killing traps?
- Should body-catch traps be prohibited ?
- Is warren ripping humane ?
- What research has been done in Australia which evaluates leghold traps using the ISO testing standards ?
- What alternatives are there to glueboards for controlling mice in food factories ?
- Should the use of anticoagulants and cholecalciferol be phased out ?
- Should the use of chloropicrin as a den and warren fumigant be made a prosecutable offence ?
- Can we reach a consensus on any of these questions, and if so what are the next steps ?

Taking the bigger picture, my own views are that we need to strive for the following general goals:

- Greater use of deterrents and repellents instead of lethal methods.
- Acceptable deterrents could include brief non-repetitive electric shocks.
- Case-by-case consideration of the acceptability of each control method that is used in Australia.
- Formulation of a list of acceptable killing methods that is based on the way in which the animals die.
- Replacement of traumatic capture methods (eg leghold traps) with humane kill traps, where the intention is to kill the animal.
- Limiting the use of shotguns to situations where all shot animals will die promptly.
- Phasing out inhumane toxicants. Toxicants that are relatively humane are α-chloralose, carbon monoxide and cyanide.

References

Anon (1941) Experiences of blast. Lancet 1941(i): 586

Anon (1987) Incidence of cruelty to wallabies in commercial and non-commercial operations in Tasmania. RSPCA, Australia. Canberra Publishing & Printing Pty Ltd. 143 pp.

Barrs P & Ennis S (1988) Injuries caused by pigs in Papua New Guinea. Medical Journal of Australia 149: 649-56

Bartels KE , Stair EL & Cohen RE (1991) Corrosion potential of steel bird shot in dogs. Journal of the American Veterinary Medicine Association 199:856-863

Bateson P (1997) The behavioural and physiological effects of culling red deer. Report to the Council of the National Trust. United Kingdom. 77 pp.

Chasey D (1997) Rabbit haemorrhagic disease: the new scourge of Orctolagus cuniculus. Laboratory Animals 31: 33-44

Clemedson CJ (1956) Blast injury. Physiological Reviews 36: 336-54

De Muth WE (1966) Bullet velocity and design as determinants of wounding study. Journal of Trauma 6: 222-32.

Edge WD, Olson-Edge SL & O'Gara BW (1989) Capturing wild goats and urial with a remotely fired net-gun. Australian Wildlife Research 16: 313-5

Edwards GP, Clancy TF, Lee J & McDonnell J (1997) An evaluation of feral goat control methods on Currawinya National Park, south-western Queensland. Rangeland Journal 19:166-73

Fackler ML, Surinchak JS, Malinowski JA & Bowen RE (1984) Bullet fragmentation: a major cause of tissue disruption. Journal of Trauma 24: 35-9

Fahim FA, El-Sabbagh M, Saleh NA & Sallam US (1990) Biochemical changes associated with acute phosphorus poisoning. General Pharmacology 21: 899-904

Farm Animal Welfare Council 1985. Report on the Welfare of Farmed Deer. Farm Animal Welfare Council, UK. 50pp.

Fraser J (1942) Intra-abdominal procedures, including wounds of the small intestine and mesentery. In: Surgery of modern warfare. Volume 1. Ed. H. Bailey. E&S Livingstone, Edinburgh pp. 403-11

Gordon RG (1918) A study of epileptiform convulsions in soldiers. Seale Hayne Neurological Studies 1: 159-66

Gregory NG, Milne LM, Rhodes AT, Littin KE, Wickstrom M & Eason CT (1998) Effect of potassium cyanide on behaviour and time to death in possums. New Zealand Veterinary Journal 46: 60-4

Guthery FS & Beasom SL (1978) Effectiveness and selectivity of neck snares in predator control. Journal of Wildlife Management 42: 457-9

Harvey EN, McMillen JH, Butler EG & Puckett WO (1962) Mechanism of wounding. In: Wound ballistics. Ed. J. B. Coates and J. C. Beyer. Office of the Surgeon General, Medical Department of the US Army, Washington, USA. 144-235

Holmstad PR (1998) Do bag records of willow ptarmigan underestimate hunting mortality ? Fauna-Oslo 51: 94-6

Humphreys DJ (1978) A review of recent trends in animal poisoning. British Veterinary Journal 134: 128-45

Irwin RJ, Lerner MR, Bealer JF, Mantor PC, Brackett DJ & Tuggle DW (1999) Shock after blast wave injury is caused by a vagally mediated reflex. Journal of Trauma 47: 105-10

Klenerman L (1962) The tourniquet in surgery. Journal of Bone and Joint Surgery 44(B): 937-43

Kreeger TJ, White PJ, Seal US &Tester JR (1990) Pathological responses of red foxes to foothold traps. Journal of Wildlife Management 54: 147-60

Lewis AR, Pinchin AM & Kestin SC (1997) Welfare implications of the night shooting of wild impala (Aepyceros melampus). Animal Welfare 6: 123-31

Littin KE, O'Connor CE, Gregory NG, Mellor DJ & Eason CT (2002) Behavior, coagulopathy and pathology of brushtail possums (Trichosusrus vulpecula) poisoned with brodifacoum. Wildlife Research 29: 259-367

Meek PD, Jenkins DJ, Morris B, Ardler AJ & Hawksby RJ (1995) Use of two humane leg-hold traps for catching pest species. Wildlife Research 22:733-9

Murphy MJ (1994) Toxin exposures in dogs and cats: pesticides and biotoxins. Journal of the American Veterinary Medical Association 205: 414-21

Norman FI (1976) The incidence of lead shotgun pellets in waterfowl (Anatidae and Rallidae) examined in south-eastern Australia between 1957 and 1973. Australian Wildlife Research 3: 61-71

Noss AJ (1998) The impacts of cable snare hunting on wildlife populations in the forests of the Central African Republic. Conservation Biology 12: 390-8

Nutman AW, Gregory NG & Warburton B (1998) A comparison of the effectiveness of three neck-hold killing traps in occluding carotid arteries in the neck of the brushtail possum. New Zealand Veterinary Journal 46: 177-81

O'Brien PH (1988) The toxicity of sodium monofluoroacetate (Compound 1080) to captive feral pigs, Sus scrofa. Australian Wildlife Research 15: 163-70

Oh WH (1978) Fat embolism: current concepts of pathogenesis, diagnosis, and treatment. Orthopedic Clinics of North America 9: 769-79

Phillips YY & Zajtchuk JT (1989) Blast injuries of the ear in military operations. Annals of Otology, Rhinology and Laryngology. Supplement 140:3-4

Pietras RJ, Stavrakos C, Gunnar RM & Tobin JR (1968) Phosphorus poisoning simulating acute myocardial infarction. Archives of Internal Medicine 122: 430-34

Proulx G, Onderka DK, Kolenosky AJ, Cole PJ, Drescher RK & Badry MJ (1993) Injuries and behavior of racoons (Procyon lotor) captured in the Soft catch™ and Egg™ traps in simulated natural environments. Journal of Wildlife Diseases 29: 447-52

Rainey JW (1933) Shooting as a means of painless despatch. Veterinary Journal 89: 307-12

Ross J (1972) Zoological and wildlife review. Myomatosis and the rabbit. British Veterinary Journal 128: 172-6

Seltzer Z, Beilin B, Ginzburg R, Paran Y & Shimko T (1991) The role of injury discharge in the induction of neuropathic pain behavior in rats. Pain 46: 327-36

Stewart OW, Russel CK & Cone WV (1941) Injury to the central nervous system by blast. Lancet 1941(i): 172-4

Van Ballenberghe V (1984) Injuries to wolves sustained during live-capture. Journal of Wildlife Management 48: 1425-9

Wall PD, Waxman S & Basbaum AI (1974) Ongoing activity in peripheral nerve: injury discharge. Experimental Neurology 45: 576-89.

Warburton B (1992) Victor foot-hold traps for catching Australian brushtail possums in New Zealand: capture efficiency and injuries. Wildlife Society Bulletin 20:67-73

Warburton B, Gregory N & Bunce M (1999) Stress response of Australian brushtail possums captured in foothold and cage traps. In: Mammal Trapping. Ed. G. Proulx. Alpha Wildlife Research & Management Ltd, Alberta, Canada, 53-66

Warburton B, Gregory NG & Morriss G (2000) Effect of jaw shape in kill-traps on time to loss of palpebral reflexes in brushtail possums. Journal of Wildlife Diseases 36: 92-6

White PJ, Kreeger TJ, Seal US & Tester JR (1991) Pathological responses of red foxes to capture in box traps. Journal of Wildlife Management 55: 75-80

Young MD & Delforce RJ (1986) Licensed kangaroo shooting in New South Wales: the people, the money they make and the animals they shoot. Australian Rangeland Journal 8: 36-45

Zuckerman S (1940) Experimental study of blast injuries to the lungs. Lancet 1940(ii): 219-24

What is possible to ensure that existing control methods are more humane?

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Summary

A paradigm that seeks to encourage best practice use of vertebrate pest control techniques must also actively promote their continuous improvement. This acknowledges that the community has diverse expectations of vertebrate pest control that may change with time and context; as will the general public acceptability of different techniques. There are many possibilities for improving the humaneness of existing techniques that also enhance their efficacy. In this paper I briefly give four examples of research that have led to tangible outcomes towards this end. (1) Fluoroacetic acid (1080) is an important lethal compound used for wild dog (Canis lupus) and fox (Vulpes vulpes) control. The welfare implications of its use in carnivores remain controversial and difficult to determine given its mode of action. The formulation of analgesic and anti-anxiety agents with 1080 is a viable approach for managing the 'possibility' that pain and distress is perceived. Studies have revealed two drug agents that do not compromise the efficacy of this toxicant. Baiting with a1080/analgesic combination is currently being implemented at two Victorian field sites. (2) Chloropicrin is a rabbit (Oryctolagus cuniculus) warren fumigant that causes intense irritation and distress to rabbits prior to death and is commonly regarded as an inhumane agent. Experimentation has shown that carbon monoxide (CO) fumigation is both humane and probably a much more effective alternative than other fumigants. Extensive research has produced a prototype CO fumigator that produces adequate quantities of CO in a cost-effective manner. (3) The humaneness of leg-hold traps has received much attention from animal welfare and anti-trapping lobby groups. Some modern traps produce much less physical trauma, but do not prevent damage caused by struggling and anxiety associated with prolonged capture. The Tranquilliser Trap Device (TTD) is used in the United States to dose trapped dogs with sedative and anti-anxiety drugs. The TTD appears to be a viable means to dose trapped dingoes and dingo hybrids upon capture with drug agents or rapid acting and humane toxicants. Use of the TTD has the potential to significantly increase the humaneness of trapping. (4) In south-eastern Australia some 35 native mammals have the potential to be exposed to chemical agents used in surface placed meat-based predator baits. Whilst exposure to bait agents does not always imply negative welfare impacts, increasing the target-specificity of control ensures that any known or possible impacts are minimised. By exploiting different methods that promote selective uptake by exotic predators, off-target impacts can be greatly minimised. The use of mechanical ejectors for fox control and selective presentations of toxicants for feral cat baiting are discussed.

There is sometimes little economic incentive for private industry to invest in the commercialisation of vertebrate pest control techniques. If better welfare outcomes are not seen to add value to current practices, there is little motivation for their adoption. In order to ensure that these and other improved vertebrate pest control techniques are adopted in the field, an implementation strategy that addresses this potential barrier should be considered.

Introduction

Since the settlement of Australia by Europeans, 99 exotic vertebrate species have become established in terrestrial habitats and inland waterways (Marks 1999). The combined populations of exotic pests such as the rabbit (Oryctolagus cuniculus), red fox (Vulpes vulpes) and house mouse (Mus domesticus) probably exceeds many tens or even hundreds of millions at certain times. This emphasises the magnitude of the known or suspected ecological and economic impacts of these pests (see summaries in Williams et al. 1995; Saunders et al. 1995; Caughley et al. 1998). Moreover, it gives some perspective to the scope of animal welfare issues inherent in the management of vertebrate pests in Australia. The legitimacy and importance of vertebrate pest control in many situations is unquestionable. However, when control activities potentially target millions of animals in a manner that may compromises their welfare, it is appropriate that welfare assessments are made (Mason and Littin 2003) and that we attempt to develop the most humane control techniques possible (Marks 1999).

In Australia much of the past and current focus in vertebrate pest research seeks to refine, apply and monitor the efficacy of existing control techniques (eg shooting, trapping, fumigation and baiting). A common paradigm promotes best practice use of available techniques and seeks to ensure their most appropriate and effective use for addressing problems caused by vertebrate pests (Braysher 1993). This paradigm does not actively include consideration of animal welfare impacts, but Mason and Littin (2003) use welfare assessments as a primary consideration to define best practice in rodent control. This reinforces that what is considered to be best practice will be contingent upon such factors as context, expectations, priority and circumstances (Walton et al. 2001).

Historically the development of destructive control of vertebrate pests has usually focused primarily upon their lethality to the pest and cost-effectiveness. Until comparatively recently, the humaneness of control techniques used for vertebrate pests has received little attention in Australia. Increasingly it is accepted that no technique used to kill or manage pest species should cause unnecessary suffering (Scott 1976; Ross 1986; Fisher and Marks 1996; Marks 1999; Littin et al. in press). However, there has been relatively little scientific attention given to the development of control techniques that improve welfare outcomes for both target and non-target animals. A rough insight into the focus of vertebrate pest research and policy in Australia can be given by examining categories of presentations made at five Australasian Vertebrate Pest Conferences held from 1987 – 2001. Of 439 reviewed papers and presentations relevant to Australia and New Zealand, only 2% (n = 9) were authored with the intent to specifically address animal welfare issues, or included this as their major theme. Three papers were authored by either representatives of animal welfare or environmental lobby organisations, hence only 1.4% (n = 6) related to operational vertebrate pest control. Of these, two concerned welfare issues associated with brushtail possum (Trichosurus vulpecula) control in New Zealand (Figure 1).

In this paper I wish to briefly discuss four approaches taken by the Victorian Institute of Animal Science to augment the humaneness of existing vertebrate pest control techniques. I conclude by discussing some needs to ensure field adoption of these and other approaches. Finally I make some suggestions concerning the potential role of scientists in the development of more humane vertebrate pest control technologies.

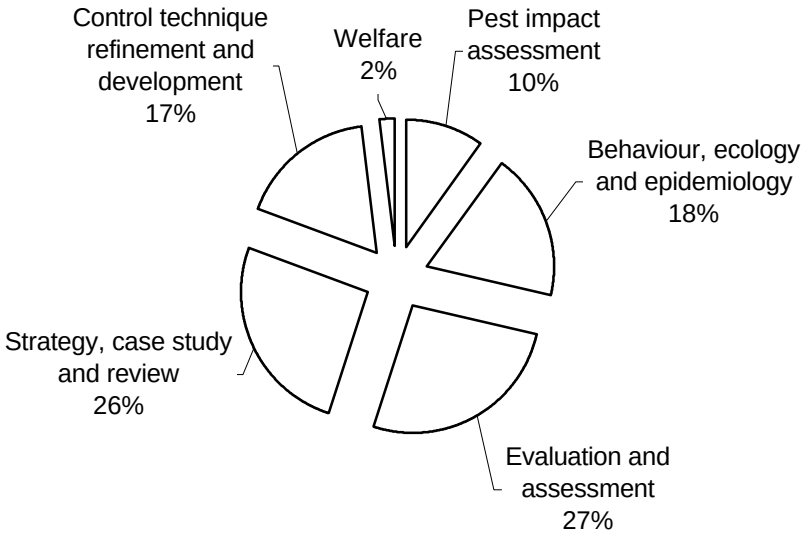

Figure 1 Categorisation of all papers and presentations concerning Australia and New Zealand (n = 439) published in the Australasian Vertebrate Pest Control Conference proceedings from 1987–2001 (Australian [Australasian] Vertebrate Pest Control Conference 1987, 1990, 1995, 1998, 2001). NB Categorisation was based on an attempt to identify the major theme of the presentations, although multiple themes were evident in some. Welfare papers (n = 9), comprise of those presented by animal welfare and environmental lobby organisations (n = 3), Australian (n = 4) and New Zealand researchers (n = 2).

1 1080 baiting of foxes and dogs

Welfare issue and context

There is general recognition that 1080 baiting for fox and wild dog control is presently a necessary wildlife management tool in Australia (McIlroy 1996) and there are no currently available alternatives. However the symptoms of 1080 poisoning in dogs can be extremely distressing to an observer, and behaviours such as manic running, yelping and shrieking, and convulsing are readily interpreted as being indicative of pain and distress (Nichols et al. 1949; Gregory 1996; Saunders et al. 1995; Marks et al. 2000). Importantly it has been demonstrated that convulsions will still occur in anaesthetised dogs that have been dosed with 1080 (Chenoweth and Gilman 1946), when the animal is apparently unconscious and insensible to pain. Gregory (1996) noted the similarities between 1080 poisoning, epilepsy and convulsions, mental disorientation and unconsciousness caused by hyperinsulinism, which is also not associated with pain in humans. He suggested that there were enough similarities between both diseases and 1080 poisoning to conclude that the latter was not inhumane, as pain was unlikely to be experienced because convulsions were probably not associated with consciousness. In herbivores, such as the European rabbit, its action does not appear to produce significant amounts of distress prior to unconsciousness after sudden cardiac fibrillation (Williams 1996). But given that the initial symptoms of running and retching occur during 1080 toxicosis in the fox when there is probably little or no central nervous system (CNS) disturbance, it is therefore possible that suffering could occur at this stage (Marks et al. 2000). The humaneness of 1080 remains controversial in respect of its use to control carnivores (Gregory 1996; Oogjes 1996; Marks et al. 2000). While there is so far an inability to determine if foxes and wild dogs are

suffering during the most dramatic symptoms, there is a likelihood that in the initial onset of symptoms animal is conscious and capable of suffering.

Promoting better welfare outcomes

The use of analgesic, sedative or anxiety reducing agents combined with 1080 was proposed as a means to limit any potential suffering that may be associated with 1080 poisoning (Marks 1996; Oogjes 1996). This approach was suggested in recognition of the difficulties involved in assessing pain or distress states in foxes poisoned with 1080, and a belief that such studies may ultimately be inconclusive. Its application has also been proposed for other pest species killed by poison baits (Mason and Littin 2003). A range of drugs were investigated as potential candidates for inclusion within predator baits. These agents were screened against a number of criteria and were deemed most suitable if they were known to be potent and effective in canids and did not provide a hazard to non-target species (Marks et al. 2000). Testing of five agents assessed their contribution to affecting symptoms associated with 1080 poisoning, influence on the toxicity of 1080, palatability and practicability as a bait formulation. Two drug agents were adopted; a potent analgesic and an anxiety reducing agent (anxiolytic). Both do not affect the palatability and acceptability of baits and doses of 1080 required for lethal affect (Marks et al. unpublished). Evidence for the efficacy of the analgesic in foxes has been accrued in laboratory trials (Jongman 2001). The analgesic agent has been formulated with 1080 and is currently being utilised in two Victorian field sites, where its use has been promoted.

2 Rabbit warren fumigation

Welfare issue and context

Chloropicrin (trichloronitromethane) was widely used during World War I as a chemical warfare agent that became known as 'tear gas' (Timm 1983). It has been adopted as a rabbit warren fumigant in Australia for many decades. It is best known for its property as a strong sensory irritant that causes profuse lacrimation and intense irritation of the respiratory tract (Chapman and Johnson 1925; TeSlaa et al. 1986). Ross (1986) rejected the use of chloropicrin in the United Kingdom as a rabbit fumigant on the basis that animals are likely to suffer severe irritation for considerable periods before death. Death result from pulmonary oedema, bronchopneumonia or destruction of lung tissues (Clayton and Clayton 1981). Gleeson and Maguire (1957) showed that rabbits that had been exposed to sub-lethal acute doses of gas died some weeks after initial exposure. Chloropicrin is not considered to be a humane fumigant (Saunders et al. 1995; Williams et al. 1995). Recent trials at the Victorian Institute of Animal Science have confirmed that some rabbits within a warren may take over one hour to die subsequent to chloropicrin exposure from a power fumigator using standard field protocols (F. Gigliotti et al. unpublished).

Promoting better welfare outcomes

Carbon monoxide (CO) inhalation causes rapid death by combining with red blood cell haemoglobin to produce carboxyhaemoglobin, which cannot carry oxygen. Atmospheric concentrations of CO greater than 2% will cause rapid death without pain or appreciable discomfort in most mammals. No odour is detectable below atmospheric concentrations of 80% CO (Carding 1977) and it is highly unlikely that the gas will cause any sensory irritation to animals even at this level. Upon exposure, mammals rapidly loose consciousness and the failure of the respiratory centre follows, with death resulting from cardiac arrest (Green 1982). Carbon monoxide is an ideal replacement gas for rabbit warren fumigation. Field experimentation contrasted CO with chloropicrin and phosphine gas for

efficacy and humaneness. Our studies concluded that at warren concentrations of approximately 3%, CO produced a much shorter time to death (approximately 30 minutes), without overt signs of distress (F. Gigliotti, unpublished data). Carbon monoxide was also extremely reliable in causing a humane death, and this contrasted to the erratic nature of phosphine fumigation using aluminium phosphide tablets that failed to cause death in approximately 20% of treatments.

Modern vehicle exhaust does not produce sufficient quantities of CO and older engines produce sulphur and nitrogen oxides that cause severe irritation before death. Previously, a CO fumigation technique was developed and commercialised for fox den fumigation based upon a pyrotechnic cartridge (Den-CO-Fume: Animal Control Technologies: Melbourne) (Hart et al. 1996). Cost-effective use of CO for rabbit warren fumigation requires much larger quantities of CO to be cheaply and rapidly produced in a portable device. We reviewed over 100 different methods of producing CO and tested three laboratory and field prototypes. The most effective prototype uses a fan blown mechanism with CO produced by a secondary combustion chamber burning readily available LPG gas in a low oxygen environment. The technique produces relatively pure CO and carbon dioxide without contaminants that can cause irritation. This prototype also produces sufficient volume to enable the treatment of a large warren system in a matter of a few minutes. Currently a prototype adapted for field use is undergoing assessment to test its performance. It appears likely that a humane CO fumigation technique will have at least equivalent efficacy to chloropicrin and better reliability than phosphine fumigation.

3 Leg-hold traps

Welfare issue and context

Steel-jawed leg-hold traps were once used almost universally in Australia for dingo control, however these traps have the potential to inflict severe limb injury (Fleming et al. 1998). The humaneness of leg-hold traps has received much attention from animal welfare and anti-trapping lobby groups world-wide (Gentile 1987). Padding of the steel-jaws and the use of alternative devices like the Victor Soft-Catch® trap have been shown to reduce trap related injuries sustained by captured animals (Meek et al. 1995; Fleming et al. 1998). However, padded traps do not prevent tooth damage, exertional debilitation and anxiety (Rowan 1988) associated with prolonged capture and this remains an animal welfare issue.

Promoting better welfare outcomes

Tranquilliser trap (or tag) devices (TTDs) were first produced by attaching rolled cloth containing tranquillisers to the jaws of traps (Balser 1965). Modern TTDs consist of a moulded rubber tube, capped at one end and affixed to the trap jaw by metal clips. After capture, canids bite at the tags and ingest a proportion of the drug. Drugs that reduce anxiety may mitigate distress associated with capture. We have shown that the TTDs can effectively deliver a sedative and anxiolytic drug to dingoes captured by padded leghold traps and that this reduces struggling behaviour after the first hour of capture (Marks et al. submitted a). It may be possible to use the TTD to deliver a rapid acting and humane toxicant to wild dogs so that the animal can be euthanased within minutes of capture. This may result in better welfare outcomes overall, as a period of distress prior to drug onset can be avoided and the capacity for the animal to suffer is further reduced. We are currently investigating the possibility of using new toxicant agents that can achieve this without presenting an environmental or human safety hazard.

4 Off-target impacts of predator baiting

Welfare issue and context

In south-eastern (SE) Australia there are a range of native terrestrial mammals that have either a carnivorous, insectivorous or omnivorous diet (Strahan 1991). Some of these mammals have been recorded to ingest meat based fox (Vulpes vulpes) or wild dog (Canis lupus) baits or have been found to consume meat whilst in captivity. Marks (2001a) proposed that 34 terrestrial mammals in SE Australia may be potentially bait consuming species. Such mammals should be considered to be at risk from exposure to meat bait toxicants, although the hazard and conservation impact of exposure cannot always be predicted. The actual incidence of bait consumption by many small non-target species in the field, the resulting hazard and its ecological significance is unclear for many species (Fairbridge 2000; Fairbridge et al. 2000; Fairbridge et al. in press).

Promoting better welfare outcomes

Reducing the opportunity of non-target species exposure to toxicants is a pragmatic strategy to reduce the risk or potential risk that exposure constitutes. Measuring hazard after exposure is difficult and often inconclusive, or variable in a range of conditions. Highly target-specific control technologies that eliminate toxicant exposure, especially to small mammals are required. We sought to identify specific physiological attributes of exotic carnivores (foxes and feral cats) that were different in native species. We wished to exploit such differences as a basis for the development of highly targeted control technologies (Marks 2001b).

The first approach exploits the highly specialised dentition of exotic carnivores, that possess specialised carnassial teeth and not grinding molar teeth (Ewer 1973, Popowics 1998). In these species it reflects a predominant, and sometimes exclusive, meat diet (Colbert and Morales 1991). The vast majority of native species that may consume meat baits possess grinding molars. This feeding strategy results in a carnivore feeding strategy where larger portions of food are swallowed without significant grinding. Therefore, we investigated if feral cats would readily ingest larger inert particles contained in baits, compared to most smaller non-target mammals. It was proposed that large particles within baits could be a practical technique for selectively delivering lethal agents to feral cats. Our research found that spherical coated toxicant pellets 4.7 mm in diameter were readily accepted by feral cats if presented in the correct bait medium. The same pellets were rejected by a wide range of non-target species. This approach was further applied in the field and compared with conventional baiting systems, using a non-lethal dye compound in place of a toxicant to examine the difference in exposure in non-target mammals. Field trials confirmed that the presentation of dye in a coated pellet, greatly reduced exposure of native rodents to the dye, whilst normal baits exposed a large proportion of the population (Marks et al. submitted b).

Another highly target-specific technique is the M-44 ejector. This device contains the toxicant within a sealed plastic capsule and uses a non-poisonous bait lure to attract the fox. When triggered the ejectors propel the toxicant into the mouth of the animal. Ejectors are activated by an adjustable upward pulling force of between 1.6 – 2.7 kg (Connolly and Simmons 1984) and most small non-target species are unable to apply enough force to trigger it, whist the fox easily can. The difference in maximum pull force that some non-target species can produce, compared to the red fox, was found to be a useful basis to promote selective toxicant delivery (Marks et al. 1999; Marks 2001). This was tested in trials that measured the forces that various mammal species could apply to the ejector. Of 31 mammals assessed, that were believed to be capable of consuming conventional fox baits, at least 26 were not found to be capable of triggering the device (Marks and

Wilson, submitted). The M-44 ejector was tested extensively in approximately 10, 000 device nights at five bushland sites in the eastern highlands of Victoria for a two year period. It appeared to be a highly effective fox control method and was not implicated in the death of a single non-target species (Marks et al. in press).

These two approaches represent just two examples of many potential techniques that can be used to significantly reduce the exposure of non-target species to bait toxicants. Both have been field tested with excellent results, but given that vertebrate pest control must be undertaken in a range of diverse habitats, it is not realistic to believe that any one technique can be adopted in all circumstances. Realistically, we require a range of approaches for a diversity of situations. For instance, techniques such as the M-44 ejector are ideal for discrete sites that require highly target-specific and intensive control, yet they are not practical for programs that need to control foxes over many 100s or 1000s of km^2.

Discussion and conclusions

All of the four briefly reviewed approaches are well advanced and have been field tested to varying degrees with encouraging results. Unfortunately, even the best research outcomes do not guarantee ultimate field adoption. Before changes are made to established techniques, or new ones adopted, an array of non-research tasks must be undertaken such as; regulatory approvals, legislative support, commercial production etc. Applied research can often provide proof of concept and test the validity of an approach, yet this alone does not ensure that these other tasks will be undertaken. Realistically, there must be an economic incentive for private industry to invest in the commercialisation of new vertebrate pest control technologies. Unless more humane techniques are more efficacious, or have an increased value over existing techniques, it is unrealistic to expect that private industry will commercialise and make new techniques available. Where market failure exists, this is essential to recognise as a barrier to the adoption of alternative strategies. However, market failure should not be used as an excuse to justify a lack of commitment to improvement. Instead, an adoption strategy for more humane techniques should investigate strategies to overcome these barriers.

The adoption of best practice use of available technologies is a sensible management strategy, yet it must be undertaken with a parallel driver that ensures the continuous improvement of these techniques. What has been best practice in the past will not necessarily remain so in the future. In the absence of a tangible strategy to foster and adopt improvements, control techniques will inevitably fall behind community expectations. There are many precedents world-wide that demonstrate that community demands for better welfare outcomes in vertebrate pest control will continue to gather pace. It is unrealistic to assume that the use of any one vertebrate pest control technology can be quarantined from increasing scrutiny; however legitimate the motivations and goals that determine its current use. Importantly, a concern for the welfare of pests and non-target species should not be confused with an attack upon the need for vertebrate pest control.

The fundamental role of science and scientists in the development of better welfare outcomes in vertebrate pest control needs to be carefully considered, especially since animal welfare has not been a traditional province of vertebrate pest research in Australia. Some wildlife scientists may still regard a focus upon improving humaneness as irreconcilable with efforts to address problems caused by vertebrate pests; sometimes welfare concerns are regarded as the antithesis of conservation objectives. Often this promotes an unproductive polarisation of the issue as 'welfare' versus 'conservation'. This is seldom justifiable and frequently makes the unfounded assumption of mutual exclusivity; that one concern must always be traded for the other. An alternative approach is to

accept that members and groups in the community will have different expectations and needs of vertebrate pest control. Combined, these expectations may be demanding and require scientists to produce techniques that are efficacious, cost-effective, safe, target-specific and humane. Scientist should accept the challenge of providing innovative approaches and solutions that accommodate this diversity of needs.

All incremental steps towards better pest control strategies and techniques enhance our ethical credibility and help us to meet legislative obligations and community expectations (Mellor and Stafford 2001; Littin et al. in review). We may never achieve all that we might wish to and fully accommodate all community expectations, yet we have an ethical obligation to try. This is a major scientific challenge where the need for an ongoing commitment should not be underrated. But, as it has been eloquently suggested in the past, perhaps the difficulty of the task is motivation enough: 'We do these things, not because they are easy, but because they are hard' (JF Kennedy, 1961)

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References

Australian Vertebrate Pest Control Conference (1987) Proceedings of the 8th Australian Vertebrate Pest Control Conference. Queensland Rural Lands Protection Board, Coolangatta

Australian Vertebrate Pest Control Conference (1990) Proceedings of the 9th Australian Vertebrate Pest Control Conference. Animal and Plant Control Commission South Australia, Adelaide.

Australian Vertebrate Pest Control Conference (1995) Proceedings of the 10th Australian Vertebrate Pest Control Conference. Department of Primary Industries and Fisheries, Hobart

Australian Vertebrate Pest Control Conference (1998) Proceedings of the 11th Australian Vertebrate Pest Control Conference. Agriculture Western Australia, Bunbury

Australasian Vertebrate Pest Control Conference (2001) Proceedings of the 12th Australasian Vertebrate Pest Control Conference. Natural Resources and Environment, Melbourne

Balser DS (1965) Tranquilizer tabs for capturing wild carnivores. Journal of Wildlife Management 29:438-442

Braysher M (1993) Managing vertebrate pests: principles and strategies. Australian Government Publishing Service, Canberra.

Carding T (1977) Euthanasia of dogs and cats: an analysis of experience and current knowledge with recommendations for research. Animal Regulation Studies 1:5-21

Caughley J, Bomford M, Parker B, Sinclair R, Griffiths J (1988) Managing vertebrate pests: rodents. Bureau of Rural Sciences, Canberra.

Chapman RN, Johnson AH (1925) Possibilities and limitations of chloropicrin as a fumigant for cereal products. Journal of Agricultural Research 31:745-760

Chenoweth MB, Gilman A (1946) Studies on the Pharmacology of Fluoroacetate. I. Species Response to Fluoroacetate. Journal of Pharmacology and Experimental Therapeutics 87:90-103

Clayton GD, Clayton FE (1981) Patty's industrial hygiene and toxicology, 3rd Ed. Vol 2. Wiley, New York.

Colbert EH, Morales M (1991) Evolution of the vertebrates. Wiley-Liss, Brisbane.

Connolly G, Simmons GC (1984) Performance of sodium cyanide ejectors. In: Clarke DO (Ed) Proceedings of the 11th Vertebrate Pest Control Conference., University of California, Davis, USA.

Ewer RF (1973) The Carnivores. Cornell University Press, Ithica.

Fairbridge D (2000) Keeping fox control on target. Trees and Natural Resources 42:14-16

Fairbridge D, Fisher P, Busana F, Pontin K, Edwards A, Johnston M, Shaw M (2000) Observations of the behaviour of free living bush rat, Rattus fuscipes and southern brown bandicoot, Isoodon obesulus at buried bait stations. Australian Mammalogy 22:125-127

Fairbridge D, Anderson R, Wilkes T, Pell G (in press) Bait uptake by free living brush-tailed phascogales (Phascogale tapoatafa) and other non-target mammals during simulated buried fox baiting. Australian Mammalogy

Fisher PM & Marks CA (Eds) (1996) Humaneness and Vertebrate Pest Control. Ropet Printing, Tynong North.

Fleming PJS, Allen LR, Berghout MJ, Meek PD, Pavlov PM, Stevens P, Strong K, Thompson JA, Thomson PC (1998) The performance of wild-canid traps in Australia: efficiency, selectivity and trap-related injuries. Wildlife Research 25:327-338

Gentile JR (1987) The evolution of anti-trapping sentiment in the United States: A review and commentary. Wildlife Society Bulletin 15:490-503

Gleeson JP, Maguire FS (1957) A toxicity study of rabbit fumigants. CSIRO Wildlife Research 2

Green CJ (1982) Animal anaesthesia in Laboratory animals handbook 8. Laboratory Animals Ltd, London.

Gregory G (1996) Perception of pain associated with 1080 poisoning. In: Fisher PM & Marks CA (Eds) Humaneness and Vertebrate Pest Control. Ropet Printing: Tynong North pp 62-6

Hart S, Marks CA, Staples L (1996) DEN-CO-FUME - Humane control of foxes (Vulpes vulpes) in natal dens. In: Fisher PM & Marks CA (Eds) Humaneness and Vertebrate Pest Control. Ropet Printing, Tynong North pp 58-61

Jongman EC (2001) The efficacy of two analgesic as potential fox bait additives. Proceedings of the 12th Australian Vertebrate Pest Conference, Melbourne, Victoria, pp 322-325

Littin KE, Mellor DJ, Waberton B, Eason CT (in review) Animal welfare and ethical issues relevant to the humane control of vertebrate pests. New Zealand Journal of Veterinary Science

Marks CA (1996) Research directions for humane burrow fumigation and 1080 predator baiting. In: Fisher PM & Marks CA (Eds) Humaneness and vertebrate pest control. Ropet Printing, Tynong North pp 50-57

Marks CA, Busana F, Gigliotti F (1999) Assessment of the M-44 ejector for the delivery of 1080 for red fox (Vulpes vulpes) control. Wildlife Research 29:209-215

Marks CA (1999) Ethical issues in vertebrate pest management: can we balance the welfare of individuals and ecosystems? In: Mellor D & Monamy V (Eds) The Use of Wildlife for Research. ANZCCART, Glen Osmond

Marks CA, Hackman C, Busana F, Gigliotti F (2000) Assuring that 1080 toxicosis in the red fox (Vulpes vulpes) is humane: fluoroacetic acid (1080) and drug combinations. Wildlife Research 27:483-494

Marks CA (2001a) Bait-delivered cabergoline for the reproductive control of the red fox (Vulpes vulpes): estimating mammalian non-target risk in south-eastern Australia. Reproduction, Fertility and Development 13:1-12

Marks CA (2001b) The Achilles heel principle. 12th Australasian Vertebrate Pest Conference. Department of Natural Resources and Environment, Melbourne, pp 330-35

Marks CA, Gigliotti F, Busana F (in press) Field performance of the M-44 ejector for red fox (Vulpes vulpes) control in eastern Victoria. Wildlife Research

Marks CA, Wilson R (submitted) Predicting mammalian target-specificity of the M-44 ejector in south-eastern Australia. Journal of Wildlife Management

Marks CA, Allen L, Gigliotti F, Busana F, Gonzalas T, Lindeman MJ, Fisher PM (submitted a) Evaluation of tranquilliser trap devices used during dingo trapping. Journal of Wildlife Management

Marks CA, Johnston MJ, Fisher PM, Pontin K, Shaw MJ (submitted b) Differential particle size ingestion: promoting target-specific baiting of feral cats. Journal of Wildlife Management

Mason G, Littin KE (2003) The humaneness of rodent pest control. Animal Welfare 12:1-37

McIlroy JC (1996) Rationale for the use of 1080 to control vertebrate pests. In: Fisher PM & Marks CA (Eds) Humaneness and vertebrate pest control. Ropet Printing, Tynong North pp 27-33

Meek P, Jenkins DJ, Morris B, Ardler AJ, Hawksby RJ (1995) Use of two humane leg-holding traps for catching pest species. Wildlife Research 22:733-793

Mellor DJ, Stafford KJ (2001) Integrating practical, regulatory and ethical strategies for enhancing farm animal welfare. Australian Veterinary Journal 79:762-769

Nichols HC, Thomas EF, Bawner WR, Y. LR (1949) Report of poisoning two dogs with 1080 rat poison (sodium fluoacetate). Journal of the American Veterinary Medical Association 15:355-356

Oogjes G (1996) The ANZFAS view of vertebrate pest control using chloropicrin fumigation and 1080 poisoning. In: Fisher PM & Marks CA (Eds) Humaneness and Vertebrate Pest Control. Ropet Printing, Tynong North pp 9-12

Popowics TE (1998) Ontogeny of postcanine tooth form in the ferret, Mustela putorius (Carnivora: Mammalia), and evolution of dental diversity within the mustelidae. Journal of Morphology 237:60-90

Ross J (1986) Comparisons of fumigant gases used for rabbit control in Great Britain. In: Salmon TP (Ed) Proceedings of the 12th Vertebrate Pest Conference. University of California, Davis

Rowan AN (1988) Animal anxiety and suffering. Applied Animal Behaviour Science 20:135-142

Saunders G, Coman BJ, Kinnear J, Braysher M (1995) Managing Vertebrate Pests: Foxes. Australian Government Publishing Service: Canberra, Canberra.

Scott WN (1976) The use of poisons in animal destruction: Humane destruction of unwanted animals. Universities Federation of Animal Welfare, Hertfordshire.

Strahan R (1991) Complete book of Australian mammals. Angus and Robertson, Sydney.

TeSlaa G, Kaiser M, Biederman L, Stowe CM (1986) Chloropicrin toxicity involving animal and human exposure. Veterinary and Human Toxicology 26

Timm RM (1983) Prevention and Control of Wildlife Damage. Great Plains Agricultural Council, Denver.

Walton C, McGraw C, Mackey P (2001) Problem + research does not equal solution 12th Australasian Vertebrate Pest Conference. Natural Resources and Environment, Melbourne

Williams K, Parer I, Coman B, Burley J, Braysher M (1995) Managing vertebrate pests: rabbits. Government Publishing Service, Canberra.

Williams D (1996) Animal welfare aspects of the use of sodium fluoroacetate to poison wild rabbits. In: Fisher PM & Marks CA (Eds) Humaneness and vertebrate pest control. Ropet Printing, Tynong North.

Long-term solutions: is there a holy grail?

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Summary

The Pest Animal Control Cooperative Research Centre was established in 1991, as the Vertebrate Biocontrol CRC, to test the hypothesis that immunocontraception could be used to control rabbits and foxes. In 1995, the house mouse was added to the CRC's activities and in 1999 the Federal Government renewed the CRC. In its current form, CRC participants include CSIRO Sustainable Ecosystems, the Australian National University, the Universities of Sydney, Adelaide and Western Australia, the Agricultural Protection Board of WA and the Department of Conservation and Land Management in WA.

In the eleven years since its inception, the CRC has made considerable progress towards development of anti-fertility vaccines for pest animal control. The search for an antigen that elicits an immune response has pointed to proteins associated with the coating of the oocyte (zona pellucida) for each of the three species studied. A viral delivery system looks promising for each of the three species: myxoma virus in the rabbit, murine cytomegalovirus (MCMV) in the mouse and the canine herpesvirus (via a bait) in the fox.

In laboratory-based studies, inoculation of wild and lab type mice with recombinant MCMV expressing mouse zona pellucida 3 induces consistent and long term infertility (>250 days). Results in the rabbit are extremely encouraging but we are yet to test the system in foxes. A regulatory package is under development for presentation of the mouse product to the Office of the Gene Technology Regulator. It is expected that regulatory approval for a field trial in mice will take up to a year. If approved, field trials of a mouse anti-fertility vaccines product could commence late in 2003 or early 2004.

The use of biotechnology for pest animal control was a highly ambitious proposal when put forward. Steady progress has been made to the point where it appears clear that a virally vectored anti-fertility vaccine is technically possible. Nevertheless widespread community discussion and debate will be required to determine whether a genetically altered virus is publicly acceptable and can ultimately be used for pest animal control.

The Pest Animal Control CRC has begun further efforts to develop novel methods of pest animal control, and has widened the number of species under study. A major new program funded by the Murray-Darling Basin Commission will test biotechnology solutions for control of carp. In addition, and through its spin off company Pestat Ltd, the CRC has received support from Australian Wool Innovation Limited to undertake shorter-term work on the wild dog and fox. Pestat Ltd is also involved in investigations of fertility control for the stoat, a significant pest in New Zealand.

It appears that given enough time and resources, fertility control of at least some pest species can be achieved. It is important that public discussion be held about the work, so that the community is aware that (1) fertility control is not a panacea that offers perfect welfare solutions – the technique is likely to be delivered by viruses that cause infection and in some cases, disease; and (2) the

technique involves use of genetically modified organisms and therefore is a controversial solution to some members of the community.

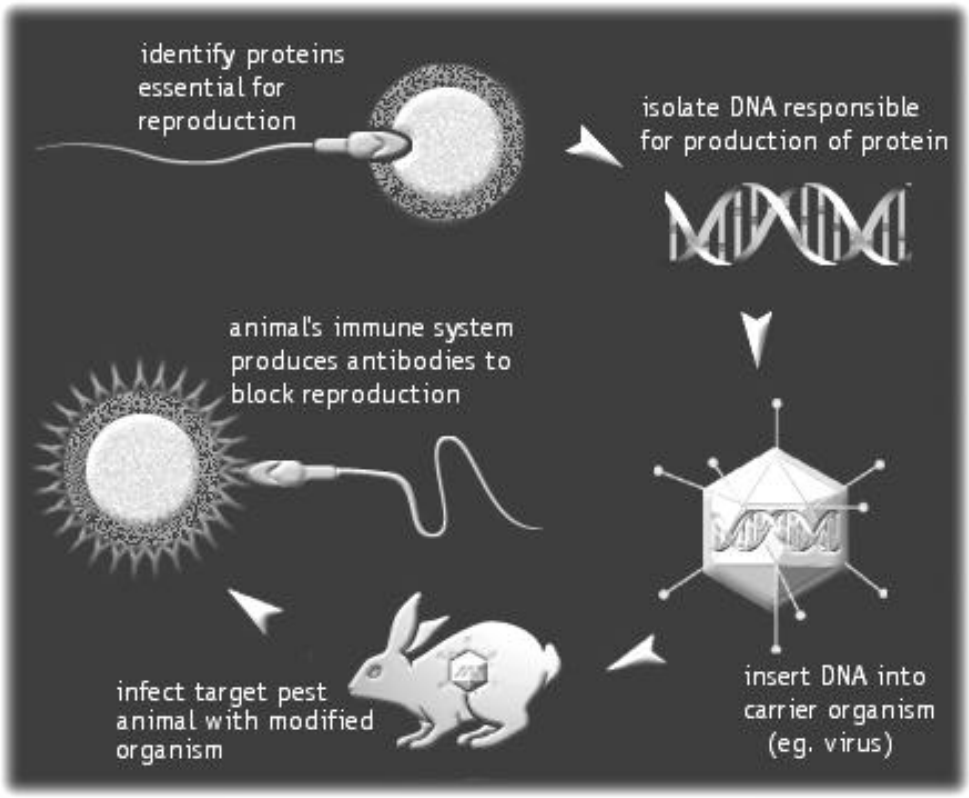

Figure 1 The concept of anti-fertility vaccines, currently under development by the Pest Animal Control Cooperative Research Centre

Biological control

Australia is the only country on earth to have successfully employed widespread biological control against a vertebrate pest. In the 1950s myxoma virus was employed to achieve an incredible reduction in the 'grey blanket' of rabbits that had grown to devastating numbers in the post-war period.

Rabbit calivirus, now referred to as Rabbit Haemorrhagic Disease Virus (RHDV), appeared in China in 1984 and Europe in 1986. Australian study of the virus as a possible biological control agent began in 1989 and it was imported into Australia in 1991. RHDV escaped from Wardang Island to the Australian mainland in 1995. In 1996 controlled releases began and continue today.

RHDV has reduced rabbit populations to around 15% of their former levels in many parts of Australia. A reduction of such magnitude has enabled a significant regeneration of vegetation; noted as one of the major environmental gains of the past five years in the 2001 'State of the Environment' report.

A number of Australians question the welfare aspects of biological control. For example, to effectively transmit from one animal to another, the myxoma virus needs to be at high levels in skin lesions for a period of time. There is no doubt that rabbits suffer during this period of infection. For some people, the suffering experienced by rabbits outweighs the benefits of their control. People will generally form a view based on a range of considerations that may include:

- the damage caused by rabbits;
- alternative methods of control;
- the commercial or recreational value of rabbits;
- an individual's cultural background; and
- an individual's perception of humaneness.

While sections of the community may differ on the relative merits of biological control for a vertebrate pest, there is no doubt of the economic benefit. A recent examination by Ryan (2003 pers comm) indicates massive national benefits from the use of RHDV in Australia (see Table 1).

Table 1 Net present value (NVP) and benefit:cost (B:C) ratios for RHDV research in Australia. 'With carbon' refers to the fact that extra stock replacing rabbits excrete more methane, reducing the net environmental benefit.

Discount rate	NPV $m	B:C
Without carbon		
0%	2,859	16
5%	2,266	15
10%	1,975	14
With carbon		
0%	4,065	5
5%	4,085	6
10%	4,404	8

Fertility control

During the 1980s a great deal of research was conducted, particularly by CSIRO in Australia, into the use of the immune system to manipulate production of livestock. The basis of the work was to stimulate an animal's immune system to produce antibodies that would affect traits that are useful for production. For example ImproVac™ was developed by CSL in Australia to immunocastrate pigs at a late stage of production. In that case, immunised pigs form antibodies to a brain hormone that drives the testes.

The concept of virally-vectored immunocontraception was a combination of the two scientific concepts of biological control by viruses and use of the immune system to block fertility. Championed by CSIRO scientist Dr. Hugh Tyndale-Biscoe, the concept was extremely bold. Controlled use of a virus to manipulate populations of a vertebrate had only succeeded once before (myxoma virus) and no product had yet been developed to manipulate reproduction utilising the immune system (ImproVac™, mentioned above, took some 12 further years of development before it entered the market, for example). The emergence of genetic engineering made the combination of the two concepts theoretically possible, but the uniqueness of the proposal should not be understated.

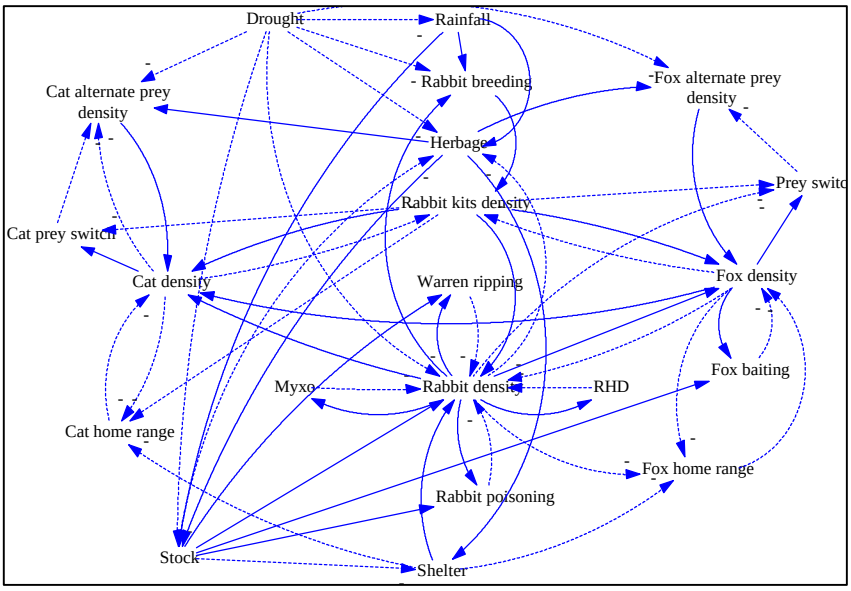

Figure 2 Fertility control must be considered in the context of ecological systems

The technical challenges

The ultimate aim of an anti-fertility vaccine for pest animals is to reduce the damage to our ecosystems caused by that particular species and its interactions with other species in the system. Knowledge must be gained from a whole range of sources and disciplines to be effective. For example, damage to the environment by rabbits is not simply a function of rabbit numbers. Rabbits form part of a complex system, as illustrated in Figure 2 above, many parts of which can influence or be influenced by rabbit numbers.

Figure 2 merely sets forth the ecological context of pest control, one of the many factors we need to consider in contemplating fertility control vaccines. The other challenges include:

- identification of a suitable infertility agent to insert into a delivery system;
- identification of a suitable delivery system;
- testing of the anti-fertility system;
- field testing;
- follow-up releases and integrated pest management.

Each step requires large investments and complex science. Stimulating the immune system sufficiently to block reproduction is no easy matter, for example. Vaccination is usually achieved by stimulating the immune system against foreign agents. A suitable anti-fertility agent must cause an immune response in an animal blocking reproduction in its own system.

Table 2 A summary of progress against some anti-fertility projects (PAC CRC and Marsupial CRC [possums])

Step	Mouse (Aust.)	Rabbit (Aust.)	Fox (Aust.)	Possum (NZ)	Stoat (NZ)
Identify a suitable infertility agent	✔	✔	-	✔	?
Identify a suitable delivery system	✔	✔ ?	✔	?	?
Combine infertility agent and delivery system	✔	✔ ?	-	-	-
Lab test the system	✔	-	-	-	-
Controlled field test	-	-	-	-	-
Field release	-	-	-	-	-

The social challenges

When anti-fertility vaccines were first proposed in the late 1980s, there was relatively little public debate or concern about genetically modified organisms (GMO's). Since that time, public concern has grown much more widespread to the extent that public opinion is now regarded as the most critical factor facing the Pest Animal Control CRC.

Since the late 1980s, Australia has seen a growing awareness and concern regarding GMO's. Debate has tended to focus on genetically modified foods, and more recently upon cloning and use of stem cells. The use of biotechnology for environmental purposes such as pest animal control has had relatively little attention in GMO debates.

Progress toward anti-fertility vaccines sparked Australian Biotechnology News to recently contact conservation groups regarding their attitude to GMO pest control. Genethics, possibly the best-known anti-GMO group, indicated they would not support disseminating GMO-viruses under any circumstances. All others contacted (Australian Conservation Foundation, Greenpeace and Friends of the Earth) either did not respond or had no specific policy as yet.

The largest selling popular science magazine in the world New Scientist noted in January 2003 that the international issues associated with disseminating pest animal control viral vaccines would be one of the '12 scientific events most likely to affect our lives'. Based on the premise that one person's pest is (possibly) another person's endangered species, New Scientist advocated that disseminating GMOs should not be developed further.

Our CRC refutes New Scientist's interpretation as too simplistic for a number of reasons including:

- Disseminating GMOs already exist. The objection to a disseminating GMO is really an argument against GMOs in general.
- Viruses have already been successfully employed against rabbits. There is no reason to believe that a genetically altered virus poses any differences in risk factors to those of a wild-type virus.
- The argument that viruses routinely spread between populations of animals on different continents is a furphy. If this were true, we'd see Foot and Mouth virus and other animal diseases consistently moving between countries. Quarantine and other barriers do generally work.
- We don't expect anti-fertility vaccines to eliminate populations. For example, the mouse herpes virus we are using is density dependent, meaning it will affect populations as they grow and become more concentrated.

In summary, we don't see GMO-viruses as fundamentally different to other viruses, and we believe virally-based techniques have proven exceptionally effective. We don't believe anti-fertility vaccines will inevitably escape Australian shores and the consequence, should it happen, would not result in extinctions. We therefore believe anti-fertility vaccines are a viable and promising approach to the Australian pest control situation.

Having made these points, it is also important to point out that:

- further experimental testing is necessary before final judgements can be made; and
- the role of the Pest Animal Control CRC is to provide potential solutions - the CRC is not the arbiter of whether these solutions are applied.

There is clearly a strong onus on the CRC to develop a dialogue with the Australian public, as well as those with land management responsibilities in Australia and internationally. At this point in 2003, it seems reasonable to summarise the situation as:

- anti-fertility viral vaccines appear technically feasible for population control of mice and rabbits in Australia;
- if applied they will not be a magic bullet but be a huge boost to integrated pest animal control;
- further experimentation, refinement and development is required, with a product for mice potentially available in 3 years;
- the community will ultimately determine whether the new technology is utilised.

Summing -up by the Chair

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I have the pleasant task of summing up what has been a very good symposium. I shall endeavour to distil some thoughts on the basis of some notes I made as the different papers were presented.

It seemed to me that the RSPCA Australia imperative is that killing is acceptable provided that it is humane and for a responsible or reasonable purpose. The landholders' imperative is that ongoing control is essential because without it there would be huge production and land management problems. The environmentalists' imperative is rather similar; that ongoing control is essential because without it environmental degradation would occur and biodiversity would be threatened.

The legal situation surprised me. We have the animal welfare imperative, we have the landholders' imperative and we have the environmentalist imperative, but it seems that whatever those perspectives are, you are legally obliged to control vertebrate pests in Australia. I am not aware that we are legally obliged to do that in New Zealand, but there is certainly a lot of effort put in to it. The National Regulatory Authority (NRA) of course is struggling with what might be called its historical role, having a primary obligation for human health, safety and wellbeing, with the capacity, as it were, to reach towards animal welfare, but no requirement to do so. The NRA seems to need some sort of support for animal welfare initiatives, both with the provision of scientific information, and also with providing the arguments that will motivate politicians to provide financial, regulatory and other support to expand the scope of the NRA remit to include animal welfare as part of best practice or quality control.

Peoples' attitudes are highly variable, as we know. If you take a cross-section of those in this room it would not be a cross-section of this country, but it would certainly cover a wide range of approaches and those here would probably be better informed than many people. Nevertheless, I think we recognize that we are participating in a shift of thinking, we are in a wave of increasing animal welfare concern at least in countries that can afford it. If you are facing devastation and poverty and you don't know where you will get your next meal or any meal for the next two weeks, animal welfare is not a major issue. We in industrialized countries can afford to focus on animal welfare and therefore, I would argue, we have an obligation to do so since we have both the opportunity and the wherewithal to do so. But it does raise the question of how long these paradigm shifts in public thinking take, and we heard about public attitudes and how they can be influenced. Regarding animal welfare initiatives, I operate on 10-year time scales. If you work hard, you can often see progress within three or four years. By five years you are beginning to see more and in 10 years you look back and are often surprised at the progress that has been made. This symposium is not the beginning of work needed to improve welfare awareness in the vertebrate pest arena, it is in fact one of many steps in a process that began some time ago, a process that is an ongoing part of what we need to do to give due consideration to the suffering vertebrate pests regularly experience at our hands. Re-examination of methods and approaches to control programmes is an imperative part of that process.

We heard about the diversity of opinions, approaches and interests on the Vertebrate Pests Committee. Managing constructive discourse between people with such wide interests is a real challenge. One way is to ensure that everyone in that situation knows that they are heard and that

their position and sincerity are respected. Relating to each person's integrity, showing respect and appreciation and really listening to others are all ways to encourage free dialogue. When you start talking about value judgments it really helps if you can find out the ethical positions other people start from, because that makes everything they say self-explanatory. If you can show that you really understand that, even if you disagree with them, then they will listen to you, even if they disagree with you. If you explain where you coming from ethically and start from a position of genuine mutual respect, you would be amazed how flexible people become.

We heard about a range of control methods, and also had one method of ranking methods explained. Ranking generated much interest and is clearly an important matter to consider.

Methodological developments. I think that the last two papers demonstrated our desire to improve methods in order to make them more humane. But at the same time, more humane methods must be practically useable, safe and cost-effective. It is clear that there is the very real possibility of improvement and, as we heard, there are examples where strategies can work and do work both by mitigating the noxious effects of some of the control methods and by providing alternative control methods that cause less suffering, including reproductive control and related methods.

I want to briefly consider the ongoing need to control vertebrate pests and the unease we feel when confronted by the undoubted suffering which numerous current control methods cause. Let me say that I think that uneasiness is a good thing.

Our objective is 'gold standard' methods: methods which are humane, practical, safe and cost-effective. The reality is that in many, perhaps most cases, we fall far short of the "gold standard". The uneasiness that creates is not something to turn away from and say, "Oh, it's too difficult, we can't do it". That uneasiness is something that should motivate us into thinking of the precise actions that we want to take in order to make progress. It should be a continuing impetus to us to rigorously and vigorously strive to do better: to seek workable solutions to finding humane pest control methods, to carry on the ranking so we can choose the most humane methods we currently have, to improve current methods, to develop new ones, to work with landholders and conservationists and others to understand their practical difficulties in implementing methods so that we end up at the end of the day with improvements. And it is an ethical position to say, "Yes, we are far from where we want to be, but that is where we are aiming, and we are really making every attempt in the full range of activities we can engage in to get there. And this includes seeking government support, regulatory support, policy change, financial support, central financial support, and other means, as well as methodological development, and ensuring that ethical perspectives are included in the training of our trainee biologists. Each successful step, however small, represents "incremental improvement" towards the 'gold standard' which is our ultimate objective.

My objective is to help our biological science trainees, graduates and others to feel comfortable about thinking through ethical issues so that such thinking becomes a natural part of the way they breathe their subject. When that occurs we won't need chairs of animal welfare science because animal welfare science, I hope and believe, will be a natural part of what people are thinking about and the way they are trained.

The written papers and the proceeding of this Symposium are going to be made available on the RSPCA Australia website soon, and there is going to be a follow-up workshop involving today's speakers at least, in Melbourne at the Animal Welfare Centre. Details will be made available in due course.

Finally, I thank you all for your attendance and for your contributions, I thank again tall of the speakers for an excellent seminar and thank the RSPCA, especially Bidda Jones, for organizing a most successful and worthwhile Symposium.