Australian Government

Bureau of Rural Sciences

Submission to House of Representatives (SCAFF) inquiry into the impact on agriculture of pest animals

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Foreword

The Bureau of Rural Sciences (BRS) is the scientific agency of the Commonwealth Department of Agriculture, Fisheries and Forestry (DAFF). It provides scientific assessments, tools and advice to rural and regional decision makers.

BRS has provided high-level national coordination and advice on exotic pest species since the early 1990s. BRS has considerable expertise in pest animal management that it is able to integrate with its social science, ecosystems, agriculture, biotechnology and spatial data management capacities to provide an integrated perspective on best practice management.

This submission focuses on the principles and technical aspects of pest control and identifies common principles that can be applied to any pest animal. Given current problems with locusts in some parts of Australia, the Product Integrity and Animal and Plant Health (PIAPH) area of DAFF have provided some information on invertebrate pests as part of this submission.

A copy of each of the 16 documents attached is provided; more copies can be made available to the Committee on request.

Dr Peter O'Brien
Executive Director
Bureau of Rural Sciences

Background

BRS provides science for rural and regional decision makers	The Bureau of Rural Sciences (BRS) is a scientific agency within the Commonwealth Department of Agriculture, Fisheries and Forestry (DAFF). It provides scientific assessments, tools and advice to rural and regional decision makers. BRS has provided high-level national coordination and advice of pest animal management issues since the early 1990s and has administered the National Feral Animal Control Program (NFACP) under the Natural Heritage Trust (NHT) since 1996. During this time it has produced national (endorsed through the National Vertebrate Pests Committee) guidelines for managing feral horses, rabbits, foxes, feral goats, feral pigs, rodents, carp and wild dogs. It has also supported a wide range of projects to demonstrate better approaches to managing pest animals.
Estimated agricultural losses caused by vertebrate pests at least $420 million per year	Conservative estimates of direct economic losses caused by vertebrate pest species are at least $420 million per year. In addition overgrazing and browsing by introduced herbivores contributes to land degradation, lowering the future productive capacity of the land. There is also clearly a large unvalued environmental cost. Control of non-indigenous vertebrate pests in Australia costs governments and landholders over $60 million each year. In addition to damage mitigation activities, around $20 million is spent annually on research to control vertebrate pests in Australia. The impacts of pest animals would clearly be much greater without this control and research expenditure; in particular, a relatively small amount of short-term research expenditure (e.g. into rabbit calicivirus disease) can yield very large ongoing benefits in terms of reduced pest impact.
There are common principles in responding to any invasive species	There are a number of common principles in responding to any invasive species and these can be applied to assessing the cost-benefit and feasibility of response, particularly once the quarantine barrier has been breached. Response is more cost-effective earlier in the invasion process. Prevention costs less than early eradication, which costs less than containment, which will usually cost much less than managing the ongoing impacts of an established pest into the future.
Based on history, introduction of new species is likely to be deliberate. **Robust, scientifically-based risk assessment is desirable**	Based on the history of current pests, introduction of new vertebrate pest species is likely to be through deliberate (legal or illegal) introduction rather than by accidental human-assisted dispersal. Hence it is highly desirable to have robust, scientifically-based risk assessment processes to distinguish species that pose a high threat from those that pose a low threat, and a sound process to ensure that species identified as posing a high threat are not allowed to enter Australia. Restricting trade or keeping of exotic vertebrate species that are already past quarantine barriers, but not yet established in the wild, is an area where threat and risk response are not fully developed nationally. These species usually have not had independent risk assessments on their

	potential for invasion if released.
Eradication is ideal but extremely difficult…six critical factors have been identified.	Eradication is an ideal response but is technically extremely difficult, if not impossible, for most invasive species. BRS has identified six criteria that need to be met before considering eradication as an option. There is potential for eradication in extraordinary circumstances of early detection or for isolated pest populations (e.g. on small islands). There is however usually a great cost and a very high risk of failure in attempting eradication.
Containment is rarely successful	Containment as a response to invasive species is usually a practically difficult and expensive option for managing vertebrate pests, and it is rarely successful in the long term.
Sustained control is a more complex strategy **Many people already accept some introduced species, despite the harm they cause.**	Damage mitigation through sustained control is a more complex but pragmatic strategy than eradication or containment and depends on a good understanding of the relationships between the pest species and its environment. There are likely to be significant changes in community and political attitudes to the presence, impact and management of non-indigenous animals in Australia over the next 20 years. Recent surveys in Australia have shown that many people (urban and rural) already accept some introduced species as a normal part of the landscape, despite the harm they cause. This will require increased justification for conducting pest control in the first place – i.e. defining the damage pests are causing in a particular area. There will also continue to be increased scrutiny on the target specificity, safety and humaneness of control techniques which will limit our ability to control pests in certain situations unless improved techniques can be developed.

Response to Terms of Reference

1. To identify nationally significant pest animal issues and consider how existing Australian and State government processes can be better linked for more coordinated management of these issues across State boundaries

PEST ANIMAL SPECIES ISSUES

A list of exotic animal species that have established in Australia is provided at Attachment A and a summary of the impacts of the most significant of these invasive species is provided at Attachment B. Detailed information on most of the species can be found in the BRS species management guidelines (Attachments F-M). Currently, the perceived and actual impacts of wild dogs and feral pigs on agricultural production have a particularly high profile.

Wild dogs

Because wild dogs can injure and kill many sheep and goats in a single night, they can have a dramatic economic and social impact on individual landholders. Where grazing is conducted on isolated properties surrounded by forested areas, wild dog impact is almost inevitable. Resultant landholder complaints have required neighbouring National Parks and State Forests in many areas (particularly Victoria and New South Wales) to devote a considerable proportion of their budgets to wild dogs control, often at the expense of other pest animal and weed management.

Wild dogs are intelligent and elusive and may cover large distances. Their impact is often unpredictable yet dramatic. Apart from the 'Dog Fence', the main control techniques are poison baiting and trapping. However, these techniques are not completely effective and pose non-target risks. They are also labour-intensive and therefore expensive.

Research supported by the BRS-administered National Feral Animal Control Program (NFACP) and the Pest Animal Control CRC (PAC CRC) may lead to significant improvements in the cost-effectiveness of wild dog control. BRS has supported research into M44 ejectors which could be set-up as 'sentinel' bait stations in key areas. The PAC CRC, with funding from Australian Wool Innovation, is currently investigating a canid-specific toxin that would theoretically allow aerial baiting of wild dogs in areas where it is currently not undertaken due to non-target risks.

BRS has also supported a project which was involved in the development of a 'nil tenure' approach to wild dog management (Attachment O) which recognises that mobile pest animals need to be managed on a local or regional rather than individual landholder basis. This approach provides a practical and effective model for coordinated management of all mobile pest animal species.

Feral pigs

Much of the current profile of feral pigs is due to industry perceptions about their potential role in a foot-and-mouth disease (FMD) outbreak, despite the fact that many experts believe that this risk has been overstated for a range of reasons outlined at Attachment C. These concerns have even led to calls for national eradication of the

feral pig population which is not considered feasible and the attempt would be extremely costly (Attachment C).

Regardless of the FMD situation, feral pigs may be involved in other emergency animal disease outbreaks and also have ongoing agricultural and environmental (listed as a 'Key Threatening Process' under the *Environmental Protection and Biodiversity Conservation Act 1999*) impacts.

The main control techniques for feral pigs are poison baiting, trapping and aerial shooting (and there is also some commercial use through trapping and ground shooting). Trapping is labour-intensive and aerial shooting is very expensive but can achieve rapid population knockdown over relatively large areas. Due to the relatively large weight of feral pigs, poison baiting poses significant non-target risks due to the amount of toxin required in each bait. BRS and Meat and Livestock Australia are currently supporting research (by Queensland Dept of Natural Resources, Mines and Energy and the PAC CRC) to investigate alternative bait toxins, mediums and strategies to allow safer and more cost-effective baiting to significantly reduce feral pig populations in a wider range of situations than is currently feasible.

Other vertebrate species

Rabbits remain a significant threat to agricultural production despite the effect of rabbit calicivirus disease (RCD), which has been particularly effective in rangeland areas, but less so in higher rainfall areas. The presence and impact of rabbits *seems* relatively innocuous compared to wild dogs and feral pigs and therefore the latter tend to attract a disproportionate amount of public, industry, media and therefore political attention. Many landholders have become complacent about rabbits due to the impact of RCD. However, it is probable that rabbits will develop resistance to RCD as they have with myxomatosis, and continue to cause profound long-term changes to landscapes (e.g. by preventing the regeneration of some native perennial plants). Federal and State government agencies have implemented a number of initiatives (rabbit control funding programs and production of extension materials) in recent years to encourage landholders to take maximum advantage of the 'window of opportunity' provided by RCD. However these efforts have been frustrated to some extent by the high cost of rabbit warren ripping, lack of landholder time and money through the recent drought and industry focus on wild dogs and feral pigs at the expense of other pest animal issues.

Foxes can have a major impact on agricultural production and the environment. However, unlike control techniques for some other pest animals, the main fox control technique (1080 baiting) is quite effective, and relatively target-specific and cheap. Target-specificity may be improved further if current research into a canid-specific toxin is successful. However, the main issue associated with current fox management is ensuring that baiting is conducted according to 'best practice' and on a large-scale to account for the mobility of the species. Government agencies have had a great deal of success in recent years in coordinating a wide range of landholders (State Forests, National Parks, graziers) to conduct regional fox baiting programs.

Rodents (predominantly house mice) cause millions of dollars worth of damage to Australian crops each year. There has been a mouse plague somewhere in the Australian grain belt every four years on average since 1900. In the last 20 years, plagues have increased in frequency to one every year or two – largely due to stubble

retention and the increase in irrigation that has provided year-round food and shelter to mice. Mice plagues often occur following a drought, which can have a devastating impact on farmers who are already economically and emotionally stressed.

Feral goats are a relatively easy pest species to manage, provided landholders are motivated to do so – which hasn't been a problem in recent years as high goat prices has encouraged commercial use through mustering and water-point trapping. This, combined with the drought, has kept feral goat numbers at reasonable levels in most rangelands areas with good transport access.

Kangaroos are a relatively difficult animal to manage to levels at which overall grazing pressure (by livestock and wild grazers) is sustainable. Being a native animal, kangaroo harvesting is regulated by a quota system. However, this quota is often not reached in many areas, and many landholders argue that the quota is too conservative in areas where it is reached. There are some major limitations to the commercial use of kangaroos including fickle export demand and the labour-intensive nature of harvesting compared with feral goats (ground shooting versus mustering/trapping). Government policy has a major role to play in this industry including: management of the quota system; facilitation of domestic and export market access; and, general industry assistance such as classification of harvesters as 'primary producers' for taxation purposes.

There has been increasing recognition of the impacts of **carp** in recent years, and some irrigators report considerable damage to irrigation channels and pump equipment. The contribution of carp to declining overall waterway quality has probably been overstated and there are many more significant influences including flow restrictions, irrigation and unrestricted livestock movement.

Apart from the direct impacts of exotic freshwater fish that are already widely established in Australia, there is a significant black market trade in aquarium fish being brought into the country that poses an exotic disease risk to aquaculture and the environment.

The National Vertebrate Pests Committee (VPC) has recently included freshwater fish on its agenda and a number of agencies (e.g. Murray-Darling Basin Commission, State Fisheries Departments) are considering a range of policy initiatives and research proposals to address the increasing threat of expanding exotic fish populations.

Invertebrate pests

The management of invertebrate pest animals is largely a matter for State and Territory Governments and the affected agricultural industries. The exceptions are the three species of **locust**, which are managed under an agreement between the Australian and several State Governments. The rationale for Australian Government involvement is firstly that locust outbreaks in one State can migrate and damage crops and pastures in several other States, and secondly that an uncontrolled locust plague would cause in excess of $100M damage in several States. The Australian Plague Locust Commission (APLC) was established in 1974 and is jointly funded by the Australian (50%), New South Wales (32.5%), Victorian (10%), South Australian (5%) and Queensland (2.5%) Governments. The APLC's annual budget is $3.5M, but the expenditure in any year depends on locust activity.

The APLC's role is to reduce the frequency and intensity of locust plagues by implementing a strategy of early intervention control. The States and industry also have a responsibility to control locusts to complement the APLC's activities. The member States invest in, and rely on, the APLC's research programs aimed at improving the effectiveness and efficiency of locust control while reducing risks to the environment, human health and trade.

OVERARCHING ISSUES

There are a number of overarching Australian and State government structural and policy issues of consequence for reducing the overall impact of pest animals. The most critical area for coordination between Australian Government and State government agencies is in the prevention of new pests becoming established through: formal risk assessment frameworks for the import and keeping of exotic species; barrier control to prevent illegal or accidental entry of exotic species; on-ground inspection capability to ensure exotic species are kept according to permit conditions; and on-ground detection and reporting frameworks to allow early intervention for newly escaped or established exotic species (e.g. foxes in Tasmania).

With regard to management of existing, widely established pest animals, this then becomes an ongoing responsibility of individual landholders with provision of advice, coordination and some control technique facilitation (e.g. 1080 administration and aerial shooting) from (predominantly State) government agencies. State government agencies may also provide destruction permits for native species under some circumstances as well as having responsibility for managing pest animals on their own properties (e.g. National Parks and State Forests).

Australian Government responsibility for management of established pest animals is limited to: management of pest animals on its own (e.g. National Park and Defence areas) properties; administration of the EPBC Act where pest animals are threatening nationally significant threatened or endangered native species of ecological communities; regulation of exports of native animals which may be considered a pest in some situations (e.g. several species of kangaroo); involvement in animal disease contingency planning and emergency response where wild animals may be involved; facilitation of research, contingency planning and extension (e.g. NFACP, PAC CRC and Wildlife and Exotic Disease Preparedness Program); and, representation on VPC which works to address national pest animal management priorities.

The Australian Government and State governments probably have not done enough to promote their achievements in pest animal management over the past decade to industry groups and the general public. There have been major improvements in control techniques (through government research) and coordination of control in this time. Regional control programs involving a wide range of landholders are now the norm rather than the exception. This means that control has become more professional, safer and cost-effective.

Part of the 'perception problem' is that pest animals are still present and causing agricultural and environmental impacts. However, there is no doubt that these impacts would be much greater without the improvements in control techniques and their implementation that government agencies have facilitated.

The issue of coordinating control across State borders is probably overstated in importance – what matters is that control is happening on a regional/catchment/local level, regardless of whether this crosses a State border.

Some industry groups have suggested that they are not seeking more government resources for pest animal control; just better coordination. However, there is no doubt that in many situations it is private and public resources for pest control that is the limiting factor. An example of this is wild dog control around the Snowy Mountains area of New South Wales. National Parks, State Forests and NSW Agriculture have dramatically improved their relationship with local landholders through a coordinated 'nil tenure' approach to wild dog management which is already yielding some good results. However, the large amount of public resources being devoted to wild dog management in this area is being drawn from an already limited pest animal and weed management budget; therefore the imperative to respond to industry concerns about wild dogs will compromise management of other issues unless more resources become available.

There have also been some industry calls for national eradication of some established pest animal species. The appeal of this concept is understandable; unfortunately the proposal is unrealistic for the reasons and costs outlined in Attachment C. The proposal in itself is also damaging to ongoing control efforts as it conceptually shifts the responsibility of pest animal control from individual landholders to governments.

The above issues are addressed further in the ToR 2 response that follows.

2. To consider the approaches to pest animal issues across all relevant jurisdictions, including:

- ***prevention of new pest animals becoming established***
- ***detection and reporting systems for new and established pest animals***
- ***eradication of infestations (particularly newly established species or 'sleeper' populations of species which are considered to be high risk) where feasible and appropriate***
- ***reduction of the impact of established pest animal populations.***

GENERAL PRINCIPLES FOR INVASIVE SPECIES RESPONSES

Exotic pest management is a shared responsibility of government, industry and community and each plays a part and bears the costs of response to the threat or consequences of it. Legislation or government intervention is not sufficient on its own and it is therefore important to have community and industry awareness of invasive species threats and their involvement in risk mitigation.

Response is more cost-effective earlier in the invasion process. Prevention costs less than early eradication, which costs less than containment, which generally costs considerably less than ongoing management of widely established pests.

There are a number of common principles in responding to any invasive species and these can be applied to assessing the cost:benefit and feasibility of response, particularly once the quarantine barrier has been breached.

Restricting imports

When examining the impact in other countries of pest species not yet in Australia, an obvious low cost option for managing the threats posed by invasive species is to restrict and manage both accidental and intentional import pathways. This needs to be supported by early detection and reporting frameworks for new species which escape or become established.

Australian ecosystems are becoming more homogenous as their isolation is broken down by human behaviour that enhances the ability of exotic invasive species to gain entry and spread, particularly thorough the exponential increase in international air and marine traffic in the past 50 years as well as shortened times in transit.

Based on the history of current pests, introduction of new vertebrate pest animals is likely to be deliberate (legal or illegal) introduction rather than by accidental human-assisted dispersal. Hence for exotic vertebrates it is highly desirable to have robust, scientifically-based risk assessment processes to distinguish species that pose a high threat of becoming future pests from those that pose a low threat.

BRS has developed a new risk assessment model for VPC that assesses the potential threat exotic vertebrate species pose of becoming invasive pests that will harm Australia's environment and economy (Bomford 2003; Attachment N). This model evaluates the many factors that determine the risks posed by particular exotic vertebrate species and separates those species that represent a high threat of becoming pests from those that pose a lower threat. For example, the climate match between a species' overseas range and Australia and whether or not a species has a history of establishing exotic populations in other countries are two of the factors the model uses to evaluate the threat of a particular species establishing in the wild in Australia.

Because the ecological processes involved are complex and available technical data is limited for most species, risk assessment models cannot provide definite predictions. However the model recently developed by BRS improves on the quantification and therefore objectivity and transparency of previous processes, although, due to constraints on knowledge, there is still a subjective component to most risk assessments that requires input by suitably qualified experts.

It is therefore essential that all risk assessments on species be conducted by appropriate experts who act independently of either those applying to import or keep them or others with a vested interest in the outcome of the risk assessment. Therefore, if the applicant pays for a risk assessment, it is desirable that this is done through an independent authority that arranges for an independent risk assessment. Such arrangements are not yet in place in Australia to ensure this independence is achieved for the import of exotic vertebrates and this can put at risk the integrity of the risk assessment process.

Restricting trade and keeping

The next lowest cost option for managing the threats posed to biodiversity from invasive species is to regulate trade and keeping of high-threat species already held in captivity in zoos, wildlife parks, pet shops, aquaria and houses to reduce the risk that they escape or are released and establish wild pest populations. These species are

already past quarantine barriers, legitimately or otherwise, and usually have not had independent risk assessments on their potential for invasion if released.

As with import risk assessments, robust science-based risk assessment processes are required to identify these high-threat species. Reasonably reliable knowledge exists on which exotic vertebrate species are already held in Australia, although there are probably many species (particularly exotic fish) being kept privately that are unaccounted for.

The VPC has attempted to list all exotic vertebrates (except fish) present in captivity or the wild in Australia. However relatively few of these species have had a risk assessment conducted to determine the threat they pose should they escape and establish wild populations. According to the VPC lists, there are currently 218 exotic mammal, 246 bird, 148 reptile, and 12 amphibian exotic species present in Australia. It is estimated that there are over 30 exotic fish species established in Australian waters and potentially over 1,000 exotic fish species being kept in captivity.

The cost and responsibility for conducting risk assessments of pest potential for exotic vertebrates already present in Australia but not yet established in the wild is an issue to be resolved. BRS is currently supporting a project to assess some of the species perceived to be highest risk, but does not have the resources to fund assessment of all exotic species currently being held in Australia. National coordination of this process is necessary because pests, once established, can easily spread over State borders.

Early eradication

Eradication of localised populations of newly established pest animals may be feasible as it is easier to meet most of the six eradication criteria (Attachment C), although being able to detect animals at low densities (to confirm whether eradication has been achieved) will still be a problem. A poor chance of *eradication* does not necessarily mean that early *control* action is not a cost-effective strategy to slow the spread of a new pest species. Early eradication or control of potential vertebrate pests requires good detection, reporting and decision-making frameworks and these do not currently exist on a formal nationally coordinated basis in Australia.

Eradication of established pests

Eradication is the permanent removal of all individuals of a target species from a location. It is an ideal response but is technically extremely difficult, if not impossible, for most invasive species. The tenacious characteristics that make them invasive species – such as adaptability, mobility and high reproductive capacity – usually require extraordinary circumstances and resources to counteract. For small, isolated pest animal populations, particularly populations on small offshore islands, the chances of achieving eradication are much higher. But as an invasive species population increases in size and spreads, the cost of an eradication attempt and the chance of failure rapidly increase by orders of magnitude.

Eradication of established vertebrate pests is sometimes put forward as a desirable option by those whose valued resources are being damaged, but wildlife managers know eradication is difficult and expensive to achieve, and it is almost certainly not possible on a national scale for widespread pest species. Despite this, the idea of eradicating these pests is appealing. If major pests such as rabbits, feral cats, foxes or

feral pigs were totally eradicated, agriculture and the environment would be free of the damage they cause, and the ongoing costs of trying to control them would also be gone. However, to mount a serious attempt to eradicate any of Australia's widespread introduced vertebrate pests would cost billions of dollars and most wildlife ecologists consider such attempts would almost certainly fail. For example, the cost of attempting to eradicate feral pigs from the Australian mainland has been conservatively estimated at $3.4 billion, even though it is considered the likelihood of eradication being successful is extremely low (Attachment C) and there would continue to be reintroductions by hunters and from the domestic pig population.

BRS (Bomford and O'Brien 1995) developed six criteria applying to vertebrate pests to assess whether eradication is a feasible and desirable goal:

1. Pest animals must be removed at a rate faster than they can breed up to replace these losses. Many Australian pests are prolific breeders. When control programs reduce their numbers, conditions improve for the remaining animals and breeding success and survival rates increase.

2. Immigration (from surrounding areas into current control areas) is zero. Localised populations of newly established species and species living on islands have little or no immigration. For example, feral goats and cats and several species of rodent have been eradicated from offshore islands in New Zealand. But on mainland Australia, widespread populations of pest animals can reinvade from outside the control area. Also, species that are kept as livestock or pets, such as pigs, goats, dogs and cats, can escape into the wild and re-infest cleared areas. Species popular with hunters, such as feral pigs, may be intentionally released.

3. All pest animals are at risk. Unless all target animals are susceptible to the control techniques, some will survive and eradication will be unachievable.

4. Target pest animals can be detected at low densities. If animals cannot be detected at low densities it is not possible to tell when it is safe to stop control efforts. This is a difficulty being experienced with the fox eradication program in Tasmania. A pest population can recover from a single fertile pair.

5. Cost is acceptable. When pest numbers are high, the cost of removal per animal is relatively low. The reverse is true when pest numbers are low. For example, it took 1,000 hunter days to find and remove the last feral goat on Raoul Island in New Zealand. And the cost of removing the last five goats was $22,000 each. This was in an area of only 2,943 hectares!

6. Social acceptance. Eradication campaigns usually rely on poisoning, shooting and trapping. These methods may not be supported in some cases. Species other than the pest may accidentally be killed, including people's pets, livestock, working dogs and native animals. Non-target kills may erode political support or lead to legal action to stop eradication programs.

These six criteria need to be assessed and answered affirmatively before considering an expensive eradication campaign for a pest species. One negative can ensure failure. When Australia's major pests are assessed for eradication potential, none of them come close to meeting all criteria. An example assessment for feral pigs is provided at Attachment C.

Containment

Containment is also usually a practically difficult and expensive option for managing vertebrate pests, and is rarely successful in long term. Examples in Australia include:

- 'Rabbit-proof' and 'dog-proof' fences – which are expensive to build and maintain and of variable efficacy (Williams et al. 1995, Attachment H; Fleming et al. 2001, Attachment G).
- Excluding starlings from Western Australia – from 1976 onwards an eradication team has been based at Eucla and Esperance to control any starling colonies that become established in Western Australia. This unit destroys about 1,000 starlings per year on both sides of the Western Australia–South Australia border and has so far been successful in preventing the species from becoming established in Western Australia.
- Excluding foxes from Tasmania – the long-term success of this strategy is uncertain due to recent incursions thought to be deliberate releases.

Damage mitigation

Damage mitigation through sustained control is a more complex strategy than eradication or containment. Optimal management depends on knowing when and where to intervene with optimal levels of control, and this requires a good understanding of the relationship between vertebrate pest density and resultant impact (Choquenot and Parkes 2001).

In general, relying on damage mitigation once an exotic invasive vertebrate has become widespread and abundant is the most expensive response option for exotic vertebrates, costing orders of magnitude more than effective early actions to prevent entry, establishment (by restricting trade and keeping) or to achieve early eradication.

Control of non-indigenous vertebrate pests in Australia costs governments and landholders over $60 million each year. In addition to damage mitigation activities, around $20 million is spent annually on research to control vertebrate pests in Australia. Estimated annual spending on damage mitigation activities and research costs compared to agricultural losses for the main vertebrate species of concern to this enquiry are presented in the table below (Source: Bomford and Hart 2002, Attachment B).

It should be emphasised that the estimates of agricultural losses below are deliberately conservative (i.e. 'best case scenario' based on reliable information) and the actual losses may be many times this. The loss estimates are also based on direct annual impacts only and do not take account of the large costs associated with long-term degradation of natural resources (e.g. grazing impacts of rabbits and feral goats). Clearly the losses would be considerably greater without the control and research activities.

Species	Agricultural losses ($Mn pa)	Control costs ($Mn pa)	Research costs ($Mn pa)
Rabbit	>200	20	5
Fox	40	7	4
Feral goat	20	2	1.5

Feral pig	100	5	1.5
House mouse	>27	10	2.5
Wild dog	>20	>10	1.5
Feral cat	0	1	1
Non-indigenous birds	>10	1.5	0.5
Cane toad	0	0	0.5
Carp	?	1	0.5
TOTALS	**>$417 million**	**>$57.5 million**	**$18.5 million**

Inaction

Taking no action to control a pest will usually be the best option when the costs of action exceed the benefits or when there is no effective method to control the pest or the damage it causes (Braysher 1993: Attachment D). Examples include: where killing pests just leads to rapid immigration into the control site by animals from surrounding areas with no decline in pest numbers or pest damage; or the general control of cane toads or feral cats (where there is currently no cost-effective broadscale control technique).

Inaction or delayed action can be an extremely expensive and inadvisable option for a recently detected exotic species. This is because costs of eradication rapidly increase by orders of magnitude as an invasive species spreads from its original area of establishment. Concurrently, the probability of achieving eradication diminishes as the species spreads, and if it is not attempted or fails, the eventual environmental and economic costs to Australia of having additional free-living exotic species may be extremely high.

Taking no action can also be an undesirable option for species that pose a high threat which are currently kept in captivity in Australia. This is because the higher the number of such species present in Australia, the higher the number of places holding such species, and the more individual animals kept, the greater the risk that new species will establish wild pest populations. The number of animals released, and the number of times and places where releases occur, is strongly correlated with establishment success for vertebrates (Duncan et al. 2001; Forsyth et al. 2004). As mentioned above, full risk assessments have not yet been conducted for most exotic vertebrate species being kept in Australia, so the issue of ensuring appropriate security arrangements are in place to regulate their trade and keeping is an issue yet to be resolved.

3. Consider the adequacy of State Government expenditure on pest animal control in the context of other conservation and natural resource management priorities, with particular reference to National Parks.

There is a perception amongst some farmers that their pest problems come from surrounding government lands, whether State forest or National Parks, and that there is insufficient control of pest animals in these areas. Much of this continuing perception is based on historical conflict between graziers and neighbouring National Parks, particularly in relation to wild dogs, foxes and feral pigs. However, over the past decade, most State governments have substantially increased their pest control budgets and improved processes for liaison and coordinated pest control with neighbouring properties. However, these budgets are not infinite, and the suite of invasive species (weeds and pest animals) that needs to be managed is increasing.

Targeting one high profile pest species such as wild dogs means that there is less funding available to address other management issues. Exacerbating the problem in some States is the ongoing purchase of additional conservation areas, without a commensurate increase in the budget to manage them properly.

However, it is also true that farmers themselves must take greater responsibility for managing pest animals in their local area. Many pest animals exist in moderate to high densities in farming areas regardless of whether there is a neighbouring forested area and it is a fallacy that pest animals harbour and breed up in forested areas and then travel large distances to infest agricultural areas. It is counterproductive to establish an expectation that governments alone will solve pest animal problems. The 'nil tenure' approach (Attachment O) to pest animal management is one way to get past the finger-pointing and embark on a constructive way for landholders to work together to address their pest problems into the future. However, this approach requires more than a positive attitude; it will also require considerable public and private investment. Clearly there are insufficient public and private funds to address all pest animal problems across the huge range in which they occur in Australia, and prioritisation will be required at the regional level and for some issues at the State and National levels. BRS has recently supported the development of the 'PESTPLAN' (Attachment P) prioritisation approach that will help regions focus limited resources on the pest issues that are likely to provide greatest return on investment.

4. Consider the scope for industry groups and R&D Corporations to improve their response to landholder concerns about pest animals.

Whilst industry groups have been vocal in calling for greater government commitment to pest animal control in recent years, it needs to be acknowledged that landholder motivation is a major impediment to more effective pest animal control. Effective control techniques exist for most of our major vertebrate pests of agriculture; what is lacking is their effective implementation. In some cases this is due to the high cost of the techniques (e.g. rabbit warren ripping and aerial baiting and shooting). In other cases it is due to a lack of information about control techniques, although State and Federal governments have focussed heavily on making pest animal management information and training available in recent years. However, in other cases, poor pest management can be blamed on apathy or an unwillingness to adopt new approaches or work with other landholders. Whilst government has a role to play in improving this latter situation, industry groups must also take responsibility for promoting the adoption of coordinated best practice pest animal management.

There has traditionally been a limited amount of funding available for developing new pest animal control techniques in Australia. Compared to chemicals for insect and weed control, there is a very limited market for pest animal control chemicals and other control techniques (apart from rodent control). Therefore there is little interest from private companies in undertaking the extremely expensive and time-consuming process of testing and registering a new pest animal control agent.

The public benefits of pest animal control are substantial and therefore there is a case for governments to subsidise the development of more effective, safer and more humane control techniques (particularly given the pressure on some current control techniques in relation to their target specificity and humaneness).

There has been pressure from landholders, industry groups and even government policymakers to spend government money on on-ground pest animal control rather than research. However, a balance is needed, and rabbit calicivirus research is a good example. The amount of money spent on researching this biocontrol agent was equivalent to ripping all the rabbit warrens in a moderate-sized catchment. However, this research expenditure has resulted in knockdown of the rabbit population in large areas of Australia for many years, where the control expenditure would have treated a single region for only 5-10 years.

Government expenditure on pest animal control and research in Australia may seem high (Attachment B) but is interesting to note that it is less than that spent in New Zealand, a country 1/30th the size of Australia with less than 1/6th of our GDP.

In the past, R&D Corporations have provided limited funding for pest animal control and research and extension, although they did contribute to RCD and fertility control research and the BRS national pest animal management guidelines. However, this seems to be changing and Australian Wool Innovation and Meat and Livestock Australia in particular are to be commended for making recent major commitments to the PAC CRC to improve wild dog and feral pig control techniques. This will complement past and current wild dog and feral pig research supported by BRS.

5. Consider ways to promote community understanding of and involvement in pest animals and their management.

Pest animal control understandably poses some community concerns ranging from issues about killing animals to the specificity and safety of the control techniques. Continuing public education about the impacts of pest animals is required to highlight the need for lethal control measures in some situations. At the same time, government agencies and researchers need to pre-empt community expectations and standards in relation to animal welfare, human safety and genetically-modified organisms (e.g. for fertility control).

BRS produces a wide range of pest animal management extension materials for landholders and the general public as well as working with the print media to promote a range of current issues. It is also currently supporting the development of a ferals web portal (**feral.org.au** – to go live in 2004), which will make a huge range of pest animal information available for landholders, researchers, policy makers and the general public.

BRS recognises that there is no substitute for face-to-face communication, and has worked with NSW Agriculture and other State government agencies to conduct regional workshops based on the PESTPLAN prioritisation process developed by BRS and NSW Agriculture in 2003. BRS has recently submitted proposals to provide these workshops to Catchment Management Authorities, the Indigenous Land Corporation and Department of Defence (a major Australian Government landholder and therefore pest animal manager).

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Attachment A Introduced vertebrate pest species

Table 1. Introduced exotic vertebrate species that have established widespread populations on mainland Australia and their pest status.

Sources: birds (Long 1981); mammals (Strahan 1995; Long 2003); reptiles (Cogger 1994); fish (Arthington and McKenzie 1997; P.J. Kailola pers. comm.).

	Serious pest	**Moderate pest**	**Minor or non-pest**
Mammals	European rabbit *Oryctolagus cuniculus* Feral goat *Capra hircus* Feral pig *Sus scrofa* European red fox *Vulpes vulpes* Dingo/feral dog *Canis familiaris* Feral cat *Felis catus* House mouse *Mus domesticus*	Feral horse *Equus caballus* Feral donkey *Equus asinus* Feral buffalo *Bubalus bubalis* Feral camel *Camelus dromedarius* Feral cattle *Bos taurus* Black rat *Rattus rattus*	European brown hare *Lepus capensis* Brown rat *Rattus norvegicus*
Birds	European starling *Sturnus vulgaris* Indian myna *Acridotheres tristis*	Mallard *Anas platyrhynchos* Rock dove (feral pigeon) *Columba livia* Spotted turtledove *Streptopelia chinensis* Blackbird *Turdus merula* House sparrow *Passer domesticus* European goldfinch *Carduelis carduelis* Senegal turtledove *Streptopelia senegalensis*	Cattle egret *Ardeola ibis* Skylark *Alauda arvensis* Tree sparrow *Passer montanus* Nutmeg mannikin *Lonchura punctulata* Greenfinch *Carduelis chloris*
Amphibian	Cane toad *Bufo marinus*		
Freshwater fish	European carp *Cyprinus carpio* Mosquito fish *Gambusia holbrooki* Mozambique tilapia *Oreochromis mossambicus*	Weather loach *Misgurnus anguillicaudatus* Tench *Tinca tinca* Redfin perch *Perca fluviatilis* Rainbow trout *Oncorhynchus mykiss* Brown trout *Salmo trutta*	Goldfish *Carasius auratus* Guppy *Poecilia reticulata*

Table 2. Other introduced species that have only established localised populations on the mainland or have only established on offshore islands.

	Localised mainland populations	**Offshore island populations**
Mammals	Asian house rat *Rattus tunezumi*; Indian palm squirrel *Funambulus pennanti*; Chital deer *Cervus axis* Rusa deer *Cervus timorensis*; Banteng *Bos javanicus*; Hog deer *Cervus porcinus*; Fallow deer *Dama dama*; Red deer *Cervus elaphus*; Feral sheep *Ovis aries*; Sambar deer *Cervus unicolor*	Pacific rat *Rattus exulans*
Birds	Ostrich *Struthio camelus* Red-whiskered bulbul *Pycnonotus jocosus* Song thrush *Turdus philomelos* Mute swan *Cygnus olor* Peafowl *Pavo cristatus* Barbary dove *Streptopelia risoria* Redpoll *Carduelis flammea*.	Wild turkey *Meleagris gallopavo* Helmeted guinea fowl *Numida meleagris* Red jungle fowl *Gallus gallus* California quail *Lophortyx californicus* Ring-necked pheasant *Phasianus colchicus* Chaffinch *Fringilla coelebs* Java sparrow *Lonchura oryzivora*.
Reptiles	House gecko *Hemidactylus frenatus* Mourning gecko *Lepidodactylus lugubris* Red-eared slider *Trachemys scripta elegans* Flowerpot snake *Ramphotyphlops braminus*	Wolf snake *Lycodon aulicus* Skink *Lygosoma bowringii.*
Freshwater fish	Three-spot gourami *Trichogaster trichopterus* Red devil/Midas cichlid *Amphilophus citrinellus* Three-spot cichlid *Cichlasoma trimaculatum* Burton's haplochromine *Haplochromis burtoni* Niger cichlid *Tilapia mariae* Roach *Rutilus rutilus* One-spot live bearer *Phalloceros caudimaculatus* Sailfin molly *Poecilia latipinna* Platy *Xiphophorus maculatus* Brook trout *Salvelinus fontinalis*; Green swordtail *Xiphophorus* helleri; Chinook salmon *Onchorynchus tshawytscha*; Oscar *Astronotus ocellatus.*	

Attachment C Response to feral pig eradication proposals

The likely role of feral pigs in an FMD outbreak

The potential role of feral pigs in any outbreak of an emergency animal disease (including an incursion of an exotic disease) depends on the particular disease. With respect to foot-and-mouth disease (FMD), the major means of spread is by direct close contact between an infected and a susceptible animal. Although windborne transmission has occurred with some strains of FMD overseas, it is unlikely in most parts of Australia for much of the year (as heat and dessication inactivate the virus) and is not likely within pig populations, with cattle being more than 12 times more susceptible to infection through this mechanism than pigs. Once a pig is infected with FMD, the vesicles (blisters) and sloughing of skin on the feet quickly induce an acute lameness, significantly or completely reducing movement until the lesions heal and the animal is no longer infective. Because pigs do not develop a carrier status, the disease will not persist unless an infected animal transmits it to a new susceptible animal. Infection might be localised and die out where feral pig populations are not continuous. Movement of feral pigs would be limited once the disease was contracted, so that even if some feral pigs were infected, they would be unlikely to infect domestic livestock.

There have been recent discussions between BRS, the Product Integrity and Animal and Plant Health (PIAPH) area of DAFF and the National Vertebrate Pests Committee about the prospect of surveying feral pig distribution and density for comparison with livestock distribution. Such mapping would be valuable for contingency planning for exotic disease outbreaks. However, most State/Territory governments are unlikely to undertake this activity at the required level of detail for their own purposes and Australian Government involvement (including financial support) would be required to ensure nationally consistent survey methodology. A national survey would be expensive and no funds are currently allocated to this task.

2001 Emergency Animal Disease simulation exercise

The project was a field trial of feral pig control in the event of a simulated outbreak of an EAD conducted in cattle country on Cape York Peninsula in late 2001. The Australian Government contributed $120,000 to the project ($60,000 from NFACP and $60,000 from the DAFF Wildlife and Exotic Disease Preparedness Program). The Queensland Department of Natural Resources and Mines and the Queensland Department of Primary Industries contributed approximately $150,000 to the exercise. The key goals of the project were to:

- Field-test the AUSVETPLAN for feral pig control;
- Improve Australia's preparedness for responding to an exotic disease outbreak;
- Increase awareness of recent developments in feral pig management techniques;
- Train staff in feral pig survey and control techniques;
- Test feral pig population control techniques;
- Integrate activities of government agencies; and
- Increase community awareness of exotic disease risks.

A key component of the project was preliminary investigation of improved poison baits for feral pigs to achieve more cost-effective and rapid broadscale knockdown of the feral pig population if required in certain areas in the event of an exotic disease incursion. Community awareness was also an important objective of the exercise.

The feasibility of eradicating feral pigs from mainland Australia
Feral pigs are mobile pest animals that occur over a wide area and in a range of habitats. Current control techniques are labour-intensive since aerial baiting and shooting will not be appropriate for many situations. It is thus simply not possible to target intensively the entire feral pig population over a short period to avoid immigration from no/low-intensity control areas into neighbouring high-intensity control areas. Reintroduction of pigs from escaped or released domestics and wild pigs moved around by recreational hunters also act as an ongoing 'immigration' source. Feral pigs also have a high potential reproductive rate and can **recover rapidly from control programs**.

An issue which has been overlooked in the current debate on feral pig eradication is the **potential for significant non-target impacts likely to be associated with intensive broadscale baiting**. Feral pigs are a large animal and require a relatively large amount of 1080 for a lethal dose. This clearly poses a non-target risk to smaller native animals (even though they generally have greater tolerance to 1080 than many introduced species) and farm dogs. These risks are addressed during routine feral pig management operations by: careful selection of bait medium and placement to suit specific situations; and employment of labour-intensive (and generally expensive) techniques such as trapping and shooting where baiting is inappropriate and/or results in unacceptable non-target risk. However, the ability to carefully tailor and place baits or employ trapping and shooting is unlikely to be feasible under the scale and intensity of an eradication campaign and the ability to manage non-target risk is therefore likely to be compromised. This compromise may result in considerable public sensitivity.

Ultimately, eradication with current technology is not considered feasible for any widespread mainland pest animal. Any such attempt would be futile and prohibitively expensive and is **likely to be counter-productive by shifting the perceived responsibility for pest control from individual landholders to Government**.

Conclusion
The most prudent use of public resources is targeted management in those areas where feral pigs are currently causing unacceptable levels of agricultural and environmental damage while preserving funding for the possibility of more widespread population knockdown if there is an outbreak of an emergency animal disease in the future. This is complemented by: enhanced barrier protection to reduce the risk of exotic disease incursion; contingency planning to ensure targeted management of feral pigs as required in the event of an incursion; and, research into more effective feral pig control techniques.

The feasibility of eradicating feral pigs from mainland Australia

Quentin Hart, Bureau of Rural Sciences, 2003

Summary

Eradicating feral pigs from mainland Australia means the *complete and permanent removal of the entire population by a time-limited campaign.* The Bureau of Rural Sciences has developed six criteria to assess whether eradication of a pest animal is likely to work. When these criteria are applied to feral pigs, it becomes clear that the prospects for a successful national eradication attempt are extremely poor.

The requirements for feral pig eradication

1. Rate of removal exceeds rate of increase at all population densities
This will clearly be difficult for feral pigs which are fecund and occur in a wide range of habitats, many of which are remote and/or montane and heavily forested. The range of available control techniques will also be limited in areas where there is poor vehicle access and/or which do not lend themselves to aerial shooting or baiting. Disease eradication may require a reduction in the density of host/carrier animal to a density at which transmission is virtually eliminated. However, animal eradication requires reduction in density to a level at which successful mating is compromised and reproduction is less than mortality and this density is usually considerably lower.

2. Immigration is zero
Feral pigs are a mobile pest animal which occur over a wide range. Given the labour-intensiveness of current control techniques (given that aerial baiting and shooting will not be appropriate for many situations) it is simply not possible to intensively target the entire feral pig population over a short time period to avoid immigration from no/low-intensity control areas into neighbouring high-intensity control areas. Reintroduction of pigs from escaped/released domestics and wild pigs moved around by recreational hunters will also act as an ongoing 'immigration' source.

3. All animals are at risk
Feral pigs are intelligent and often secretive animals and we know from current programs that some pigs are difficult to remove using the range of current control techniques. The fact that in some parts of the feral pigs range there are no or very few appropriate control techniques makes it highly unlikely that all animals can be removed with current technology.

4. Animals can be detected at low densities
Not feasible given the remoteness and vegetation cover of much of the feral pigs range.

5. Discounted cost benefit analysis favours eradication over control.
The above criteria suggest that eradication is extremely unlikely and the attempt would be prohibitively expensive.

6. Suitable socio-political environment
Compared to say, feral horses, there would be minimal public and therefore political resistance to the concept of feral pig eradication. However, given that private and public expenditure on pest animal (excluding rodent) management in Australia is probably only around $100 million per year, and a feral pig eradication attempt would cost many times this, it is unlikely that there would be political support. The scale and intensity of an eradication attempt is also likely to pose non-target risks that are unacceptable to the general public.

Cost of eradicating feral pigs from the entire mainland of Australia over five years

Mary Bomford and Quentin Hart, Bureau of Rural Sciences, 2003

Summary

It is conservatively estimated it would cost $3.4 billion over 5 years to eradicate feral pigs from the Australian mainland assuming a starting population of 7.2 million pigs spread over 2.1 million square kilometres. The likelihood of eradication being successful is extremely low. The likelihood of reintroduction is extremely high.

Methods

Pig distribution and abundance was digitized by Robert Smart (BRS) from the feral pig distribution map published by Wilson et al. (1992):

Area of high abundance = 300,000 square kilometres

Area of moderate abundance = 600,000 square kilometres

Area of low abundance = 1,200,000 square kilometres

Total area where pigs occur = 2,100,000 square kilometres.

After consulting with Glen Saunders (NSW Agriculture), we assumed the following pig densities for the 3 categories in the Wilson et al. (1992) map:

High density = 10 pigs per square kilometre

Moderate density = 5 pigs per square kilometre

Low density = 1 pig per square kilometre.

Based on these data we estimated the total population of feral pigs in Australia as 7.2 million pigs.

Based on costs of pig control from previous studies, we made the following conservative assumptions about the costs of finding and killing pigs:

Cost per pig at densities:

Greater than or equal to 5 pigs per square kilometre = $10/pig

Less than 5 but greater than or equal to 4 pigs per square kilometre = $30/pig

Less than 4 but greater than or equal to 3 pigs per square kilometre = $50/pig

Less than 3 but greater than or equal to 2 pigs per square kilometre = $100/pig

Less than 2 but greater than or equal to 1 pigs per square kilometre = $200/pig

Less than 1 but greater than or equal to 0.2 pigs per square kilometre = $400/pig (assuming possible)

Less than 0.2 = $1,000/pig in 1st three years assuming possible

Less than 0.2 = $5,000/pig in 4^{th} and 5^{th} years assuming possible.

Rate of increase can be as high as 86% per year (Choquenot et al. 1996) so we assumed conservatively that the pig population increased by 20% per year.

We assumed control operations halved all populations in each of the 1st, 2nd and 3rd years. In the 4th year we assumed pigs were eradicated (zero density) over half their original range (all from original Low-density areas), and knocked down to a density of 0.2 pigs per square kilometre in the remaining Low and Medium density areas and down to 1.0 pig per square kilometre in original High density areas. In the 5th year we assumed all the remaining pig populations were eradicated (zero density).

Results	Costs
Year 1	$333,000,000
Year 2	$291,000,000
Year 3	$271,800,000
Year 4	$1,324,080,000
Year 5	$1,164,000,000
Total for 5 years	**$3,383,880,000**

Disclaimer

It is not considered technically possible to reduce the feral pig population to zero pigs per square kilometre (i.e. eradication) over all of mainland Australia. There have been rare cases where local feral pig populations have been reduced by 99%. However, this was over a small area using a poison (warfarin) that is not currently registered for pig control. Models based on other data suggest that the cost of removal per pig becomes prohibitive (and in some habitats would cost many thousands of dollars/pig) once densities are reduced to less than one feral pig per square kilometre. Yet recovery of feral pig populations from this density can be rapid.

The cost and feasibility of feral pig removal is highly dependent on terrain. For example, high-level population knockdown (but *not* local eradication) has been achieved in some open rangelands for an average of $50 per feral pig because poison baiting was possible and detection of feral pigs was relatively easy. In contrast, in the wet tropics of north Queensland, where more labour intensive techniques (trapping, dogging and ground-based shooting) are required, the average removal cost of a recent program was $250 per pig with control using some techniques in some areas costing an average of $1,000 per pig. This was in a farming area and control in forested areas of north Queensland would be even more expensive. This expensive program did not come close to achieving local eradication. Regardless of cost, there are simply not the human or equipment resources, or control techniques available to target all pigs across Australia in a time-limited campaign. Pigs have litters of 4–8 piglets and can have more than one litter per year, so population recovery can be rapid and at low population densities, detecting and removing additional pigs is time consuming and expensive.

The other problem with proposing a 'National eradication campaign' is that it promotes a transfer of ownership of the 'pig problem' from landholders to government, which is likely to be detrimental to long-term feral pig control objectives.

ADDITIONAL INFORMATION HELD BY THE COMMITTEE

ATTACHMENT TO SUBMISSION NO. 76

ATTACHMENTS B, D to P PROVIDED WITH THE SUBMISSION ARE HELD IN THE COMMITTEE OFFICE