CENTRE FOR
INVASIVE SPECIES SOLUTIONS

Committee Secretary
Senate Standing Committees on Environment and Communications
PO Box 6100
Parliament House
Canberra ACT 2600

26 October 2018

Dear Committee Secretary

Thank you for the opportunity to provide a submission to the Senate Environment and Communications Reference Committee inquiry into *The impact of feral deer, pigs and goats in Australia, and national priorities to prevent the problems worsening for the natural environment, community and farmers.*

About the Centre

The Centre for Invasive Species Solutions (CISS) is one of the world's largest pest animal RD&E collaborations. Our current collaboration involves 17 government, industry and research provider partners. Our first vertebrate pest focused RD&E portfolio was launched in September 2018, and we are in the process of scoping a 10-year weeds RD&E investment plan. Information on the Centre and its Strategy is available at: invasives.com.au.

CISS plays a leadership and enabling role in relevant National Biosecurity System collaborative RD&E initiatives and develops new knowledge, tools and practices to continually improve best practice invasive species management. We currently facilitate 40 collaborative projects involving environmental, community and agriculturally based invasive species issues across the entire invasion curve. CISS is maintaining the knowledge and innovation momentum gained through the national collaborative research pursued through the Invasive Animals Cooperative Research Centre and its participants.

Relevant to this submission, CISS has been a significant facilitator of large-scale collaborative deer and pig management research, and to a lesser extent goat research. Apart from species specific

research, our non-species-specific research is relevant to all three of the species under the purview of your Committee's inquiry.

CISS research collaborations have been instrumental for the conceptualisation, development and release of a range of new tools that have reduced the impact of invasive species in Australia and internationally. These tools range between digital platforms to facilitate community engagement and participation in cooperative regional management programs, to biological control agents for rabbits - Australia's most costly invasive species – and carp, and new toxins and baits delivery systems for managing foxes, wild dogs and feral pigs to minimise the impact of these species on agriculture and the environment.

General Comments

The impact of invasive species is felt across the environmental, agricultural and social / community sectors. Invasive species are the greatest risk to Australia's threatened flora and fauna impacting some 1,257 species or 82% of all threatened species in Australia [1]. In 2013-14, invasive vertebrate pest species, excluding deer, cost Australian agriculture at least $596.57 million per year in direct losses alone [2]. The social impact of invasive species is difficult to measure and apply a fiscal value to however the research indicates that pest have a profound impact on the lives of not only primary producers but also their families and the whole community. Significant among these impacts is mental health [3].

CISS is a strong advocate for best practice strategic management of all invasive species in Australia at a scale that is appropriate to best mitigate their impact. For most invasive species, management action needs to be undertaken at the landscape scale to have measurable sustained impact. Similarly, best practice requires that the focus of any management intervention be on minimising the impact of the invasive species rather than, simplistically, on reducing the number of pest species present. This outcome-based approach allows an effective, integrated, landscape scale approach to invasive species management resulting in a greater reduction of impact across all environmental, agricultural and community sectors. CISS is active is developing and enhancing best practice management for invasive species and maintains an openly accessible best practice management toolkit available through www.PestSmart.org.au

Background

Deer

Six introduced deer species occur in Australia, with all states and territories having at least one species present. Deer were initially introduced into the Australian environment in the 1880s by acclimatisation societies for hunting purposes [4]. More recently accidental releases from deer farms and deliberate translocations and releases by hunters have augmented the spread of deer across the landscape [4].

Unlike many of the other introduced ungulates, the impacts of deer in Australia have not been well studies and documented. To identify the knowledge gaps and research priorities to improve deer management in Australia, the Invasive Animals CRC held a national workshop in Adelaide in 2016. Experts on the impacts and management of deer from across Australia and New Zealand attended and reviewed the current knowledge on deer distribution, impacts, and management strategies and tools. The workshop identified priorities for future deer research and management actions and also noted that investment in research and innovation to identify and reduce the negative impacts of deer has been *ad hoc* and lacked national coordination [5]. A copy of the Workshop proceedings is appended to this submission, and is also available on-line at: https://www.pestsmart.org.au/2016-national-workshop-deer-management-proceedings/

As deer are distributed across every state and territory of mainland Australia and Tasmania, available evidence highlights that like many other large vertebrate pests, that a national, coordinated, nil tenure approach to deer management and research is needed to effectively mitigate deer impacts on the environment, agriculture and the community. Based on the outcomes of the National deer workshop, CISS has instigated Australia's largest collaborative research effort into deer management and impacts bringing together five state and territory governments, three local councils, three universities and three private environmental groups. This collaboration has four interlinked projects with each state taking the lead in a project.

Pigs

The first record of pigs in Australia is of 49 hogs arriving with the first fleet in 1788 [6]. These were not securely housed and subsequently escaped into the surrounding areas. The spread of pigs in Australia initially followed the pattern of European expansion across the continent. Pigs were generally kept in semi-feral conditions which allowed many to escape. By 1880 pigs had run wild in New South Wales and were being shot in their thousands [7].

CISS has continued to build of the foundational work undertaken by the Invasive Animals CRC into building best practice tools and management techniques for feral pigs. The development of the first commercially manufactured feral pig bait (Pigout®) through extensive collaboration with Animal Control Technologies Australia (ACTA) provided land managers with an effective shelf-stable tool for feral pig management. Since then continued collaboration with ACTA and the United States Department of Agriculture has resulted in an additional toxic bait (Hoggone®) and a bait delivery system (HogHopper™) that minimises non-target impacts and provides a long-term management tool for land managers. The Invasive Animals CRC also funded a range of projects examining the population genetics of feral pigs, and the effectiveness of management techniques in wet tropics, RAMSAR wetlands, and coastal lowlands forests. The research project also examined the socio-economic impacts of feral pigs and the conflict within communities that can arise through the use of different management techniques. Many of the outputs from these research projects are now implemented as best practice management for feral pigs.

Goats

Goats were regularly transported on long sea voyages due to being easier to keep than other sources of milk and meat and were released on islands, including those around the Australian mainland to provide food resources for stranded or transient sailors [8]. Goats were introduced to the Australian mainland with the First Fleet and through numerous further introductions since that time. Through a combination of escapes, abandonment and deliberate releases, feral goats have now spread across most of Australia.

A collaborative project between the Kangaroo Island Natural Resources Management Board, CISS predecessor the Invasive Animals CRC, the South Australian Government and Kangaroo Island landholders and community groups, resulted in feral goats eventually being successfully eradicated from Kangaroo Island. This large-scale collaboration showed that by employing best management practices combined with a long-term strategic approach, goats were able to be eradicated from a large island [9].

While CISS has undertaken collaborative research and developed best practice management standards for all three invasive species being examined by the Senate inquiry, our submission to the Senate inquiry will focus primarily on feral deer and pigs.

Invitation

The Centre for Invasive Species Solutions would be available to attend the Senate inquiry to provide expert advice and commentary to the inquiry and to answer questions from Senators.

Recommendations

CISS makes the following recommendations to the Senate inquiry.

1. Legislation and policy should not form an impediment to the formation of national collaborative approaches to the management of feral deer and pigs.
2. A nationally coordinated landscape scale nil-tenure approach should be taken to the management of feral deer and pigs.
3. National facilitators for both feral deer and pigs should be appointed along the lines of the wild dog management facilitator positions.
4. Regional scale nil-tenure demonstrations sites for the integrated management of feral deer and pigs using and enhancing best management practices should be established across the country, initially in areas where impact is greatest.
5. Management actions should take a nil-tenure approach allowing and encouraging management across local, regional and state boundaries to ensure effective management of feral deer and pigs.

6. Increased resources should be allocated towards management actions for invasive species during the periods when populations are already being impacted by external factors such as drought.
7. A model code of practice for the humane control of feral deer should be developed.
8. Research into the list of priorities identified in the National wild deer workshop should be implemented to increase the solutions needed for the management of deer.
9. Research based actions in the feral pig threat abatement plan be implemented to ensure that the identified outcomes of the plan are met.
10. A national approach should be taken for identifying emerging future research priorities for feral deer and pigs.
11. Research activities should be undertaken to answer priority questions and take place at the scale that is appropriate to the scale of the problem and the distribution of the invasive species.
12. That the Environment and Invasives Committee consider the pros and cons of listing feral deer as an Established Pest of National Significance to foster stronger national coordination and strategic action.

CISS provides the following more detailed comments to the Terms of Reference for the inquiry.

Detailed Response Addressing Terms of Reference

The Centre for Invasive Species Solutions response to the terms of reference for the Senate inquiry into *The impact of feral deer, pigs and goats in Australia, and national priorities to prevent the problems worsening for the natural environment, community and farmers.*

a. The current and potential occurrence of feral deer, pigs and goats across Australia.

Six species of deer have become established in Australia following their introduction and at least one of these species is present in each state and territory. Deer have increased in range through a combination of natural expansion of range, escapes and accidental releases from deer farms, and through intentional releases by hunters. The recent distribution maps indicate that deer are primarily distributed through eastern Australia. The following distribution maps (Figure 1) are extracted from a recent publication – A systematic review of the impacts and management of deer (Family Cervidae) in Australia - by Naomi Davis and colleagues [10]

These potential distribution maps show in stark detail the potential distribution of feral deer across the Australian landscape and demonstrate the need for a nationally coordinated nil tenure approach to the management of deer and their impacts and to prevent them from reaching the full extent of their potential range.

Pigs were introduced into Australia as food resources with the First Fleet. As Europeans spread across the continent, pigs spread with them. Ineffectual fencing and containment of these domestic pigs allowed many to escape into the environment and these formed the basis of the current feral pig populations in Australia. The most recent estimate of the distribution of feral pigs (Figure 2) is provided by the *Assessing Invasive Animals in Australia 2008* report [11]. These 2008 estimates are used in the background document for the 2017 Threat abatement plan for feral pigs [12]. It is estimated that feral pigs inhabit approximately 45% of Australia. They have expanded beyond their initially predicted range into areas of New South Wales, Queensland, the Northern Territory and Western Australia that do not correspond with their suitable climate and habitat characteristics [11]. Despite this extension of range into areas that were not deemed suitable habitat, feral pigs have not yet expanded into the full extent of their predicted range in other areas of these states (Figure 3).

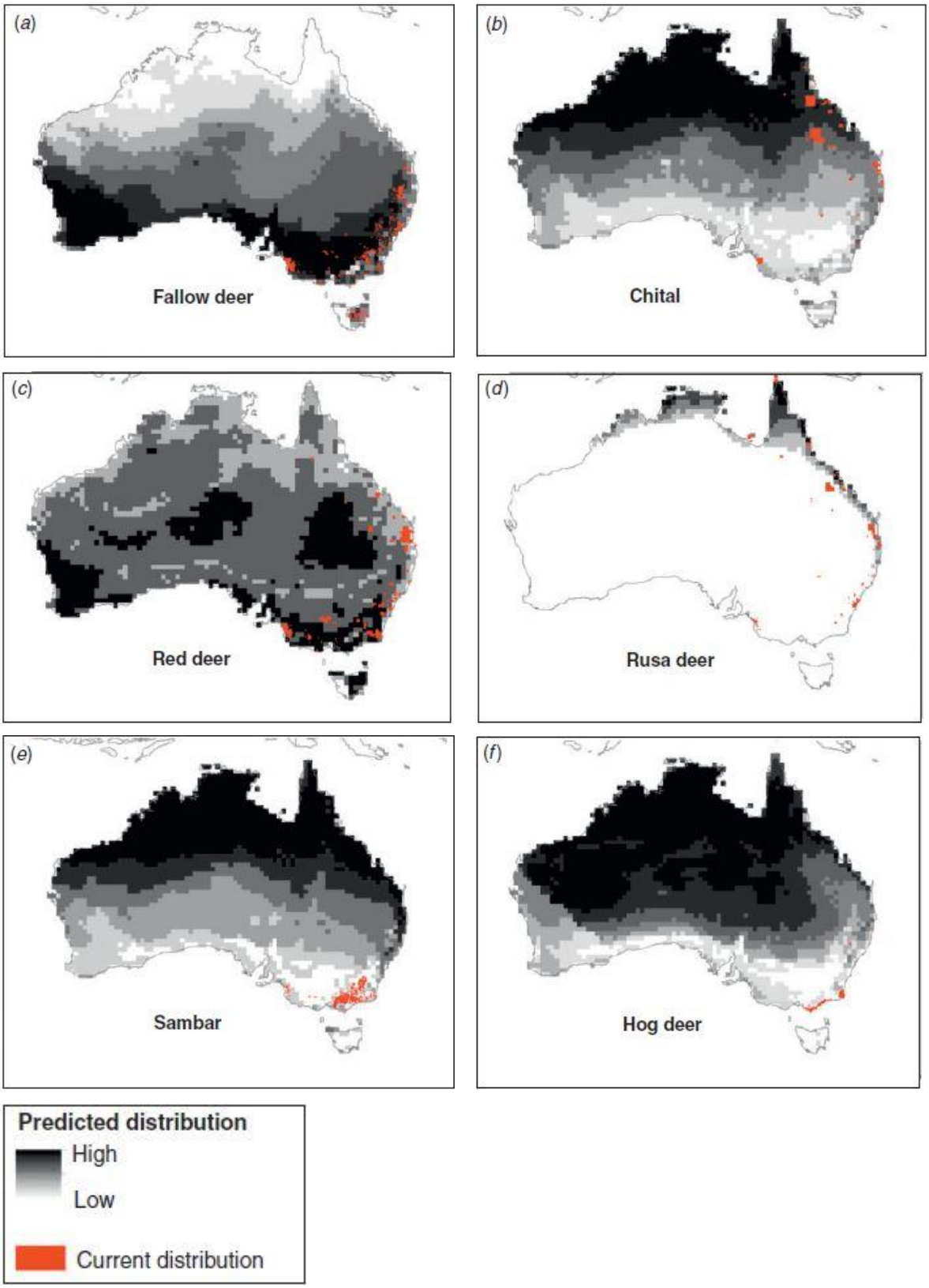

Figure 1. Current and potential distribution maps for the six species of deer in Australia.

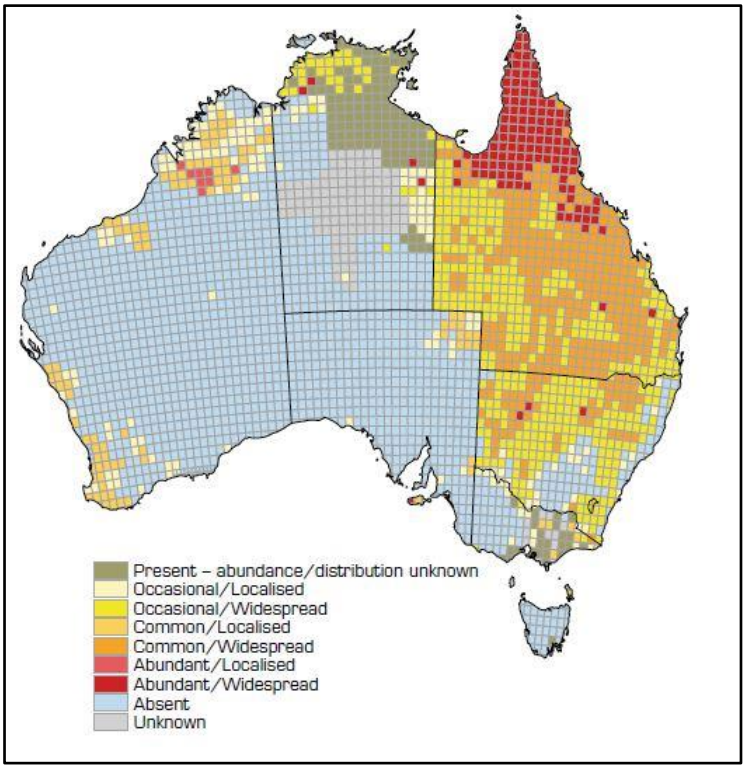

Figure 2 Distribution of feral pigs in Australia as of 2008.

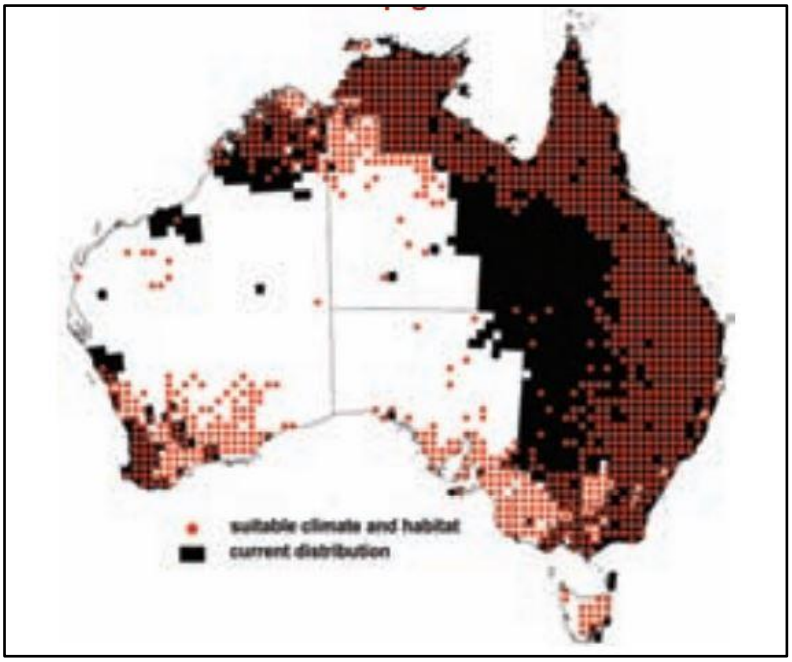

Figure 3 Current and potential range of feral pigs in Australia as of 2008. Current range is shown in black and potential suitable range is shown in red.

b. The likely and potential biosecurity risks and impacts of feral deer, pigs, and goats on the environment, agriculture, community safety and other values.

Feral deer

The full extent of feral deer risks and impacts in Australia have not yet been established, however their impacts on environmental, agricultural and community assets has been well researched and documented internationally. Feral deer are currently a reservoir for diseases endemic to Australia. Wildlife Health Australia indicates that 16 diseases have already been identified in feral deer as of 2013 including hydatids and leptospirosis which are able to be transmitted to humans [13]. The Queensland Feral Deer Management Strategy identifies feral deer as hosts for cattle ticks and can transport and transmit those to cattle in tick free areas [14]. Bovine Johne's disease, a wasting disease caused by the bacterium *Mycobacterium paratuberculosis,* has been detect in feral deer in Australia and can be transmitted from deer to domestic livestock.

Deer are likely to become reservoirs for exotic diseases on their entry and spread into Australia. The Queensland Feral Deer Management Strategy recognises this risk and states

> "The Australian veterinary emergency plan (AUSVETPLAN) has been developed to manage exotic disease outbreaks. The plan lists feral deer as being susceptible to a range of exotic diseases including Aujeszky's disease, surra, brucellosis, bovine tuberculosis, foot-and-mouth disease, rabies and bluetongue. If there was an outbreak of exotic disease, feral deer in an infected area would require epidemiological assessment in line with AUSVETPLAN."
>
> Extracted from "Queensland Feral Deer Management Strategy" [14] – page 8.

The impact and scale of response necessary should an exotic disease like foot-and-mouth be detected in Australia is demonstrated by the 1924 outbreak in California. Treatment included the killing of over 100,000 domestic (stock) animals, and 22,214 native deer (White-tail Deer) were culled in the Stanislaus National Forest, in the Sierras [15].

> "At various times, from one hundred to four hundred hunters were housed in some forty-three separate camps scattered throughout the mountains. Adding to the difficulties of finding and killing the deer amid some of the most rugged terrain in the West was the outraged opposition of local hunters, whose threats against government officials led to a temporary suspension of the operation in September. A few days later the hunt resumed, however, and continued until November, when snowstorms drove both deer and hunters to lower altitudes where the systematic slaughter continued throughout the winter. By June 1925 more than twenty-two thousand deer had been killed, of which a little over 10 percent were infected with foot-and-

> mouth disease. The national forests of the sierras remained under quarantine and were not reopened until June 1926, a year after the last infected deer was killed."
>
> Extracted from "Managing a National Crisis: The 1924 Foot-and-Mouth Disease Outbreak in California" [15]

Feral deer impact directly on environmental, agricultural and community values predominantly through herbivory on plant communities and crops however there is little direct quantification of the extent of this impact at present. The impact of feral deer in Australia were systematically reviewed [10] and it was determined that deer can potentially impact the natural environment by changing plant communities through grazing and damage from antler rubbing, competition with native fauna, and habitat modification through altering vegetation, opening up the understory, and seed dispersal.

Australia's agricultural assets are impacted through feral deer grazing on crops, pasture, fruit and vegetable crops, competing with livestock for food, trampling crops and fouling water sources resulting is losses of productivity, expenditure of time repairing damage and the financial costs of managing deer impacts. Deer also impact managed native and pine forestry plantations through browsing and antler rubbing [10].

The greatest threat that deer pose to community assets and humans is through vehicular impacts. Deer create a domestic nuisance through entering people's gardens and damaging gardens, vegetable patches and household fruit trees. However, there are additional social and emotional impacts and stresses on those land managers impacted through damage to crops and horticultural industries as well as from illegal hunting on their properties [16].

> "Deer are attractive quarry for hunters and, while landholder permission is often sought by hunters, illegal hunting is often reported. Illegal hunters are accused of leaving gates open, shooting at domestic livestock, cutting fences, stealing fuel and causing unease to landholders. There are reports of illegal hunters using social media to report where high deer densities occur which attracts other illegal hunters to the site."
>
> Extracted from "Negative social impacts of wild deer in Australia" [16]

Feral pigs

Feral pigs currently form a reservoir for 14 endemic diseases of which 11 are zoonotic diseases able to be transmitted from pigs to humans, with an additional zoonotic disease carried by ticks infesting pigs [13]. The two most common zoonotic diseases isolated from feral pig populations were identified as leptospirosis and brucellosis [12]. Brucellosis (caused by the bacteria *Brucella suis*) which is currently endemic in both Queensland and New South Wales feral pig populations and can be transferred to humans and other livestock. Pig hunters and their dogs are particularly at risk with a 17 fold increase in identified cases in dogs New South Wales between 2011 and 2015 [17] . Ninety percent of these cases were in dogs that had participated directly in pig hunting activities.

Transmission of disease between feral and domestic pigs was shown to be possible with feral pigs being recorded within 100 metres of commercial piggeries in Queensland [18].

Feral pigs may become a reservoir for many exotic diseases should they enter Australia including foot-and-mouth disease, classic swine fever, Aujeszky's disease, and African swine fever [6]. These diseases have the capacity to cause extensive impacts on Australian agriculture through direct losses and loss of international markets.

> "Feral pigs are also susceptible to many virulent exotic pathogens, with foot and mouth disease virus being the greatest concern. The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) has modelled the cost of hypothetical foot-and-mouth disease outbreaks in Australia. ABARES has estimated that two small foot and mouth disease outbreaks in Queensland and Victoria would result in revenue losses of between $5.6 billion and $6.2 billion (in present value terms) over 10 years, depending on the response strategy used. In the event of a large multi-state foot and mouth disease outbreak, ABARES estimated revenue losses of between $49.3 billion and $51.8 billion (in present value terms) over 10 years"
>
> "If there were a foot and mouth disease outbreak in Australia, feral pigs could contribute to the persistence and transmission of the disease, because they are highly susceptible to the virus, they are abundant in northern Australia, they are often in close contact with livestock, and they are highly efficient amplifiers and transmitters of the virus. The wide range of landscapes/habitats in which feral pigs occur also makes it difficult to predict the spread and persistence of a foot and mouth disease outbreak [19]."
>
> Extracted from the background document to the feral pig threat abatement plan – page 19 [12]

Feral pigs currently cause $14.4 million of direct impacts to Australian agricultural enterprises annually. These losses are predominantly from damages to grain crops and reduced yield from sugarcane, vegetable and fruit crops through rooting and trampling, predation of livestock, in particular, lambs, damage to fences and water points, and competition with livestock and damage to pasture [6].

The environmental impacts of feral pigs are generally well established with habitat degradation and consumption of native species being the areas of greatest impact. Feral pigs are known to consume a diverse range of native plants including their foliage, stems, roots, fruit, seeds, tubers and other underground parts [6]. Feral pigs depredate on many native arthropods, earthworms and are known consumers of turtle eggs and hatchlings, freshwater crocodile eggs and small native vertebrates. Feral pigs are dispersers of seeds through excreting consumed seeds facilitating the spread of invasive plants [20].

c. The effectiveness of current state and national laws, policies and practices in limiting spread and mitigating impacts of feral deer, pigs and goats.

As an RD&E organisation, the Centre for Invasive Species Solutions does not specifically comment on current state and national laws and policy regarding feral deer and pigs. The continent-wide distribution of feral deer, pigs and goats requires a coordinated and consistent national, landscape scale, nil-tenure approach to their management to minimise the impacts of these species on the environment, agriculture and community values. CISS advocates that any state or national laws and policy should not form an impediment to the creation of national collaborations for the effective management of these species nor should there be any legislative or policy barrier to the implementation of best practice management actions.

Recommendation.

1. **Legislation and policy should not form an impediment to the formation of national collaborative approaches to the management of feral deer and pigs.**

d. The efficacy and welfare implications of currently available control and containment tools and methods, and the potential for new control and containment tools and methods.

At present most of the management actions to control feral deer and pigs are undertaken as a local or, at best, a regional level. Management action needs to be undertaken at a scale appropriate to the population being managed to be effective. The extensive distribution of these species requires a nationally coordinated, landscape scale, nil-tenure approach to their management to effectively minimise their impact and damage to the environment, agriculture and community values. Best practice pest management requires focussing on reducing the impact of these species on environmental, agricultural and community assets rather than focussing on the abundance of these species and simply reducing their number.

Current tools and techniques: feral deer

At present feral deer can only be managed through aerial and ground shooting, trapping, and using exclusion fencing. These techniques generally sit at the lower end of the range of effective techniques used in the management of invasive species that have spread across Australia. Unlike for many other invasive species, there is not a Model Code of Practice for the humane control of feral deer. There is a current Standard Operating Procedure for the ground shooting of feral deer to ensure their humane management through shooting [21]. There are no toxins or biological control measures approved or available for deer in Australia. CISS, as part of its forthcoming application to the Australian Pesticides and Veterinary Medicines Authority (APVMA) to register an immunocontraceptive called Gonacon to

be applied to manage small populations of macropods in urban and peri-urban areas, is also seeking approval of an immunocontraceptive to manage small deer populations in areas where shooting, trapping and exclusion fencing are not appropriate, such as in some peri urban areas. Gonacon was developed and registered in the US as a fertility control agent for deer, and as such is included in the CISS Australian registration application, even though our focus is registration of a fertility control for macropods in peri-urban and urban contexts. It needs to be stressed that fertility control is an expensive option compared to shooting and other conventional controls, and is not suitable for landscape scale application.

The humaneness of currently available techniques for deer management were examined in a report assessing the relative humaneness of pest control methods [22]. This assessment method examines both the welfare impacts on the animal prior to death and the mode of death and ranks the perceived suffering of the animals against both these criteria. This analysis showed that these methods are generally humane. The assessment matrix has been extracted from this report and is shown below together with a guide to interpret the outcomes (Figure 4 & Figure 5). CISS is a strong proponent for humane management of vertebrate invasive species and all new tools and techniques are assessed using this matrix to ensure that these tools and techniques minimise impacts on animal welfare.

Given the continued spread of feral deer across the Australian landscape and their increasing impact on the environment, agriculture and social assets, it is apparent that the available control methods for feral deer are insufficient to limit the expansion of range or to decrease the impact of deer at the levels at which they are currently implemented. This situation is unlikely to change unless innovative new techniques and tools are developed in conjunction with a national landscape scale nil-tenure approach to deer management.

Following the National wild deer workshop in 2016, CISS facilitated the development of a national deer management research program comprising four collaborative projects with partner organisations based on the agreed research priorities to enhance best practice management techniques and to increase knowledge of deer impacts and the effectiveness of the currently available tools. These projects include research into innovative techniques to aggregate feral deer to increase the efficiency and cost effectiveness of control measures and to critically assess current techniques and community acceptance of deer management in peri-urban areas.

Current tools and techniques: feral pigs

A greater range of techniques are available for the management of feral pigs than for deer. In addition to shooting, trapping and fencing, feral pigs are managed using toxins such as 1080, warfarin, CSSP (yellow phosphorus), and in the near future - sodium nitrite. Commercial harvesting of feral pigs is also used as a management tool in parts of New South Wales and Southern Queensland [12]. Collaborative research projects through CISS predecessor, the Invasive Animals CRC, and the private company Animal Control Technologies Australia resulted in the development of commercially available pig baits PigOut®, a 1080 based bait and HogGone® a sodium nitrite-based bait product.

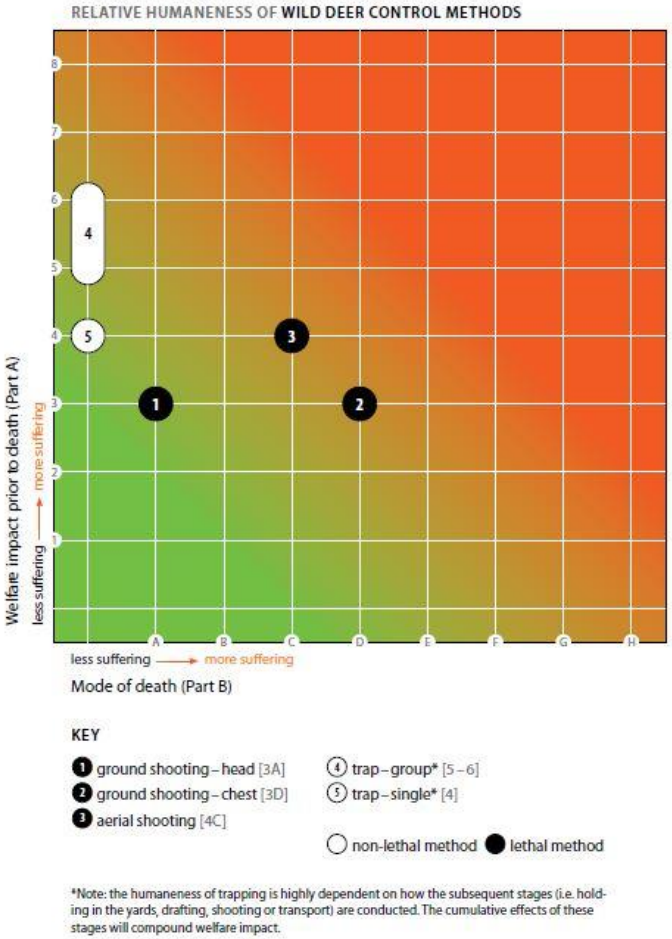

Figure 4. Assessment of humaneness of methods of control for feral deer. Extracted from Sharp and Saunders (2011) A model for assessing the relative humanness of pest animal control methods [22]

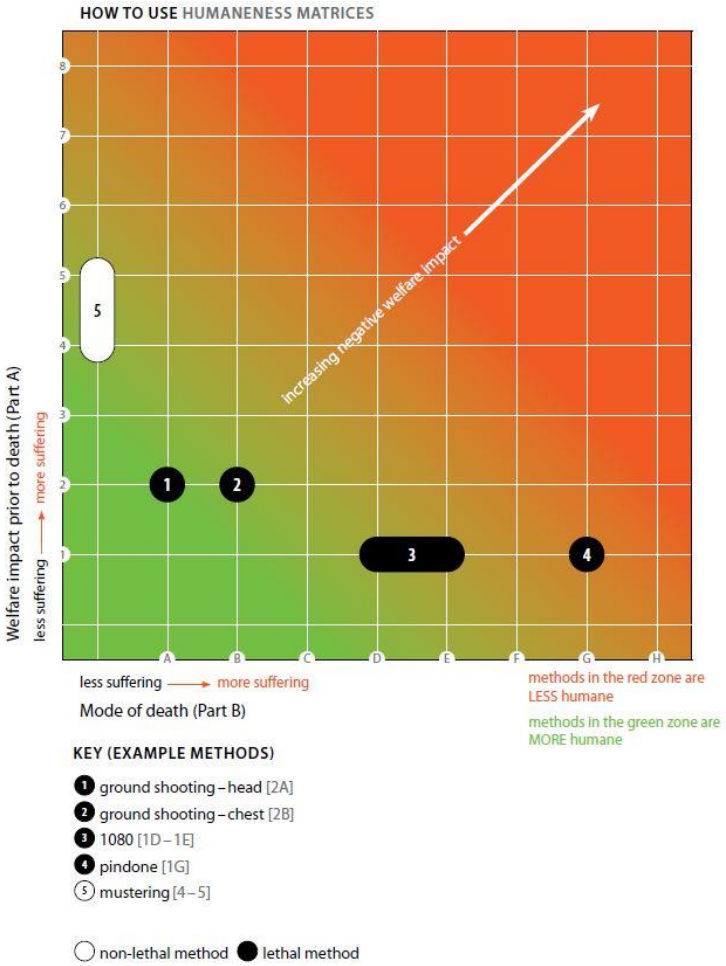

Figure 5 Information of how to interpret the relative humaneness matrix. Extracted from Sharp and Saunders (2011) A model for assessing the relative humanness of pest animal control methods [22]

These collaborations also resulted in the development of a novel bait delivery device, the HogHopper™ that minimises the potential for non-target species to access the baits and therefore the toxin. These tools are complementary to previously available management techniques and are not intended to replace existing management tools. Having an improved range of management tools increases the options that land managers have available to effectively manage feral pigs.

As with deer, the humaneness of the management techniques has been assessed using the Model for assessing relative humaneness of pest control techniques [22] (Figure 6). A national Model code of practice for the humane control of feral pigs and been developed [23] as have standard operating procedures for many of the control measures used to ensure that feral pigs are managed in the most humane way possible.

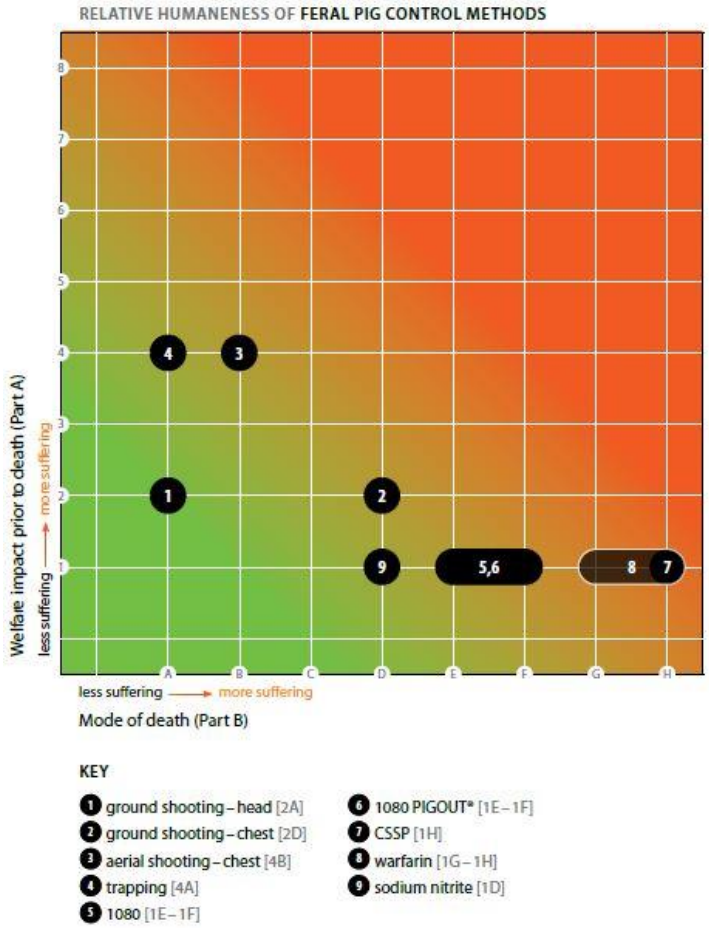

Figure 6. Relative humaneness assessment for the current management techniques for feral pigs. Extracted from Sharp and Saunders (2011) A model for assessing the relative humanness of pest animal control methods [22]

HOGGONE ®

The need to reduce feral pig impacts across much of Australia's grazing and irrigated agricultural landscapes has dramatically increased in parallel with their increased national abundance since 2010. Developed through an international collaboration through the predecessor of CISS, HOGGONE® is a new feral pig control product containing sodium nitrite to which feral pigs are very susceptible. Field trials in both Australia and the United States have demonstrated that is a very effective tool to reduce pig abundance. An application for registration was submitted to the Australian Pesticides and Veterinary Medicines Authority on the 4th August 2017. Hoggone® will provide an effective additional tool for land managers in their efforts to manage feral pig impact.

Need for coordinated, landscape-scale, nil-tenure management approach

As previously noted, feral deer and pigs are spreading across the Australian continent however most of the management of these species is undertaken at a local level with few management programs being undertaken at a regional scale and none at a state or national scale. To effectively manage the impacts of these species, a coordinated, landscape-scale, nil-tenure approach must be taken. A key driver for CISS is to optimise regional level management of these species rather than focus on local level management where the outcomes, while potentially being beneficial for local areas, are not replicated across a wider area to optimise the benefits from management actions. This national level coordination can be accomplished through the funding and appointment of national and/or state facilitator positions for both feral deer and pigs similar to the national and state coordinator positions that exist to promote best practice wild dog management. These roles will encourage and assist with the flow of new tools and techniques and to promote best management practices to land managers and allow the formation of a collaborative and coordinated approach to the management of feral deer and pigs. This national facilitator approach has proven very effective in managing and reducing the impacts of wild dogs and has resulted in the formation of many regional level management groups working together on a common invasive species problem.

CISS sees the creation of regional scale participatory demonstration sites as an essential step for the development, testing and optimisation of integrated management tools and techniques for feral deer and pigs. Experience has shown that these sites effectively validate that management at this large scale is effective and provides benefits for all impacted groups within the region.

National facilitators and demonstrations sites are key factors in enabling communities to take effective action against invasive animals. CISS has in place effective digital platforms in FeralScan and PestSmart that offer a supporting role in the distribution of knowledge and information to communities to enable them to undertake best practices pest management.

FeralScan is an award winning (Banksia Award 2016) community mapping and monitoring platform developed through a CISS collaboration between New South Wales Department of Primary Industries and recently Australian Wool Innovation aimed at facilitating adoption of tailored digital resources that will allow the community to actively contribute to the detection, mapping and management of invasive species, including feral deer and pigs and allow mapping of distribution, impacts and management actions being undertaken. This project will allow land managers to readily access the latest information about the invasive species in their local area, applicable management technologies and resources and will provide relevant invasive species mapping to facilitate effective control at a national, state, regional and local level.

Management actions need to be undertaken when the greatest impact can be achieved. For many species this is during drought when the animals are reduced and are congregated around limited water resources. Increased control at these times can reduce the invasive species populations to a level where impacts and damage are lessened when weather conditions improve. It is acknowledged that drought is also a time when land managers have vastly reduced resources to undertake invasive species management however this is the time when greatest results can be achieved.

Recommendations.

2. **A nationally coordinated landscape scale nil-tenure approach should be taken to the management of feral deer and pigs.**
3. **National facilitators for both feral deer and pigs should be appointed along the lines of the wild dog management facilitator positions.**
4. **Regional scale nil-tenure demonstrations sites for the integrated management of feral deer and pigs using and enhancing best management practices should be established across the country, initially in areas where impact is greatest.**
5. **Management actions should take a nil-tenure approach allowing and encouraging management across local, regional and state boundaries to ensure effective management of feral deer and pigs.**
6. **Increased resources should be allocated towards management actions for invasive species during the periods when populations are already being impacted by external factors such as drought.**
7. **A model code of practice for the humane control of feral deer should be developed.**

e. Priority research questions.

As part of the National wild deer management workshop in 2016, expert participants were tasked with identifying the priorities for future feral deer research and management across the four themes of a) impact, b) management tools and systems, c) monitoring deer distributions and abundance, and d) community engagement, use and awareness. Several priorities were identified across multiple themes (Table 1). The Centre for Invasive Species Solutions has funded four research collaborations

between state and university partners, and multiple third-party organisations to address several of the identified priorities. This is Australia's largest research collaboration on feral deer with the projects spanning four states and one territory with each state having taken the lead in one of the projects. The collaboration has a combined investment of $8.7 million.

The research priorities for feral pigs are identified in Actions 3 and 4 of the 2017 threat abatement plan for feral pigs [24]. These are framed in broad terms and are extracted for clarity (Table 2).

Table 1. Research priorities identified by experts during the National wild deer workshop and extracted from the proceedings of that workshop for this submission [5].
Priorities identified over multiple themes are marked with an *. Priorities funded through CISS are marked with #

Priorities for future work into feral deer
Impacts
• #Review impacts of deer on agriculture and metrics for monitoring those impacts. • Improved understanding of damage/density relationships and control thresholds required to protect assets.
Management, tools and systems
• Assess animal welfare outcomes of aerial shooting. • Evaluate efficiency of using suppressors during ground shooting to reduce community concern and improve management efficiencies. • #Improve understanding of lures and options for baiting deer. • Building capacity and training of contractors to control deer with dogs and ground shooting. • How cost-effective are guardian dogs and fences at protecting crops? • Understand motivations of recreational shooters to shoot more females / more deer. • Can commercial use of deer products be used to reduce deer impacts. • *#Best practice guide for monitoring and controlling deer and their impacts. • #Improved trapping techniques.
Monitoring deer distribution and abundance
• *#Best practice guide for monitoring and controlling deer and their impacts. • Assess and validate emerging techniques (eg thermal imaging, drones, species recognition algorithms) for monitoring distribution and abundance. • Improve understanding of how fast and where deer will spread.
Community engagement, use and awareness
• Develop a community engagement model. • *Understand motivations of recreational shooters to shoot more females / more deer.

Table 2. Future research priorities included in the Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (2017) [24]

Future research priorities for feral pigs
Action 3.1: Research into feral pigs impact on nationally threatened, and near threatened, species and ecological communities
Action 3.2: Research into feral pig populations dynamics and ecology
Action 3.3: Research into spatial and temporal use of landscapes by feral pigs
Action 3.4: Research into the effectiveness of feral pig control methods
Action 4.1: Encourage monitoring to enable the evaluation of the effeteness of feral pig control.
Action 4.2: Develop further effective monitoring techniques

Feral deer and pigs are widespread across the Australian continent. This requires a national level iterative approach to identify current and emerging future research priorities. The national deer workshop and feral pig TAP have identified those areas that are current priorities however changing climate and distributions of these species will require that these priorities are regularly re-evaluated to ensure that emerging priorities are not overlooked. Similarly, research to answer priority questions needs to be undertaken as a scale that is appropriate to both the problem and the distribution of the species. Undertaking local, small scale research projects to answer national questions will likely result in answers that cannot effectively answer the question and will not provide suitable best practices management outcomes for land managers.

Recommendations

8. **Research into the list of priorities identified in the National wild deer workshop should be implemented to increase the solutions needed for the management of deer.**
9. **Research based actions in the feral pig threat abatement plan be implemented to ensure that the identified outcomes of the plan are met.**
10. **A national approach should be taken for identifying emerging future research priorities for feral deer and pigs.**
11. **Research activities should be undertaken to answer priority questions and take place at the scale that is appropriate to the scale of the problem and the distribution of the invasive species.**

f. The benefits of developing and fully implementing national threat abatement plans for feral deer, pigs and goats.

Threat abatement plans are an important tool in identifying, planning and undertaking management actions to minimise key threatening processes posed to threatened native species and ecological communities. They, together with their background documents, allow the collation of knowledge, best practice management and future research needs to be condensed into a plan designed to assist the

long-term survival on many of Australia's threatened native species through the reduction of clearly identified threatening processes. To date Threat Abatement Plans have been developed for feral pigs and goats based on their listing as discrete Key Threatening Processes.

There threat abatement plan for feral pigs was recently revised and released in 2017 outlining the research and management required to minimise the threats posed by feral pigs. For a threat abatement plan to be effective they must be well resourced.

On the other hand, feral deer are captured under the broad listed Key Threatening Process (KTP) Novel biota and their impact on biodiversity [25]. This mitigates against feral deer from being listed as a new separate KTP under the Environment Protection and Biodiversity Conservation Act 1999 (Cwlth) and is thus ineligible under the Act for a specific threat abatement plan for their impacts.

A key condition for a Threat Abatement Plan being considered feasible, effective and efficient is that there is benefit from a cooperative cross-jurisdictional approach. This condition is also a policy principle of the National Biosecurity Committee 'National framework for the management of established pests and diseases of national significance' for those pests assessed to be nationally significant (Principle 6). An additional policy principle is that government will work with stakeholders to support research and development for more effective pest and disease management (Principle 4).

The CISS national deer management research program is an example of existing cross-jurisdictional cooperation to progress deer best practice management innovation. Given that this initial program is up and running, a potential benefit of listing feral deer as a nationally significant established pest under the Australian Pest Animal Strategy [26] and developing the concomitant national plan could be to concisely articulate further deer research, innovation and extension priorities derived from the 2016 IA CRC national deer management workshop and other sources.

Recommendations.

12. **That the Environment and Invasives Committee consider the pros and cons of listing feral deer as an Established Pest of National Significance to foster stronger national coordination and strategic action.**

g. Any other matters.

Nil.

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