



## CONFERENCE PROCEEDING

## Feral pig management in Australia: implications for disease control

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Aust Vet J 2022;100:492–495

doi: 10.1111/avj.13198

Feral pigs (*Sus scrofa*) were introduced to Australia following European settlement and are now widely distributed in a variety of habitats (Figure 1). High-density populations are found particularly in north-eastern Australia. Feral pigs are commonly viewed as a valued hunting or commercial resource, occasionally as an important cultural resource, but overwhelmingly as a devastating agricultural and environmental pest.<sup>1,2</sup> Their wide-ranging impacts demand intervention through control programs on many production and conservation lands. Feral pigs also carry pathogens of human health significance and contribute to the persistence and transmission of a range of endemic diseases or pathogens of livestock and wildlife. Feral pigs are the invasive species of most concern in Australia as potential vectors of exotic disease.<sup>2</sup>

The 2022 outbreak of Japanese Encephalitis (JE) on 79 pig farms in South Australia, Victoria, New South Wales and Queensland together with cases in feral pigs in the Northern Territory and Queensland highlights the importance of both feral and domestic pigs as important amplifying hosts of the JE virus.<sup>4–6</sup> In addition, the recent African swine fever (ASF) epizootic in Europe and Asia has focused attention in Australia on the potentially devastating implications of ASF to the domestic pork industry. Data following outbreaks in Europe have demonstrated that there is an ASF epidemiological cycle involving wild boar and their habitat, and that wild boar is an important reservoir of the disease. In Australia, this ‘feral pig-habitat’ cycle would involve direct transmission of the disease between infected and susceptible feral pigs, and indirect transmission arising from infected carcasses in the habitat.<sup>5–8</sup> Of particular concern is the potential spread to the ‘domestic-cycle’ via direct or indirect contact between domestic pigs and feral pigs, or their habitat.

## Feral pig control methods

Tools to manage the ASF ‘feral pig-habitat’ cycle and interactions with domestic pigs are available. They include poisoning, trapping,

aerial shooting, and recreational and commercial harvesting. Poisoning is typically seen as the most effective and cost-efficient technique for managing pig populations, with population reductions greater than 80% commonly recorded.<sup>2,9</sup> Poisoning is still reliant upon the toxin 1080 (sodium fluoroacetate), although sodium nitrite-dosed baits have recently become available.<sup>10</sup> In some jurisdictions 1080 can be added to different bait substrates (e.g., grain, meat) to help tailor acceptability to local pig population dietary preferences. Sodium nitrite is available in commercially manufactured baits which offer advantages in shelf-stability and ease of use. Generally, the most effective applications of poisoning rely on prefeeding of bait substrates (e.g., grains without toxin added) to increase uptake of the bait when the toxin is added, increasing the proportion of the population encountering and ingesting toxic material. However, aerial applications of bait are more efficient for pig control over extensive or inaccessible areas. There are restrictions on toxin use, particularly to safeguard wildlife, pets, and domestic stock, and use in closely settled environments is difficult. Given the generally long period following between consumption and death, carcasses can be difficult to locate following poisoning operations, making disposal difficult.

Trapping can be effective at population reduction but ‘catchability’ can vary widely among individual pigs and environments.<sup>9</sup> Trapping can often be applied in situations where other control techniques cannot (e.g., closely settled areas) and there are trap designs that ensure target-specificity. Trapping is often applied as ongoing or maintenance control at a local scale, with traps activated following pig activity. Trapping is generally considered labour-intensive and costly compared to other control like poisoning and shooting<sup>9,11</sup> although the increasing availability of various technologies to remotely monitor traps and activate feeders and traps have reduced labour requirements.

Shooting or hunting of pigs is common. Aerial (helicopter) shooting remains a useful technique for rapid population knockdown when used over a number of adjacent properties.<sup>2</sup> However, it can be difficult to efficiently remove a large proportion of the population with these techniques as the effort (time/costs) of finding and destroying pigs disproportionately increases as density declines. Capture success is usually group-size dependent, with individuals becoming increasingly difficult to capture with increasing group size, particularly during ground shooting or hunting operations. However, small, or isolated pig groups may be difficult to detect when encounter rates are low. The use of hunting dogs is legal in some states and territories but remains controversial.<sup>2,12</sup>

Like recreational hunting, commercial harvesting of pigs is often seen as a ‘free’ form of control for pest managers. However, harvest

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offtake rates are highly variable, usually well below population replacement levels, and restricted in spatial extent, allowing populations to quickly recover.<sup>13</sup> There is also a risk of deliberate introductions by hunters to seed new populations.

Nonlethal techniques are also used to manage pig populations or their impacts. Exclusion fencing is used to restrict pigs from small, high-value areas (e.g., horticultural cropping, intensive livestock) where the economic benefits exceed the construction and maintenance costs. Fencing is also used to protect highly sensitive environmental areas (e.g., mound springs, freshwater lagoons) where total exclusion is required to mitigate impacts. Fencing is a commonly used asset protection biosecurity measure to restrict contact between feral pigs and domestic livestock in livestock production settings (e.g., commercial piggeries). Electric fencing is cost-effective to restrict pig movements, but more robust and expensive designs are required for total exclusion.<sup>14</sup> Temporary, panel-style fences have also been effective at containing pig movements.

Fertility and biological control are not currently viable ways to manage feral pig populations. Fertility control applications remain unlikely until target-specific, oral delivery mechanisms are developed, and results are proven in wild pig populations.<sup>1</sup> Furthermore, impacts from treated animals would remain, including as reservoirs or agents of disease transmission. The use of any biological control agents to manage feral pig populations is considered problematic given the susceptibility of domestic pigs.

The cost and effectiveness of removal techniques vary widely and not all pigs are susceptible to each control technique. Therefore, combinations of techniques are recommended<sup>2,9</sup> and should ideally be applied at a landscape or population-scale to reduce repopulation from uncontrolled areas. Pig populations subjected to control may also compensate with increased fecundity or survival, assisting population recovery. When populations are reduced to low levels, and the environmental conditions are favourable (i.e., food and resources are not limiting), population growth can be unrestricted and can reach maximum rates (*r<sub>max</sub>*). For a population potentially growing at *r<sub>max</sub>*, 60%–70% of the population needs to be removed continuously throughout the year to hold it stable.<sup>13</sup> This is difficult to achieve without continual control efforts (i.e., removals). Hunting or commercial harvesting of pig populations cannot consistently achieve these levels of reduction, particularly across landscapes,<sup>13</sup> a problem shared by most other lethal control programs.

### Strategic management

In most circumstances, eradication of feral pigs is not considered feasible,<sup>9</sup> thus management should target reducing damage or risk, not necessarily pig abundance, although these are inextricably linked.<sup>15</sup> For example, the relationship between damage and pig-density for fruit and vegetable crops is likely to be curvilinear at high pig densities<sup>2</sup> (i.e., once pigs reach a certain density, no more damage is expected with further increases in pig density). This translates to an unlikely reduction in damage/impacts until pig numbers are greatly reduced. A similar relationship is expected for many disease management scenarios where densities may need to be significantly reduced to below density thresholds required for disease persistence

or transmission. Control programs should aim to reduce impacts to acceptable levels, and continue as necessary to inhibit recovery.<sup>1</sup> Therefore, continued monitoring of the impacts (or benefits) of control is required to ensure that the strategic aims are being met.

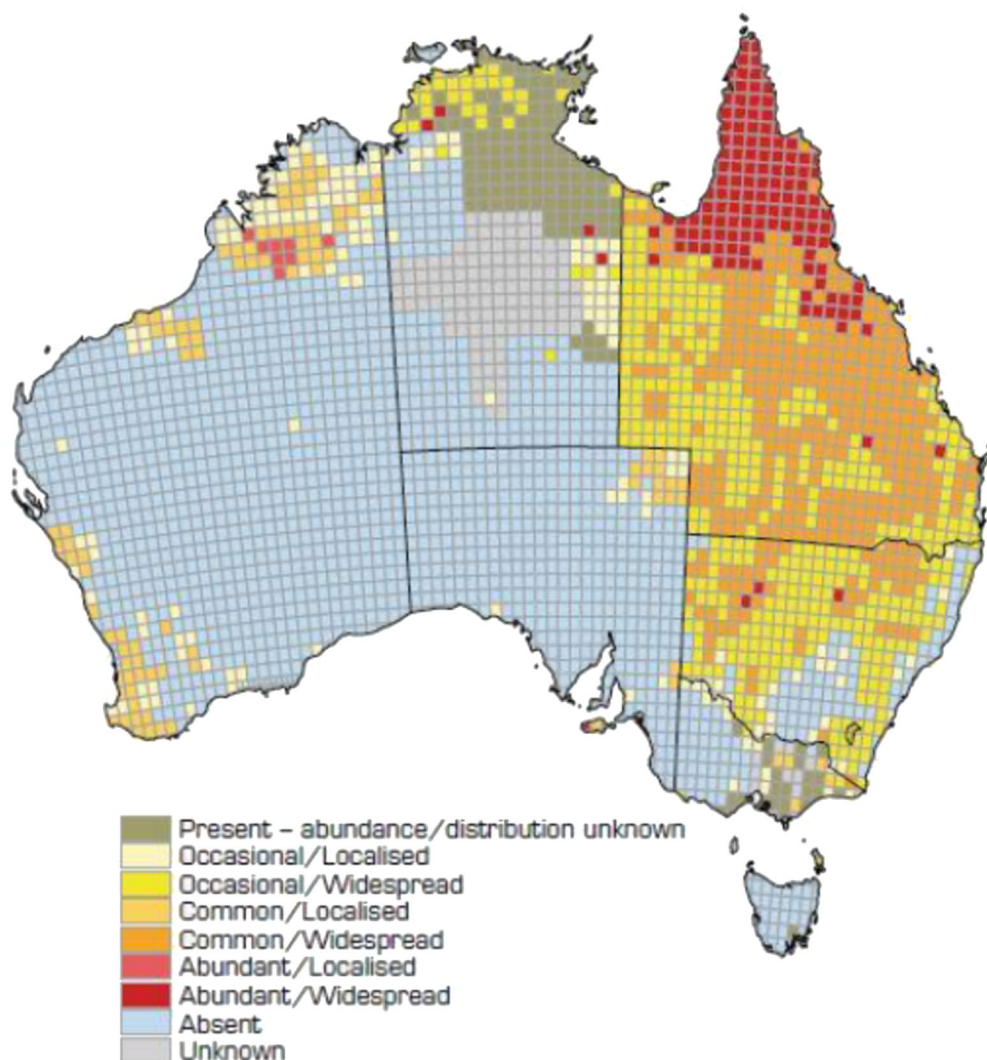
### Implications for disease surveillance and management

There has been significant work completed on developing strategies on biosecurity preparedness for porcine exotic disease in Australia.<sup>8</sup> Review of recent mitigation strategies used to manage European wild boar populations during ASF outbreaks are also essential to guide local developments.<sup>16</sup>

External to managing ASF transmission in the ‘domestic pig cycle’, a challenge with ASF in the ‘feral pig-habitat’ cycle involves managing disease transmission between feral pigs and indirect transmission arising from contact with infected carcasses in habitat.<sup>7</sup> ASF has been positively associated with wild boar population density in Europe.<sup>7,17</sup> A major risk factor for JE also includes populations of pigs (feral or domestic) particularly where the climate supports the mosquito vectors. Unfortunately, detailed information on current feral pig densities and habitat distribution (and influences of climatic or seasonal conditions) across their range in Australia is lacking. This is needed to identify where and when feral pigs may overlap with domestic pigs and the likelihood of disease transmission. This in turn will identify key locations for emergency animal disease preparedness, surveillance, and likely response. Detailed pig distribution can also be used to inform and refine decision support modelling tools, including the Australian Animal Disease spread model,<sup>18</sup> adapted to ASF.

ASF virus can persist in infected carcasses and nearby soil for extended periods despite high wild suid depopulation,<sup>7,19</sup> making carcass removal and site management critical to avoid cannibalism and oral transmission.<sup>20,21</sup> Although local data are lacking under Australian conditions, ASF virus persistence in the environment is likely to be greater in the southern, cooler areas than the more northern, warmer regions. Conventional control methods that allow for carcass retrieval (e.g., trapping, shooting, hunting, harvesting), are required for active surveillance and sanitary carcass disposal. Poison baiting is considered efficient for population control, but is problematic for carcass retrieval and site management, and may thus be less effective to reduce ASF prevalence or spread in feral pig populations. Regulatory changes will limit the use of different bait substrates (e.g., fruit, vegetables, meat) in poisoning campaigns, potentially reducing baiting efficiency in some areas.<sup>22</sup>

Exclusion fencing has obvious applications in ASF management to reduce the likelihood of contact between domestic and feral pig populations and restrict the movement of feral pigs. Secondary fences may further mitigate the potential for domestic pig, feral pig and pig habitat interactions. The resources and maintenance required are prohibitive for landscape scale deployment, but suitable for targeted applications (e.g., excluding feral pig access to domestic pig production or, processing facilities). Fencing (including electric and ‘odour’ fencing) has been successfully used to manage wild boar dispersal and ASF spread from high-risk zones in Europe.<sup>16</sup>



**Figure 1.** Feral pig distribution in Australia, 2008.<sup>3</sup>

Aerial shooting is popular and effective for rapid knockdown of pig populations, particularly useful for exotic disease management, and can be applied in some areas where ground access is limited.<sup>2</sup> However, sanitary carcass disposal needs to be considered for ASF. Intensive control programs using more ‘aggressive’ techniques such as intensive hunting with dogs may possibly disperse or alter pig behaviour and are obviously problematic for limiting disease spread.<sup>23</sup> However, such potential effects on pig behaviour require further assessment. Hunting with dogs may be particularly useful to target pigs that survive other control techniques.<sup>24</sup>

Hunting or commercial harvesting may be applicable for passive surveillance, particularly to assist in early detection, or to supplement more intensive, restrictive sampling in higher risk areas. Passive and active surveillance, particularly through testing wild boar carcasses has been critical in early detection and effective responses to ASF outbreaks in Europe.<sup>16</sup> Processing depots or facilities used for game meat processing<sup>13</sup> may also offer initial sampling points for ASF or JE surveillance where domestic pigs cannot be used as sentinels. All surveillance and control measures need to mitigate the potential for

movement of infected material, using measures such as bans on feral pig hunting or entry to infected areas by the public.<sup>16</sup>

Conflicting values between stakeholders (e.g., feral pigs perceived as either a resource or pest) can lead to difficulties in implementing or agreement on objectives of control programs. At worst, conflicts could result in accidental or deliberate breaches of biosecurity measures. Anthropogenic factors are often associated with long-distance spread of ASF in Europe,<sup>7</sup> and will be important locally given human interactions with feral pigs through hunting and commercial harvesting are common.<sup>13</sup> The cooperation of hunters, harvesters, land and pest managers and other members of the public will be essential for an effective, cohesive ASF response. ASF control options adapted to and accepted in local contexts – as informed through social science approaches – are required to ensure their high acceptance and success.<sup>25</sup> Understanding the ‘human element’ of ASF, through behaviour study, community engagement and consultation, is thus critical to successfully develop, implement and monitor ASF management plans, particularly where conflicting values are apparent.

## Conclusion

The wide distribution and habitat range of feral pigs in Australia offers challenges to developing and implementing effective disease management strategies. A variety of methods (including shooting, trapping, poisoning, exclusion fencing, recreational and commercial harvesting) of variable efficacy are available as part of surveillance and control options for application in the event of a potential future ASF outbreak affecting feral pigs in Australia. Detailed information on feral pig distribution, habitat use and the likely epidemiology of an ASF incident in Australian feral pig populations is needed to collectively inform or refine the type, intensity and location of surveillance and interventions required to manage risk to acceptable level. Understanding the 'human element' of managing ASF in feral pigs is also essential to ensure management approaches are successfully adapted to local contexts.

## Acknowledgments

The assistance of Carmel Kerwick, Malcolm Kennedy, Tony Pople, Robyn Grob and Mark Cozens is acknowledged. Support for this work was provided by Biosecurity Queensland. Open access publishing facilitated by Queensland Department of Agriculture and Fisheries, as part of the Wiley - Queensland Department of Agriculture and Fisheries agreement via the Council of Australian University Librarians.

## Conflicts of interest and sources of funding

The authors declare no conflicts of interest or sources of funding for the work presented here.

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(Accepted for publication 3 July 2022)