AFRICAN SWINE FEVER (ASF) FERAL PIG TASK GROUP REPORT

2020

African swine fever – Feral Pig Task Group Report

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Terms of Reference

A. Purpose

The purpose of this Terms of Reference (ToR) document is to describe the governance arrangements and responsibility and scope for the members of the African swine fever – Feral Pig Task Group.

B. Membership

Chair

Allison Crook	Queensland AHC representative

Government response jurisdictional representatives

QLD	Jonathan Lee / Mark Cozens
NT	Sue Fitzpatrick
WA	Graham Mackereth
Victoria	Clare Death / Di Phillips
NSW	Ofir Schwarzmann
ACT	Wendy Townsend
SA	Allison Crawley / Celia Dickason
Commonwealth	Andrew Breed

Industry partner representatives.

NAQS	Skye Fruean / Guy Weerasinghe
AAHL	Peter Durr
WHA	Tiggy Grillo

Expertise based representatives

Agriculture Victoria	Jason Wishart
CSIRO JCU	Justin Perry
ABARES	Sandra Parsons
PIRSA	Annelise Wiebkin
BQ	Ted Vinson
DPI NT	Hayley Pearson
DPI NSW	Troy Crittle
APDHA	Mark Beattie / Ned Makin

The membership of the Working Group may change over time as required and as agreed by Members. Members may delegate the meeting to an appropriate senior staff member where they are unavailable.

The secretariat will be provided by Queensland and supported by AHC Secretariat.

C. Objectives

1. Use the expertise of the group to share knowledge and resources to understand the impacts of the introduction of African swine fever (ASF) into the feral pig population in Australia and to guide response planning in the event of;
    i. confirmation of African swine fever in the feral pig population in Australia with potential spill over to farmed pigs.
    ii. confirmation of African swine fever in the farmed pig population in Australia with potential spill over to feral pigs.
2. Develop principles and practices that underpin the necessary activities in the feral pig population as part of the agreed AUSVETPLAN response policy on confirmation of ASF in Australia.
3. Determine the priority preparedness activities to address the risk pathways of ASF into the feral pig population in Australia, including specific advice on early detection activities, including surveillance and sampling and appropriate pre-emptive interventions.
4. Identify any targeted/specific communications requirements relevant to these priority activities.
5. Provide opinion on any referred key questions relevant to feral pig populations and ASF.

D. Scope

The scope of this Working Group is the provision of specific advice on the role of the feral pig population in Australia in the event of an ASF incursion to inform emergency animal disease response plans.

If it becomes apparent that the work of the Task Group has been overtaken by other arrangements, the Task Group will cease and provide its inputs to the relevant body to continue the preparedness approach.

E. Funding

There is no specific funding for the ASF feral pig preparedness Task Group or its activities.

F. Operating Procedures

1. SCHEDULE

Item	Schedule
Working Group meeting	The Working Group will meet regularly by teleconference as agreed
Agenda and supporting material	The agenda and associated materials to be discussed at a meeting will be distributed no later than three (3) working days prior to the scheduled meeting.
Meeting minutes	The minutes of a meeting will be distributed no later than five (5) working days after the meeting has occurred.
OOS papers	Out of session papers may be circulated to Members at the discretion of the Chair.

2. GOVERNANCE AND REPORTING

- All parties can nominate agenda items for discussion and recommendation.
- The group will report to Animal Health Committee and provide contemporaneous briefings to the Environment and Invasives Committee. Both committees are sectoral committees under the National Biosecurity Committee.

3. CONFIDENTIALITY

- Details of discussions are to remain within the group unless required to fulfil the terms of reference.
- In cases where deliberations or resolutions are required to be transmitted outside of the group, they will be de-identified and/or approval sought from the group to release.
- Papers and resolutions are not intended for widespread distribution. However, these documents can be distributed outside the group to progress the business of the group and maintain communication with other groups as appropriate. In these cases, appropriate confidentiality is to be practised.

African swine fever – Feral Pig Task Group

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African swine fever – Feral Pig Task Group

Mapping component

Summary report (October 2020)

Summary

Feral pigs are likely to play a significant role in Australia's ability to respond to an ASF incursion. The Animal Health Committee African swine fever feral pig task group (the TG) has compiled information on feral pig presence and abundance to assist with preparedness activities. This spatial information, when combined with other spatial layers, can be used to generate likelihood maps that provide insight into things such as the relative likelihood of incursion and the likelihood of transfer between domestic and feral pigs. These insights can inform the development of surveillance systems for early detection as well as response activities. Key things to note are:

1. The mapping component of the TG, led by ABARES, has created:
    i. A dataset for mainland Australia of domestic pigs, at 5 km grid resolution
    ii. A dataset for mainland Australia of abattoirs that process pigs
    iii. A dataset for mainland Australia of saleyards that process pigs
    iv. A dataset for mainland Australia of feral pig point locations, at 5 km grid resolution
    v. A national dataset of feral pig occurrence and abundance
2. The quality of the data available is variable, therefore there are several limitations with the data that will affect its use. For example, the national feral pig occurrence and abundance map is not consistent across jurisdictions in currency, resolution, or by the methodology employed by each jurisdiction.
3. There are restrictions on dissemination of these datasets that satisfy requirements of the primary data owners.
4. The Department of Agriculture, Water and the Environment, through an ABARES project, is currently aiming to address issues with national mapping of vertebrate pests (including feral pigs).

Introduction

Feral pigs are likely to play a significant role in Australia's ability to respond to an ASF incursion. The Animal Health Committee African Swine Fever Feral Pig Task Group (the TG) has been compiling information on feral pig presence and abundance to assist with preparedness activities. This spatial information, when combined with other spatial layers, such as domestic pigs, can be used to generate likelihood maps that provide insight into things such as the relative likelihood of incursion and the likelihood of transfer between domestic and feral pigs.

Development of spatial layers

Feral Pigs

Measured data

The TG has obtained spatial information on feral pigs from all jurisdictions. There are two main types of spatial datasets that have been acquired for the mapping exercise: state-wide occurrence assessment maps (which includes data based on opinion elicited from land managers), and 'point-based' data (which includes atlas data, locations where control activities occurred etc.). A broad description of datasets used is provided in Box 1. These data differ in terms of resolution, currency and the methods used to obtain them. There are gaps in the data, including from sensitivity that restricts availability in some cases. These issues create obvious challenges for subsequent analyses.

Box 1 Description of datasets on feral pigs that were obtained

State-wide occurrence assessment maps

These maps are created for each state or territory, and are, in general, created periodically through information provided by a series of workshops. These workshops are typically conducted by jurisdictional staff and participants with local knowledge are asked to provide information about the occurrence, distribution, and relative abundance of certain problem species, including feral pigs. The spatial resolution of these maps varies greatly, and they are created at different time intervals. The resultant maps present occurrence information derived from subjective, albeit consistent means within (but not necessarily between) jurisdictions. They present relatively complete information for a jurisdiction and indicate where information is lacking. While design and methodology may differ between the jurisdictional programs, assessments conducted at the jurisdictional scale like this are available for most jurisdictions. For two jurisdictions, the most recent state-wide occurrence information was collated from a range of sources during an earlier, national exercise (West, 2008).

Point-based data

Point location data for feral pigs have been collected in every state from mainland Australia. Datasets of point records created by state or regional staff for targeted, on-ground management purposes make up the majority of point location datasets. They often include a detailed set of attributes including observation date, group size, collector details and sometimes have absence data, repeated visits to sites, as well as incidental observations. Point-based data collected specifically for management purposes are limited in their spatial extent. The targeted nature of control work (e.g. shooting, trapping) makes the data a poor basis from which to extrapolate beyond the localised area where control is being implemented. Information about the methodology and metadata is often not submitted with the data and requires further clarification with the data providers.

Other point location data sources include observations made by members of the public and submitted to various databases. These data usually only have simple attribute sets (e.g. only date of observation, group size), are collected without any structured survey design and show strong bias to areas of higher human population density. They usually indicate presence, and observations of absence are rare. Datasets of point records contributed by the public or universities sometimes occur in state-owned data platforms, or other platforms such as the Atlas of Living Australia (ALA). In some cases, state-owned datasets are also uploaded to public platforms, meaning the data could be found in two different places.

Modelled data

Habitat suitability models provide an alternative way to infer distribution and density or to refine measured data. Detailed habitat suitability models exist for the dry and wet season for northern Australia (Froese et al. 2017). These models highlight the dynamic nature of feral pig abundance in the short term at regional scales. Over longer timescales (multiple years) abundance will change with underlying environmental conditions (for example dry periods vs. wetter periods), as well as management activities. Appropriate habitat suitability models for the southern areas of Australia are not available. In most cases, actual data on the species distribution is preferred as it provides the true representation of where a species exists. However, this information is rarely available over large areas and is not necessarily collected frequently to deal with temporal changes. Therefore, modelled data, such as habitat suitability models (otherwise known as 'species distribution models', 'ecological niche models' etc.) combined with population models may fill these knowledge gaps. There needs to be careful consideration of which modelled data are appropriate for the question to be addressed.

Domestic and commercial pigs

Pig density

The domestic pig dataset combines data provided by all jurisdictions, and reflects information known in 2019. The initial request to jurisdictions was to provide the total number of pigs per 5 km grid, to overcome any confidentiality issues, while providing a reasonable resolution for likelihood mapping. Through this exercise, we discovered that there is no consistent domestic pig data collection across Australia by governments – jurisdictions collect similar, but not always comparable data on domestic pigs.

Abattoirs

The abattoir dataset combines data provided by all mainland jurisdictions and reflects information of abattoirs that process pigs known in 2019/2020.

Saleyards

The saleyard dataset combines data provided by all mainland jurisdictions, and reflects information known in 2019/2020. The request to jurisdictions was to provide information on saleyards that currently process pigs.

Analysis to assess the likelihood of incursion, establishment and spread

A sub-group of the TG undertook a simple example analysis of how data on feral pigs and domestic pigs could be used to assess the likelihood of incursion, establishment and spread.

For an animal disease to become a problem for Australia it needs to be introduced and then establish and spread. Likelihood maps provide a spatial assessment of this likelihood, and can be derived using a multi-criteria analysis approach. This type of approach was employed by the General Surveillance Epidemiology Working Group (GSEWG) of the Animal Health Committee (2011) and published in East et al. (2013) – 'Use of a multi-criteria analysis framework to inform the design of risk based general surveillance systems for animal disease in Australia'. The sub-group members employed a similar approach and used a small number of example scenarios for ASF introduction to demonstrate how spatial information can be combined to develop likelihood maps for subsequent ASF establishment and spread. As in East et al. (2013) the group used the MCAS-S tool for analyses.

Discussion

The TG has compiled datasets that will inform preparedness activities, including some that are currently underway – for example, a cost-benefit analysis of African Swine Fever. However, there are significant limitations in creating a national map with existing feral and domestic pig data due to the inconsistent way they are collected across Australia. For example, point based data about feral pigs has been collected for a range of different purposes and has generally had sampling bias to areas of high human population or human interest. This is understandable given that feral pigs are a naturalised and widespread pest, and management is primarily conducted for asset protection, however it leaves large gaps where basic information such as occurrence remains unknown. State-wide abundance assessments, where they are available, are created subjectively at different periods and vary in their spatial resolution and classification of abundance and/or distribution. Dealing with temporal variation in density also creates challenges. There has been no consistent nationwide collation of national feral pig data since the 2008 National Land and Water Resources Audit (West, 2008), however current work by the Department of Agriculture, Water and the Environment, through an ABARES project, aims to address this issue.

The main implication of these data issues is that it makes comparable national scale analysis difficult. Nonetheless, particularly for finer spatial scales the task group has produced a useful asset for preparedness and response activities.

References

East, I. J., Wicks, R. M., Martin, P. A. J., Sergeant, E. S. G., Randall, L. A., & Garner, M. G. (2013). Use of a multi-criteria analysis framework to inform the design of risk based general surveillance systems for animal disease in Australia. *Preventive veterinary medicine*, *112*(3-4), 230-247.

Froese, J.G., Smith, C.S., Durr, P.A., McAlpine, C.A. & van Klinken R.D., 2017, 'Modelling seasonal habitat suitability for wide-ranging species: Invasive wild pigs in northern Australia', PLoS One, vol. 12, issue 5, e0177018.

West, P. (2008). Assessing Invasive Animals in Australia 2008. National Land & Water Resources Audit and Invasive Animals, CRC, Canberra.

African swine fever – Feral Pig Task Group

Risk assessment

5 June 2020

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Summary

A rapid risk assessment used expert opinion to determine the relative influence of societal, industry, and environmental factors in the spread of ASF to, from and among feral pig populations in Australia.

This study assigned a relative score to the degree to which factors, believed important for ASF persistence and spread in or to and from feral pigs, are present at various locations and zones. The summary scores are often similar between locations or jurisdictions, yet the composition of risk as revealed by sub-factor scores is different. Therefore any priority preparedness, prevention or surveillance activity to mitigate risk should be tailored to the nature of the risks at a location or in a zone.

Aim

The aim of this work was to conduct a rapid risk assessment to identify the relative influence of societal, industry, and environmental factors in the spread of ASF to, from and among feral pig populations. The level of those factors were assessed at locations throughout Australia using local jurisdictional expert knowledge. The characterisation of risk in different areas allows for tailored preparedness, prevention and surveillance initiatives.

Method

With reference to a study in Europe by Sihvonen *et al* (2019), five factors, comprising 35 sub-factors were identified for risk assessment in the Australian context.

Locations were assessed in six jurisdictions, across 11 livestock production regions, including four peri-urban locations.

The sub-factors for each location were scored from 1 to 5, where 5 was highest risk and 1 was minimal risk.

The sub-factors were weighted to reflect their perceived importance to the risk of ASF in feral pigs and to compensate for double counting (where the risk was already represented in another sub-factor).

The regions reflect livestock production and were adopted from ABARES that divided Australia into twelve regions based on environmental, production and marketing factors (Figure 1). The regions were used in a general surveillance assessment tool (GSAT) that standardised jurisdictional inputs with respect to likelihood assessments of consecutive steps in the disease recognition and reporting continuum. Although the ABARES regions used the beef industry as a basis, classical swine fever and foot-and-mouth disease were two of the eight diseases under study.

Each jurisdiction assessed the risk factors in the ASF risk factor tool based on the livestock regions. For example, NSW considered the factors for Regions 3, 5, 6, 7. 8 and 9 while the Northern Territory considered Regions 1, 2 and 4. Tasmania was not included in the study due to the near absence of feral pigs.

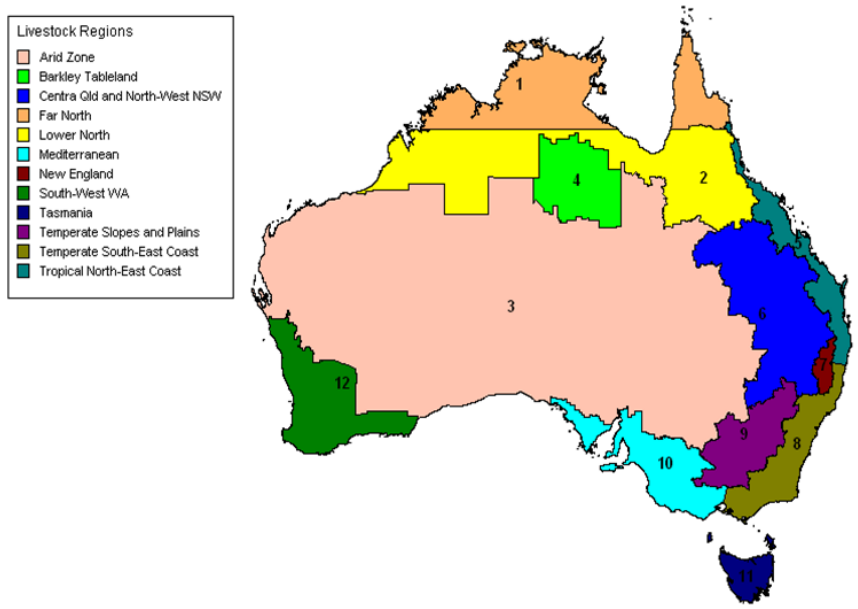

Figure 1. ABARES Livestock Regions, 2012

Factors for assessment

Appendix 1 lists the factors, sub-factors, and the weighting used. The five risk factors that were considered to play a role in the persistence or spread of ASF in feral pigs were:

- Spread to and from domestic pigs: sub-factors describe domestic pig population types and potential risk activities.

- Connectedness: sub-factors describe the volume and nature of people and pig movements.
- Preparedness and capability: sub factors describe traceability, surveillance, education, policy and legal powers.
- Societal context: sub-factors describe human population and behaviours.
- Spread within feral pig populations: sub-factors describe feral pig population, density, habitat and control

In all, 35 sub-factors were scored at each location by the subject matter experts in that jurisdiction.

Appendix 2 lists the locations assessed and feral pig related information in those locations.

Discussion

The risk factors for ASF spread to, from and within feral pig populations in south-eastern Europe are different to those in Australia, where in Europe wild boar are endemic, and cultures have valued them throughout history. In Australia, feral pigs are an introduced pest and they are controlled to reduce economic and environmental damage. In south-eastern Europe, the spread of ASF was mostly dependent on societal factors, such as home slaughter and hunting for consumption. In comparison, the spread of ASF among feral pigs in Australia, is likely to depend on the extent to which the pigs can access home ranges and suitable habitat, and the level to which they are controlled, as well as, the level of surveillance, and contingency planning and awareness/training.

Wild boar ASF surveillance is conducted in many of the south-eastern European countries whereas it is largely absent in Australia.

This study is not suggesting that ASF will establish and spread in Australia, rather it is assigning a relative score to the degree to which factors, believed important for ASF persistence and spread in feral pigs, are present at various locations and zones.

The summary scores are often similar between locations or jurisdictions, yet the composition of risk as revealed by sub-factor scores is different, hence any programme or policy to mitigate risk should be tailored to the nature of the risks at a location or in a zone. For example, the peri-urban summary scores are similar to the non-peri-urban summary scores, however the sub-factor scores are very different.

Our aim was to inform preparedness, prevention and surveillance work priorities in different settings across continental Australia. Where surveillance and/or control activities in feral pigs are being considered, the study provides zones and locations with high scores for relevant factors such as habitat or density, to inform the design of those activities. The risk assessment model provides a tool to evaluate relative risk into the future as inputs can be re-examined and changed according to evolving conditions in the feral and domestic pig landscape.

The aim was not to identify hot-spots for introduction risk, such as where feral pigs may have access to domestic rubbish. However, it may inform areas where additional risk mitigation measures, such as surveillance or prevention activities, may be employed.

The risk assessment also provides a knowledge base for use in the initial phase of a response to detection of ASF in feral pigs, informing rapid risk assessment in regard to how long ASF may have been in the pigs undetected, how they may have been exposed, and the possible geographical extent of the infected area.

References

Animal Health Committee (2012). Improving general surveillance in Australia - final report of the General Surveillance Epidemiology Working Group (AHC), AHC22 M01 Item 1.1.

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Appendix

1. Table of factors, sub-factors, weighting and scoring method.

FACTORS	SUBFACTOR	WEIGHT	SCORING METHOD
SPREAD OF ASF IN FERAL PIGS	Relative feral pig density	5	Score 1 = < 1 pig per kmsq, Score 3 = 5-7 pigs per kmsq, Score 5 = >10 pigs per kmsq
	% Suitable habitat	5	Score 1 = low suitability (e.g. desert), Score 5 = ideal habitat (rich open wetlands for e.g.)
	Feeding of feral pigs	5	Score 1 = unlikely to occur (majority of scores are 1; this factor probably relates more to Europe where the feed to maintain hunting stocks)
	Lack of constraints to home ranges	5	Score 1 = disagree with statement (e.g. there are a lot of constraints), Score 5 = agree completely (there are NO constraints)
	Lack of pig control	5	Score 1 = A lot of coordinated pig control happens, Score 5 = No pig control at all
ASF IN DOMESTIC PIGS	% free ranging pigs properties	4	What % of piggeries are free range? Score 1 = 0-20% also means no piggeries, score 3 = 40-60%, score 5 = 80-100%
	% backyard pigs properties	4	What % of piggeries are backyard? Score 1 = 0-20% also means no piggeries, score 3 = 40-60%, score 5 = 80-100%
	% population free ranging pigs	4	Of total farmed pigs, what % are free range (Difference here is, 80% of piggeries may be free-range but they commonly don't stock as many animals as intensive piggeries. So 80% free range farms may only have 20% total pigs.) Score 1 = 0-20% also means no
	% Population backyard pigs	4	Of total farmed pigs, what % are backyard (Difference here is, 80% of piggeries may be backyard but they commonly don't stock as many animals as intensive piggeries. So 80% backyard farms may only have 5% total pigs). Score 1 = 0-20% also means no piggeries
	Swill feeding	5	Percentage of properties/farms that probably swill feed. Score 1 = low to zero likelihood, Score 3 = medium likelihood, Score 5 = high likelihood
	Home slaughter	2	% of properties/farms that home slaughter
	Overseas workers/visitors	4	% of workers from international locations Score 1 = 0-20%, score 3 = 40-60%, score 5 = 80-100%
CONNECTEDNESS	Movement of pigs	5	The amount of pig movement that occurs. Sale yards, abattoirs etc. This is a more open system. Score 1 = Low, Score 5 = high
	Movement of pig products	4	The amount of pig products that get moved around. Semen, Meat, etc. Score 1 = Low, Score 5 = high
	Number of people movements in or out	3	Amount of people "traffic". Score 1 = isolated rarely visited, low population and tourism, Score 5 = huge turnover and people in and out of region.
	Number pigs moved in/out for breeding	3	Movement for pig breeding. From breeder farms to grower farms or from breeder unit to a different unit owner by the same company. Less open system, generally more integrated., Score 1 = Low
	Number pigs moved in or out for production	1	Movement for pig production. Generally movement between buildings and units from weaner to grower areas etc. More contained/integrated system within the one producer. Score 1 = Low
SOCIETAL CONTEXT	Lack of compliance	5	Score 1 = Total compliance, Score 5 = No compliance
	Customary practices that may limit control	3	Score 1 = Little to no customary practices exist, Score 5 = Many customary practices limiting control
	Recreational hunting	2	Score 1 = Little to no hunting occurring in this area (e.g. Hopefully national parks have zero hunting), Score 5 = hunting permitted and popular
	lack of trust in authorities	2	Score 1 = High trust in authorities, Score 5 = Very low trust in authorities.
	Pork consumption	1	Score 1= Low pork consumption, score 3 = moderate, score 5 = High

	Commercial hunting	2	Two part question - is there the capacity for commercial harvesting (drop-off points etc.) and if there is, is it common/popular? Score 1 = Little to no hunting occurring in this area, Score 5 = hunting permitted and popular and commercial capacity in place
	Human population	3	Score 1 = low (e.g. N.T. regions all scored 1), Score 5 = High (e.g. a lot of towns, high density of people)
	% human population rural	3	Score 1 = 0-20%, score 3 = 40-60%, score 5 = 80-100% (e.g. the N.T, regions are all score 5)
	Unemployment rate	2	Score 1= Low compared to national average , score 3 = moderate compared to national average, score 5 = High unemployment compared to national average
POOR PREPAREDNESS AND CAPABILITY	Unregistered pigs	4	Likelihood of unregistered pigs occurring in the region Score 1 = 0-20%, score 3 = 40-60%, score 5 = 80-100%
	Lack of Pig ID and tracing	3	Score 1 = Likely all pigs are identified and capable of being traced, Score 5 = Little to no Pig ID or tracing capacity.
	Lack of passive and active surveillance	5	Presence of disease surveillance programs, or population of people who exist to observe death clusters etc. Score 1 = a lot of surveillance, Score 5 = No surveillance
	lack of contingency planning	5	Existence of viable plans for these areas. Score 1 = Good plans, Score 5 = No plans
	Lack of access to capable laboratories	5	Laboratories in the area to process samples for ASF. Score 1 = Labs accessible and capable nearby, Score 5 = No labs, or hard to get samples to them
	Lack of legal powers	5	Law capable of being involved. Score 1 = Good legal capacity, Score 5 = poor legal powers
	Lack of awareness and training activities	5	The amount of ASF awareness and training that exists in the area. Score 1 = Good awareness, Score 5 = poor awareness
	Poor compensation policy (animal value/production loss/timeliness)	3	Score 1 = Good compensation policy in place, Score 5 = Poor compensation policy in place
	Lack of cooperation between agencies (hunters, wildlife, ag depts.)	5	Score 1 = Good cooperation between agencies, Score 5 = poor agency cooperation

2. Location of risk assessments

STATE	NAME	REGION	LOCATION DETAIL
NSW	3 - Western NSW Arid Zone	3	Western Local Land Services region and represents approximately the western half of NSW from the Queensland border in the north to the Victorian border in the south. It has a medium to high density of feral pigs and minimal domestic pigs (a few holdings with less than 25 pigs). It is a common area for pig hunting both locally and from outside the region.
NSW	5 - Tropical North-East Coast	5	This coastal strip of New South Wales has a large number of small pig producers and the Lismore - Casino area, south of the Queensland border, has a large number of commercial pigs and one of two NSW export pig abattoirs. Feral pigs are only occasional with the exception of the forested National Parklands from Coffs Harbour to Evans Head where feral pig presence becomes more common. Human population is quite dense in this coastal area.
NSW	6 - Central Qld and North-West NSW	6	This region extends south from the Queensland border and west from the northern tablelands and has a mix of large commercial piggeries and smaller pig producers. The smaller producers have less than 100 pigs, while the commercial enterprises have thousands. Feral pigs are described as common to abundant and are widespread in this region
NSW	7 - New England	7	This area encompasses the northern tablelands of NSW. It has one large commercial pig with 1000+ pigs on the NSW-QLD border and an abundance of small pig producers (<200), mainly in the north of the region. Feral pigs are known to be common in this area.
NSW	8 - Temperate South-East Coast	8	This region runs along the coast from Port Macquarie in the north to Bega in the south and inland from Dunedoo to Batlow. It incorporates the Sydney basin and the south coast of NSW. It is heavily populated, with feral pigs tending to be occasional along the coastline but increasing in numbers into the dividing range and tablelands. Domestic pigs are abundant in small numbers (<20) in the heavily populated areas with few larger piggeries. There is a pig saleyard operating in Camden (Sydney basin) and a domestic abattoir.
NSW	9 - Temperate Slopes & Plains	9	This region makes up approximately 1/3 of the state and lies between the temperate SE coast and arid regions. It has the bulk of the large pig enterprises in NSW with sow numbers of 1000 – 5000 common. In addition, there are numerous medium sized domestic pig operations with sow numbers of 20 – 200. Feral pig presence in this region is typically absent with exception of small pockets of low numbers, particularly as you move toward the northern end. There is a moderate sized pig saleyard located at Forbes and the second NSW pig export abattoir at Corowa. There is also a large domestic pig abattoir at Cowra.
NT	Humpty Doo	1	Humpty Doo is a town situated 38km South East of Darwin, with a population of 5000 people. Many of the residents in this area live on rural block and are permitted to keep pigs. There are 18 properties with registered backyard pigs in the region. Feral pigs are in the area in a fairly low density (<1 pig per kilometre^2. There may be unregistered pigs in the area.
NT	Barkley Tableland	4	Walhallow is a very large pastoral property that raises cattle. It covers nearly 10,000 square kilometres and is sparsely populated with approximately 100 people living there at any given time. Feral pigs are present with little to no constraints to their spread. There are no commercial or backyard pigs registered in the area.
NT	Wak Wak	1	Wak Wak flood plains are 65km South East of Darwin. The area includes some tourism for river and wetland cruises and encompasses a conservation area where feral pig hunting is permitted. Feral pigs are present at a density of approximately 5-7 pigs per kilometre^2. There are no commercial or backyard pigs registered in the area.
QLD	1 - Far North	1	This region covers Cape York and the Torres Strait Islands, extending south to the pig production area in the Atherton Tablelands. The focus of the assessment was on Cape York and the Atherton Tablelands areas rather than on the Torres Strait Islands as there are few pigs on the islands whereas feral pigs are thought to be in abundance and widespread throughout Cape York. There are several large pig producers in the Atherton Tablelands and feral pigs are described as abundant and widespread in the region.
QLD	2- Lower North	2	This region extends inland from the east coast and has few pig owners. Most have less than 100 pigs. Feral pigs are described as abundant-and-localised to common-and-widespread in this region.
QLD	3 - Arid zone	3	This region has very few pig owners and feral pig populations are described as absent or occasional and localised.

QLD	5 - Tropical North-East Coast	5	This coastal strip of Queensland has a large number of small pig producers and some significant pig producers in the Burnett area. It extends inland from Fraser Island and Maryborough, has a large number of commercial pigs and Queensland's largest and only export pig abattoir. Feral pigs are occasional and localised in the Burnett while there are common and widespread in other parts of this region
QLD	6 - Central Qld and North-West NSW	6	This region extends inland from the east coast and has few pig owners. Most have less than 100 pigs. Feral pigs are described as common and widespread in this region.
QLD	Darling Downs	6	This area is a subset of Region 6 where there are significant numbers of commercial pig producers but also feral pigs. A range of small and large producers with varying levels of biosecurity occupy this area.
QLD	Peri-urban - SE Qld	5	This area is a subset of Region 5 and represents the peri-urban area around Brisbane. Large numbers of small holdings exist in this area; however, feral pig density is not as great as in other Queensland areas.
SA	Peri-urban - Adelaide	10	Extends from Gawler (north) to Aldinga (south) and east to Mt Barker, excluding Strathalbyn; There are very few feral pigs in the area due to vigilant control efforts by authorities. The numbers are unknown but feral pigs are thought to be rare, or only occasionally present; Most domestic pigs are kept outdoor/free-range, and most registered properties report having fewer than 20 pigs; There are likely to be additional unregistered backyard pigs with fewer than 20 pigs; this region does not include the intensive domestic indoor piggeries in the Coorong (south east of Adelaide) or in the Balaklava/mid-North regions
SA	Western Kangaroo Island	10	Western half of Kangaroo Island (Mediterranean, region 10) – national park/bushland with some surrounding production land had approximately 5000 feral pigs prior to the bushfires in January 2020, but it is believed the fires resulted in high feral pig mortality, which are concentrated in small unburnt patches with limited food and cover; This risk tool assessed the feral pig population before the fire; Eastern Kangaroo Island has very few feral pigs, and low numbers of domestic pigs, the majority of which are kept outdoor, and only two registered properties report more than 100 pigs; There are likely to be some unregistered backyard properties with fewer than 20 pigs
SA	Lake Eyre Basin	3	Feral pigs are known to occur/travel along the Diamantina & Cooper Creek waterways from Qld. Pig numbers and presence fluctuates with wet seasons; There are no domestic piggeries or backyard pigs present in the area.
SA	Riverland	10	Murray River waterways/flood plains habitat, and horticultural and cropping areas, including Barmera, Loxton, Renmark and east of Chowilla; approximately 500-2000 feral pigs are likely to be present (but surveys have not been conducted for >10 years), the population extends across the border into NSW/Victoria; most commercial domestic pigs are kept outdoors (~75%); Most registrations (80%) report having fewer than 100 pigs; 40% of registered domestic pig properties report having fewer than 20 animals, which are defined as Backyard; there are likely to be some additional backyard pigs on unregistered properties.
VIC	Ballarat, Mediterranean	10	Extends from the west and north of Melbourne to South Australian border. It includes the majority of the large commercial piggeries and is also interspersed with many properties with <10 or 10-50 pigs. There is likely to be a small number of unregistered pigs. Housing systems include everything from large indoor sheds to free range outdoor enterprises. Feral pig populations are distributed in isolated pockets throughout this area, largely in crownland or national park reserves. The locality that was considered to populate the data in the risk table was around Ballarat.
VIC	Buchan, Temperate SE Coast	8	Extends from north of Melbourne to the NSW east coast, excluding a corridor in the north surrounding the Murray valley. This zone contains a small number of larger commercial piggeries and a very scattered distribution of private properties with <10 pigs or 10-50 pigs, as well as a small number of properties with unregistered pigs. Feral pigs are distributed in isolated pockets through this region, with relatively larger populations ranging through crown lands towards the east and north. The example of this region that was used to populate the risk table is the locality around Buchan and Gelantipy, which is a largely beef and sheep pastoral area with a few properties with backyard pigs and seasonally variable feral pig populations in the national parks and crown lands surrounding the farming land.
VIC	Murray River, temperate Slopes and plains	9	Located south and along the central section of the Murray River valley in the north of the state. This area contains a mixture of large commercial piggeries interspersed with many properties with pig numbers ranging from <10 to 10-50. There is likely to be a small number of unregistered pigs. Housing systems include everything from large indoor sheds to free range outdoor enterprises. Feral pig populations are distributed in isolated pockets throughout this area, largely in crownland or national park reserves.

VIC	Peri-urban - Melbourne	10	King Lake – located to the northeast of Melbourne, which includes a large number of hobby and pastoral farms, scattered properties with pig populations from 1-10 or 10-50 pigs but no large commercial piggeries. There is likely to be a small number of properties with unregistered pigs. It is also interspersed with crown land and national parks where relatively small populations of feral pigs have been sighted or are known to exist.
WA	12 - South-West WA	12	Incorporating intensive agricultural cropping and grazing areas as well as extensive tracts of state forest and national parks. Feral pigs are described as widespread and abundant within this region, with a decreasing gradient of feral pig density moving from west to east. Feral pig distribution is expanding into the agricultural areas to the east of the native forest of the Darling Scarp. There are both registered and unregistered pigs within this region. Feral pig density is approximately 1 pig per km^2 within forested areas.
WA	2- Lower North	2	Lower North Fitzroy River Catchment, major river system in the southern Kimberley area, primarily pastoral cattle grazing properties with some limited intensive agriculture mostly for livestock fodder. Feral pigs are described as common and wide spread within this region with little to no constraint to their spread along the river system. There may be unregistered pigs in the area, most likely feral pigs being raised for later consumption
WA	Peri-urban - Perth	12	Represents the peri-urban area to the south and east of the Perth metropolitan region. Large numbers of small to medium holdings exist in this area as well as nature reserves and state forest. Feral pig density has anecdotally increased in recent decades along with urban expansion and improved road infrastructure in the region.

African swine fever – feral pig task group

Principles and Practices Executive Summary

This document identifies the principles and practices that underpin the necessary activities in the feral pig population as part of the agreed AUSVETPLAN response policy on confirmation of African swine fever (ASF) in Australia. Priority preparedness activities are also identified to address the risk pathways of ASF into the feral pig population in Australia. These include specific advice on early detection activities, surveillance and sampling and appropriate pre-emptive interventions. Targeted communications requirements relevant to these priority activities are also described.

Below is a summary of the key principles that have been used to guide response planning for ASF in feral pigs in Australia. The following sections examine the practical actions (practices) which align with these principles, and provides further evidence and commentary to demonstrate the rationale and support for these recommendations.

Pre-emptive culling

The aim of pre-emptive culling is to reduce the contact rates between individuals to the point where a disease cannot move through the population. Evidence and expert opinion shows that complete eradication of feral pigs from Australia is not possible at this point in time due to economical, logistical and technical reasons.

- Widespread pre-emptive culling of feral pigs is not an efficient strategy to prevent the introduction, establishment and spread of ASF prior to an incursion of ASF into Australia, or its establishment and spread post incursion.
- Targeted pre-emptive culling and exclusion is a potentially feasible option to assist in the prevention of the establishment and spread of ASF prior to, or following, an incursion of ASF into Australia.

Biosecurity & Communications

Critical to mitigating ASF risk, minimising the threat of introduction, establishment and spread, and reducing potential impacts on Australia's pig industry, is community awareness and uptake of biosecurity practices.

- Application of enhanced biosecurity measures to mitigate the risks of virus transfer from feral pigs to domestic pigs.
- Implementation of targeted communication strategies for ASF in feral pigs to varied stakeholders.

Movements

The aim of movement controls is to reduce the spread of disease by preventing the movement of infected animals, infected animal products and infected vectors (where relevant for the disease), and by allowing movements that pose a minimal risk.

- Movement controls will likely be applied upon confirmation of ASF in feral and/or domestic pig populations.
- To address and mitigate ASF disease pathways, appropriate movement controls will likely be applied to pigs, pig products, people, vehicles, equipment and other risk items that may contribute to disease spread.

- The movement controls will serve to minimise the spread of ASF between feral pigs and domestic pigs while minimising the risk of ASF spread within and between feral pig populations.

Destruction, disposal and decontamination

One of the primary policy options for control and eradication of ASF is stamping out. In conventional control programs stamping out involves a combination of infected pig destruction and disposal practices, followed by decontamination practices to eliminate the pathogen. The stamping out strategy in feral pigs is adapted to suit the altered context.

- Minimisation of the exposure of susceptible feral pigs to ASF by reducing direct and indirect contact of at-risk pigs with infected pigs, feral pig carcass reservoirs and contaminated environment.
- Self-elimination of the infection by the protection of infected feral pig populations from disruption and rapid destruction of greater than 70%-80% of feral pigs using a combination of lethal control methods in a treatment area ahead of the ASF advance front.
- Disposal activities in accordance with AUSVETPLAN and ensure reduction of infection pressure by prompt, sanitary disposal of contaminated pig products, substrate and fomites (as far as practicable depending on terrain/conditions).
- Decontamination activities in accordance with AUSVETPLAN and ensure elimination of infection by prompt decontamination.

Surveillance

Since there is no vaccine available for ASF, prevention, control, and eradication of ASF is based on the implementation of appropriate surveillance and biosecurity measures.

- Passive surveillance is the recommended primary approach for the early detection of ASFV in feral pigs as it has a higher sensitivity and probability of detection relative to active surveillance. Serological surveys for ASFV in healthy feral pig populations are not recommended as they are inefficient and highly insensitive.
- If there is an incursion of ASF in feral pigs, Australia should consider having a policy to establish a containment zone to enable expedited recognition of freedom more quickly than the 12-month period mandated by the OIE.
- There is a requirement to collate data derived from feral pigs prior to, during and after an ASF incursion (e.g. latitude, longitude, pig age, sex etc.) from the individual jurisdictions into a cohesive national database.
- Where feral pig populations are identified, but where their densities and distribution are unknown, sampling by the use of a geospatial grid may be appropriate.

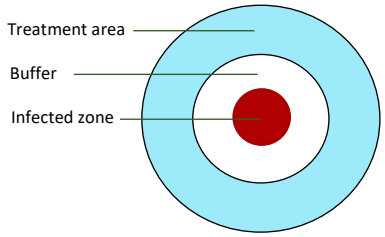
Diagnostics

Success of surveillance activities depends on the availability of the most appropriate diagnostic tools. Diagnosis should be based on the interpretation of the results derived from the use of a number of validated tests, in combination with the information from disease epidemiology, scenario, and the clinical signs.

- Introduction of validated ASF diagnostic screening testing in the field for feral pigs early in the response can support rapid response planning and decision-making.
- Diagnostic sample collection from the feral pig population in remote locations using sterile swabs (Genotube, eNAT and FLOQSwab) without cold chain is a valid sampling method.
- Observation and diagnostic sample collection from the feral pig populations by landholders, rangers and hunters can support early detection and proof of freedom phases of response.

Table of recommended principles and practices

Principles	Practices
Pre-emptive cull*	
Widespread pre-emptive culling of feral pigs is not an efficient strategy to prevent the introduction, establishment and spread of ASF prior to an incursion of ASF into Australia, or its establishment and spread post incursion.	Widespread pre-emptive culling is not recommended
Targeted pre-emptive culling and exclusion is a potentially feasible option to assist in the prevention of the establishment and spread of ASF prior to, or following, an incursion of ASF into Australia.	Destroy feral pigs in targeted areas following careful consideration of the advantages and disadvantages of available methods described in Wild Animal Response Strategy for the given target area(s) (Animal Health Australia 2011). Monitor and maintain reduced population until the risk of ASF has passed. Exclusion fencing around domestic pig farms and areas of high risk of transmission (i.e. garbage dumps) would be ideal.
*Principles and practices should be read alongside with reasoning to provide context.	
Biosecurity and communications	
Application of enhanced biosecurity measures to mitigate the risks of virus transfer from feral pigs to domestic pigs.	- Minimise the presence, proximity and access of feral pigs to managed domestic pigs. - Recommend reduced interactions of stakeholders with feral pigs to reduce anthropogenic spread.
Implementation of targeted communication strategies for ASF in feral pigs to varied stakeholders.	- Identify and train 'champions' to develop and deliver targeted communications for stakeholders. - Release of consistent targeted messages to mitigate ASF risk by feral pigs. - Establish national repository on a website for communication tools accessible by all stakeholders
Feral pig movement controls	
Minimise the spread of ASF from feral pigs to domestic pigs and vice versa	- Assess and re-assess classified premises and declared areas (i.e. (IA/s), RA/s and CA/s) based on best available knowledge - Apply a precautionary approach to defining these areas as there is likely to be uncertainty in distribution of ASF in feral pig populations - Apply movement controls as per domestic pig commodity matrices and feral pig meat matrix

Principles	Practices
	- Undertake appropriate decontamination of vehicles, equipment and people before moving from contaminated sites/areas to reduce spread - Domestic pig premises should apply biosecurity controls (e.g. fencing; removal of feed spills) to limit attractiveness and interaction between domestic and feral pig populations - Equipment used in potentially contaminated areas (e.g. IAs) should be decontaminated before being moved from the IA
Minimise the risk of ASF spread within and between feral pig populations	- As above - Prohibit feral pig movement/relocation (except under permit) - Prohibit feral pig hunting (except under permit) in specified areas - Control movement of feral pig carcasses and meat/meat products as per the recommended movement controls of feral pig meat and meat products - Where movement is permitted, carcasses should be transported to approved disposal sites in a biosecure manner - Carcasses should be disposed of in a sanitary manner - Prohibit feral pig hunting (except under permit) in specified areas
Destruction, disposal & decontamination	
- Minimisation of the exposure of susceptible feral pigs by reducing direct and indirect contact of at-risk pigs with infected pigs, feral pig carcass reservoirs and contaminated environment. - Self-elimination of the infection by the protection of infected feral pig populations from disruption and rapid destruction of greater than 70% of feral pigs using a combination of lethal control methods in a treatment area ahead of the ASF advance front.	- Destroy infected populations via baiting (ground and aerial) and protect them from disturbance. Destroy 70-80% feral pigs in a treatment area ahead of the ASF advance front using the combination of baiting (ground and aerial), trapping and shooting (ground and aerial) in accordance with WARS (Animal Health Australia 2011; Table 8.1 p.72). - Collection of all carcasses in the Infected zone, Buffer and Treatment area (as far as practicable depending on terrain/conditions). 

Principles	Practices
In accordance with AUSVETPLAN: - Reduction of infection pressure by prompt, sanitary disposal of contaminated pig products, substrate and fomites (as far as practicable depending on terrain/conditions).	Recommended deep burial or open-air burning in accordance with AUSVETPLAN Disposal manual (Animal Health Australia 2015). *Variation for deep burial pre-treatment
In accordance with AUSVETPLAN: - Elimination of infection by prompt decontamination.	In accordance with AUSVETPLAN Decontamination manual *Animal Health Australia 2007) and APVMA permit #88135. *Consideration required for specialised equipment, temporary wash down bays and run-off management
Surveillance	
Passive surveillance is the recommended primary approach for the early detection of ASFV in feral pigs.	- Clinical syndromes in feral pigs consistent with ASFV should be investigated rapidly. - Where possible, samples should be collected during all disease investigations of feral pigs to enable ASFV confirmation / exclusion. - Where sample collection is not immediately possible from affected pigs, additional enhanced passive surveillance in the vicinity (e.g. looking for dead feral pigs) should be considered to actively monitor for further potential cases.
Surveillance during an incursion of ASF in domestic and/or feral pigs would include: - Detecting infection in feral pigs and feral pig carcasses - Delineating the temporal and geographical extent of infection in feral pig populations to identify the Infected Area - Measuring the incidence of infection over time to track the progress of control methods	- Options to achieve these objectives may include: o enhanced passive surveillance of sick/dead pigs o active surveillance using PCR and/or serological testing of samples from pigs killed as part of a population control program. - In a post-incursion scenario: aerial surveillance, tracking and shooting with subsequent carcass sampling is the most time-efficient and cost-effective method to delimit the spread of ASFV in a feral pig population where appropriate - A specialised, targeted surveillance program may be required to measure the incidence of infection over time. - Use of non-government stakeholders to assist with sampling of feral pigs in remote areas.
Tracing of transmission within feral pig populations is unlikely to be of value. Tracing of human-mediated movements of feral pigs and fomites may be important to identify potential long distance spread of infection.	- Tracing should consider long distance movements of: o Feral pigs (live or dead) o Feral pig products, waste material, vehicles, equipment and other contaminated material

Principles	Practices
	- Tracing would require effective engagement with feral pig producers and hunters and shooters who are more likely to be involved in movement of live and dead feral pigs, feral pig products and other potentially contaminated materials.
Post-incursion surveillance requires implementation of geographically targeted methodologies to confirm disease freedom from ASF.	- Scenario tree analysis (complex surveillance system analysis using multiple data sources) can be applied in southern states, utilising multiple data sources including: o Targeted surveillance in high risk areas o Representative surveillance in previously infected areas o Suspect case investigations and passive surveillance or clinical syndrome surveillance (as referenced above) - Targeted surveillance likely more appropriate in northern states.
Collation of data on clinical syndromes in feral pigs consistent with ASFV is valuable to correlate with similar domestic pig data and to support control activities.	Requirement to collate data derived from feral pigs prior to, during and after an ASF incursion (e.g. latitude, longitude, pig age, sex etc.) from the individual jurisdictions into a cohesive national database. eWHIS database (Wildlife Health Australia) is the agreed national repository for feral pig disease data outside of an EAD response. A central feral pig data database formatted for an EAD incursion is not currently available.
Diagnostics	
Current recommendations for emergency animal disease (EAD) diagnostic tests emphasise the importance of taking a surveillance system approach	Diagnosing ASF in feral pigs needs to consider all aspects of surveillance – purpose, availability and skill of resources to undertake surveillance and sampling, cost-effectiveness etc. – and not be narrowly confined to technical aspects of laboratory tests
The primary objective of EAD surveillance in both feral and domestic animal populations in a country free from that disease is to achieve the earliest detection possible	Detection of ASF in feral pigs as early as possible following an incursion – when disease is localised - will make eradication much more feasible than a late detection
Different diagnostic approaches may be required for different scenarios and the objective of the surveillance	There is a need to develop a diagnostic matrix for the preferred diagnostic system for the scenarios of infected vs. non infected areas, group vs. individual test, acute vs. chronic disease, screening vs. definitive test, proof of freedom vs. prevalence testing, etc.
The principles of diagnosis in the context of a surveillance system needs to be wider than simply a laboratory test, and	Due to the scarcity of veterinary surveillance in many of the remote locations where feral pigs are most at risk of ASF, field observations and sample collection by

Principles	Practices
include *inter alia*, clinical observations and the analysis of available data to rapid field and detailed laboratory assays	landowners, rangers and hunters need to be considered a critical part of Australia's ASF feral pig surveillance system
To achieve diagnostic test accuracy, the practicality of sample collection and transport needs to be taken into account when considering methods for collecting samples for diagnostic testing	For feral pig sampling, whole blood (EDTA and serum) and fresh and fixed tissues (tonsils, spleen, lymph nodes, lung, kidney and ileum) are the preferred samples, however for simplicity in collection and transport due to limitations in cold chain, training of sample collectors and to avoid spillage, the use of swabs for whole blood is a valid diagnostic sample method
Diagnostic test system accuracy can be enhanced by combining tests in series or parallel rather than individual diagnostic tests with imperfect test sensitivity (DSe) and/or test specificity (DSp)	Diagnosis of ASF in feral pigs in Australia should use screening tests in accredited state veterinary laboratories which provide maximum DSe (i.e. no false negatives) followed by confirmatory tests at the Australian Centre for Disease Preparedness (ACDP) on the positives to provide maximum DSp (i.e. no false positives)
Point of care (POC) tests can support rapid response planning to implement control measures early in an EAD incursion, but should achieve comparable DSe to accredited state veterinary laboratory-based tests	Molecular POC tests based on mobile PCR or isothermal technology achieve comparable DSe and provide opportunity for field based screening of feral pigs for ASF early in a response Serological POC tests based on lateral-flow detection of either antibodies or antigens does not achieve sufficient DSe to be used for early detection of ASF in feral pigs.
State/Territory legislation should regulate the use of POC tests for EADs based on national policy recommendations from the Subcommittee for Animal Health Laboratory Standards (SCAHLS) and Animal Health Committee (AHC)	Legislative amendments are required for the use of POC tests for ASF screening in feral pigs across Australia

Definitions

Principle	Theories or propositions that something is based on. A basic idea or rule that explains or controls how something happens or works.
Practice	The application or use of an idea. Action rather than thought or idea.
Feral pig	A pig that lives without direct human supervision or control

Acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ACDP	Australian Centre for Disease Preparedness
AHC	Animal Health Committee
ALA	Atlas of Living Australia
ASF	African swine fever
ASFV	African swine fever virus
AUSVETPLAN	Australian Veterinary Emergency Plan
IA	Infected area
IP	Infected premises
CA	Control area
DCP	Dangerous contact premises
DDD	Destruction, Disposal and Decontamination
EAD	Emergency animal disease
FFD	Freedom from disease
eWHIS	electronic National Wildlife Health Information System
LAMP	Loop-mediated isothermal amplification
LGA	Local government area
NAHIP	National Animal Health Information Program
NAQS	Northern Australia Quarantine Strategy
OIE	World Organisation for Animal Health
PCR	Polymerase Chain Reaction
POC	Point of care
RA	Restricted area
SCAHLS	Subcommittee for Animal Health Laboratory Standards
SP	Suspect premises
WHA	Wildlife Health Australia

An overview of the background, legislation, statement of policy and case definition of ASF can be found in the surveillance and tracing section (pg. 106-110).

Principles and Practices Contents

Critical factors for formulating response policy for ASF in feral pigs

Features of the disease:

AUSVETPLAN

(Version 4.1, pg 21)

- General:
  - African swine fever (ASF) is clinically indistinguishable from classical swine fever.
  - ASF is a highly variable disease with several forms, ranging from disease with high morbidity and high case mortality to a very mild disease
  - ASF is not a zoonotic disease
- Movements:
  - Human movement of infected animals is the most significant means of spread of the disease.
  - ASF virus cannot be transmitted over long distances without human assistance.
- Diagnostics:
  - Diagnostic tests are available for rapid detection of ASF, but early diagnosis of an outbreak may be delayed if ASF is present in the mild form, or if the initial infections are in small, pig herds or feral pigs.
- Epidemiology:
  - ASF virus is shed in high concentrations in secretions and excretions containing blood during the acute phase of the disease. The virus may be shed for 2 days before clinical signs appear. The reported period of shedding following infection varies from up to one month (Wilkinson 1986) to more than 70 days (Beltrán-Alcrudo et al 2017; Petrov et al 2018). Surviving animals of ASF infection may have ASFV persisting for prolonged periods in tissues or blood; these animals are known as carriers. Carriers may remain persistently infected for up to six months or more (Wilkinson 1984; Oura et al 2005).
  - ASF virus may remain viable for long periods under Australian environmental conditions, and the virus is resistant to many treatments that inactivate other pathogens.
  - The persistence of ASF virus in the environment may delay restocking after an outbreak and requires ongoing monitoring due to the potential for re-emergence of ASF.
  - The status of vectors in Australia is uncertain, although it is likely that competent vectors are present. Transmission of ASF in Australia is more likely to occur via the movement of animals rather than through vectors. Mechanical spread within a herd and between herds may occur via mosquitos and biting flies (Stomoxys spp.) feeding on viraemic pigs. It is not known if ticks from the genus Ornithodoros will play a role in ASF spread in Australia.
  - Total cleaning and removal of all animal products (faeces, blood, etc) is essential before disinfection begins.
- Treatment / vaccination
  - There is not treatment and no commercial vaccine is currently available.

Recommended Additions

- The strain of ASF in current circulation has a high morbidity and high case mortality
- No indication that a density threshold exists for ASF, nor whether density would reflect sustainability of an infection in feral pigs (EFSA 2018)
- Density may be one of many contributors to ASF spread in feral pigs. Indirect transmission from infected carcasses, mechanical vectors and small-scale social structure of host population may modulate transmission dynamics (e.g. young wild boar contact many individuals within a population and may contribute to transmission (EFSA 2018)).
- Spread of virus through carcasses is more important than infected live animals for wild boar in Europe (Chenais 2019).
- In relation to movement - Note that majority of backyard pigs in rural and remote northern Australia, are likely to be wild-caught ferals. Another means for human-assisted spread and spread across the feral/domestic interface.

Features of susceptible populations:

AUSVETPLAN

(Version 4.1, pg 21)

- Domestic and feral pigs are the only susceptible species in Australia, apart from animals in zoological collections.
- Feral pig and smallholder pig populations may not be easily identified or located.
- Smallholders may not recognise or report the disease, or seek assistance.
- Market fluctuations due to public health perceptions or product withdrawals would reduce the value of the industry.
- Trade in animal products may be jeopardised because of disease in feral pig populations.
- Intensive production systems are prone to rapid overcrowding if output is disrupted, and feed stores may not last longer than a week; thus, welfare implications will need to be considered during movement restrictions on live pigs.

Wild Animal Response Strategy

(Version 3.3, pg 37, feral pigs)

- Feral pigs are distributed over a wide range of habitats, including agricultural areas, where they mix with other feral and domestic animals. They inhabit approximately 40% of Australia.
- They are scavengers, feeding on refuse and carcasses. They can travel significant distances for food and water but will stay in an area with a good supply of food, water and shelter.
- Boars are generally solitary.
- Mortality is usually 15 to 50 percent but it can be 100 percent in dry times.
- They have a potentially high rate of population growth where food, water and shelter are abundant (producing two weaned litters every 12–15 months, with an average of 5–6 piglets per litter), which means that reducing and maintaining low population densities will be difficult, expensive and ongoing. Populations can double in 12 months

- They are occasionally found in large groups, particularly in tropical Australia (groups of more than 400 animals have been observed around waterholes); the interaction between individuals from different litters early in life would facilitate disease transmission.
    - The ability of boars to move great distances daily and over longer periods would facilitate disease spread
- Feral pigs may become wary and employ avoidance behaviour if they are subjected to intensive or prolonged disturbance. Under these circumstances, they may shift home range or disperse over large distances to remote areas, thereby complicating control and containment operations.
    - Restricted access to water and shelter, particularly in hot environments, limits dispersal (Dexter 1999).

Recommended Additions

- Factors known to affect feral pig home-range and dispersal include: meteorological variables, landscape features (e.g. water sources), broad scale geographic factors, individual-level characteristics, and disruptive population control (e.g. aerial shooting) (Kay et al 2017; HA Campbell – unpublished).
- Precise density of feral pig populations can only be collected at the local level and may fluctuate year-by-year and by season.
- Some backyard pigs are likely to be wild-caught feral pigs (remote areas of the Northern Territory for example). This provides another means for human-assisted animal movement and potential transmission at the feral/domestic interface.
- Control approach needs to take in to consideration environmental conditions, timing and habitat.
- An integrated coordinated approach is important for the long-term management of feral pigs. No one control measure alone will manage feral pigs in the long term. Controlling population's needs to be coordinated across a number of landholders or it will not be effective.
- Initial control of a population with any method to which a high percentage of the population is susceptible is important. This is normally followed by secondary control methods designed to reduce the population and feral pig impacts while preventing populations building back up.
- Initial control methods include shooting from helicopters and large-scale poisoning. Secondary control methods include trapping, shooting from the ground and strategic poisoning.
- Monitoring of signs of feral pig activity is important in regards to further control measures, which should be maintained (trapping, ground shooting). Cameras and ground surveillance can be used to gauge the success or failure of the initial control program.

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Pre-emptive culling

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AUSVETPLAN (version 4.1; Animal Health Australia 2016, p.22) recommends “management of feral pig populations, and prevention of direct and indirect contact with domestic pigs.” This document outlines the principles and practices for pre-emptive cull of feral pigs. Where they have been required, variations from Animal Health Australia documents (AUSVETPLAN, Wild Animal Response Strategy, and the Biosecurity Incident Public Information Manual) have been identified.

Definition

Pre-emptive cull: A reduction in the density of a population that is free of the disease. There must be a high level of confidence that the disease is absent from the population. The term pre-emptive cull needs to be contextualised according to location of population e.g. national vs regional.

Summary of African swine fever feral pig pre-emptive cull in Australia.

Principles*	Practice	Reasoning
Widespread pre-emptive culling of feral pigs is not an efficient strategy to prevent the introduction, establishment and spread of ASF prior to an incursion of ASF into Australia, or its establishment and spread post incursion.	Widespread pre-emptive culling is not recommended	• Broad scale feral pig eradication has been proven to be logistically unfeasible and cost prohibitive. • A lower density of feral pigs is a more likely outcome of wide-spread pre-emptive culling and the relationship between feral pig density and the potential for ASF to spread and establish is not known in Australia. • If the disease is unknowingly present in feral pigs there may be an added risk that activities associated with culling could facilitate the spread of ASF. This perverse outcome of culling has been demonstrated in other wild animal populations. • Resources directed to a widespread cull would be better utilised for targeted culling and other strategies that increase jurisdictional preparedness to mitigate the risk of disease spread and/or introduction.
Targeted pre-emptive culling and exclusion is a potentially feasible option to assist in the prevention of the establishment and spread of ASF prior to, or following, an incursion of ASF into Australia.	Destroy feral pigs in targeted areas following careful consideration of the advantages and disadvantages of available methods, including those described in Wild Animal Response Strategy for the given target area(s) (Animal Health Australia 2011). Monitor and maintain reduced population until the risk of ASF has passed. Exclusion fencing around domestic pigs and areas of high risk of transmission (i.e. garbage dumps) would be ideal.	• Targeted pre-emptive culling could be an effective preparedness control tool for identified areas of high connectedness within risk pathways. • The four target areas are: a) in proximity to domestic pigs, b) high ASF transmission risk areas such as garbage dumps, c) areas of high/critical feral pig movement near an ASF outbreak, d) high feral pig density near an ASF outbreak (refer to DDD section, pg. 91). • Further work is needed to understand the efficiency and effectiveness of targeted culling as a tool for reducing ASF spread.
*Principles and practices should be read alongside with reasoning to provide context.		

Social messaging: There needs to be careful thought given to social messaging around the issue of pre-emptive culling, noting that this could be seen by the wider community as advantageous but, depending on circumstances, may be contraindicated in controlling ASF.

1.1. Principles

1.1.1. Widespread pre-emptive culling

Based on existing knowledge, widespread pre-emptive culling to prevent the introduction, establishment and spread of ASF prior to an incursion of African swine fever into Australia, or its establishment and spread post introduction is not recommended. The major reasons for this are listed below;

1. The total population of feral pigs is unknown, but upper estimates are around 24 million (Ref: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/pests/invasive-animals/restricted/feral-pig).

2. The goal of widespread pre-emptive culling would be to reduce the contact rates between pigs to the point where ASF cannot move through the population; however, there is no indication that a density threshold exists for ASF, nor whether the actual density would reflect the sustainability of infection (EFSA, 2018).

3. Evidence shows that complete eradication of feral pigs from Australia is not possible at this point in time due to economical, logistical and technical reasons (Bengsen et al 2013; Izac and O'Brien 1991).

4. Some overseas control programmes achieving drastic reductions (up to 80%) in feral pig numbers have experienced a recovery of the population up to 77% the following year (More et al, 2018)

5. Published work indicates that in certain circumstances indiscriminate and uncoordinated culling of the wild animal host could potentially increase the spread of ASF (Donnelly et al 2006; Woodroofe et al 2005; Ham et al 2019; Prentice et al 2019). This is supported by Australian research which has found that in some situations reducing the density of feral pigs through aerial shooting led to increased spatial movement of the surviving individuals, potentially leading to higher pig-to-pig transmission of disease (HA Campbell - unpublished).

6. Given the diversity of habitat (Figure 1) and currently available tools, culling high number of pigs would be logistically challenging and extremely expensive in many parts of Australia.

7. Feral pigs have a high reproductive rate, averaging 5-6 piglets per 12-15 months which can be exceeded with suitable environmental conditions (Choquenot et al 1996).

8. Any widespread culling programme would have to be maintained while the threat of ASF is considered an unacceptable risk for this approach to be effective and is almost certainly going to be cost prohibitive.

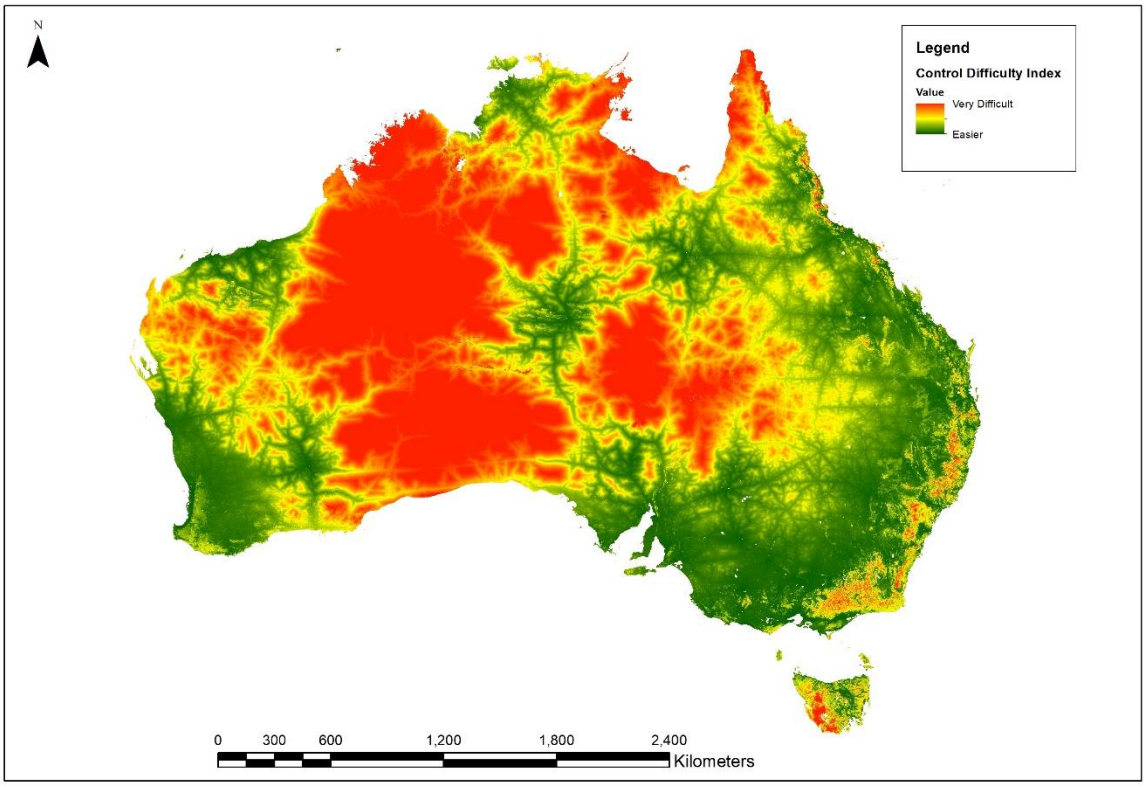

Figure 1. Map of Australia representing the Control Difficulty Index, those areas that present the least difficulty (green) graduating to most difficulty (red), for implementing an African swine fever outbreak control strategy in feral pigs. https://doi.org/10.25919/5ec45bbb43ee4 (Further work required on this map)

1.1.2. Targeted pre-emptive culling

Targeted pre-emptive culling aimed at reducing the density of feral pig populations to zero, would be a more useful preparedness tool than widespread pre-emptive culling to assist in mitigating potential high-risk pathways. Following an incursion of ASF, targeted pre-emptive culling could also be used as a tool to assist in controlling the spread of the disease in Australia.

There are four target areas in Australia where pre-emptive culling may be an effective strategy to reduce the likelihood of introduction, establishment and spread of ASF. These target areas are;

a) areas in close proximity to domestic pigs (feral pig to domestic pig)

b) areas where ASF might be introduced from infected pork (environment to feral pig),

c) areas that have been demonstrated to have high/critical feral pig movement near an ASF outbreak, (feral pig to feral or domestic pig)

d) high feral pig density near an ASF outbreak (feral pig to feral pig)

Any targeted pre-emptive cull aimed at reducing populations prior to ASF incursion would need to be maintained for as long as the risk of ASF incursion remains unacceptable. A targeted approach needs to consider the unique situational circumstances present.

Any proposed pre-emptive cull should therefore be planned by a group which has expertise in feral pig biology, behaviour and management; disease control and management; epidemiology; mapping and risk analysis to assist in the development of a robust and effective strategy. As there is high uncertainty in how ASF will manifest in feral pig populations in Australia, culling should be paired with a rigorous and consistent post-monitoring program so that management solutions can be informed by the results. The area of a cull could cross jurisdiction boundaries and sites of importance (e.g. sites of cultural significance). Consideration should be given to this when planning is undertaken.

The use of pre-emptive culling as a control tool for identified 'high' risk target areas would need to consider a number of factors to determine the suitability and effectiveness of this tool in each individual circumstance (refer to ASF feral pig risk mapping by ABARES). Such factors include;

1. Characteristics of the disease, including the relative importance of transmission pathways
    a. Slow spread – pig-to-pig. These pathways include direct contact; airborne spread (around 2 metres); contaminated carcasses (perpetuate the disease but for a variable amount of time depending on climate and other scavengers); contaminated water (waterholes);
    b. Fast spread – fomite (e.g. in meat products) and human-facilitated movement of the virus, (e.g. spread by hunters, recreational and occupational users of feral pig habitats or even other sectors (refer to Biosecurity section, pg. 52, for stakeholders that may be using such locations));
    c. Variable spread – insect transmission (seasonal; limited range); potential disease reservoirs (e.g. ticks such as Australian *Ornithodoros* spp.).

2. The link between feral pig behaviour, population dynamics and disease spread
    a. Social grouping, interactions between social groups, annual cycle of behaviour.

3. Feral pig meta-population boundaries and relationship to the spread of disease
    a. Consideration of the genetic relatedness of feral pig populations with respect to developing control measures as opposed to physical barriers e.g. fences.

4. Local environment, including seasonal variations
    a. Changes in the season and local environment e.g. drought, floods, fire, land clearing etc. can affect feral pig numbers and behaviour and impact on a potential culling programme.

5. The effectiveness of different culling and exclusion methods on reducing pig density in different landscapes
    a. Accessibility (control difficulty index, Figure 1)
    b. Effectiveness needs to be established by quantitative measurement. Any culling should be followed up by rigorous monitoring.

6. Animal welfare

a. Impact on non-target species
b. Use of ethical and best practice control methods

7. The impact of culling on surviving pig behaviour and that of adjacent pig populations
    a. The scientific evidence to indicate that disease spread will be reduced is lacking.

8. Landscape barriers to disease spread (potential to aid in zoning?)
    a. Geological features such as rivers, mountains and deserts and man- made features such as fences, clearing and urban development may impact on feral pig movements and disease spread.

9. Feral pig abundance and distribution-target area identification and mapping

10. Changes in the nature/behaviour of ASF in feral pigs over time following its introduction.

11. Need for ongoing maintenance of population reduction
    a. This is not a one-off event – A sustained effort will be needed until ASF is eradicated. Cost of an ongoing culling programme.

In the event of an incursion prior to background information being available to inform pre-emptive culling strategies, the opportunity should be taken to gain data and knowledge from any culling activity implemented. This will help inform future control and eradication efforts.

1.1.2.1. Unanswered questions and priority areas of research and collaboration

1. How do we effectively measure feral pig density?
    a. Develop methods (analytical and field based) to produce robust and repeatable population estimates of feral pigs in different habitat types with a specific emphasis in accounting for detection probability (e.g. places where you can see under the trees from above and places where you can't).
    b. Undertake aerial survey in different climatic zones across seasons and use ground-truthing to establish detection probabilities given different environmental covariates.
    c. Integrate the data from above to predict populations across environmental space in Australia and establish control effectiveness and risk indices given environmental constraints and human influence data.

2. How does ASF spread through feral pigs?
    a. Explore mixed technology solution to understand feral pig populations, behaviour and environmental constraints (i.e. drone, "the internet of things", motion sensor cameras with Artificial Intelligence, genetic methods etc.).
    b. Explore technology to support remote monitoring of sentinel animals in wild populations (measure heat, movement, behaviour etc.)
    c. Metapopulation studies
    d. Australian Ornithodoras spp. as reservoirs for ASF virus

3. How do we effectively control feral pigs?
    a. Evaluation of the field deployment of the newly licenced Hoggone® poison.

b. Experimentally apply control methods to quantify feral pig population reduction and recovery in different habitat types. Systematic control should include consideration of shooting, trapping, baiting and combinations of these. Field work should include the implementation of a detailed mark recapture study and apply methods developed above to estimate populations and quantify variance of estimates
   - Include diet and genetic research in this element to develop links to robust environmental covariates to enable scaling of results.
c. Establish detailed cost estimates for operations to achieve >70% reduction of the pig population (to reflect the AUSVET plan requirements) in different habitat types.
d. Include social science / human geography dimensions to support more coordinated approaches to control in remote areas;
e. Detailed assessment of skills, equipment, training and seasonal access for target areas. This will require interviews with regional organisations, councils, land councils, Traditional Owners and ranger groups.
f. Participatory Action Research to evaluate and improve ASF response with land managers. Use the results to establish advice for local land managers, state and territory agencies responsible for control and federal policy.

1.2. Practices

Target areas and the recommended culling methods are described in Table 1.

Table 1. Targeted areas in Australia suitable for pre-emptive culling of feral pigs as an African swine fever control strategy.

Targeted Area	Purpose/Approach	Methods of control	Further information
Proximity to domestic pigs (approximately 500m buffer). Before or after ASF introduction into Australia.	Domestic pig asset protection. Eradication followed by maintenance.	Initial aerial survey and shooting followed by baiting and permanent traps and exclusion fencing. Detector dogs may help. Follow up monitoring with aerial surveys or baited camera traps	- Animal Health Australia (2011; W.A.R.S.) - Choquenot et al 1996 - Hone and Atkinson 1983 - Negus et al 2019 - Pearson et al 2014 & 2016
High ASF transmission risk (e.g. garbage dumps). Before or after ASF introduction into Australia.	Mitigate the risk of ASF entering the feral pig population. Eradication followed by maintenance.	Ground baiting and/or trapping followed by shooting. Detector dogs may help. Maintain by either feral pig proof fence or bait lines etc. Exclusion fencing is recommended approach. Monitoring (e.g. cameras) to assess the population.	- Animal Health Australia (2011; W.A.R.S.) - Choquenot et al 1996 - Hone and Atkinson 1983 - Negus et al 2019
Feral pig movement corridors, close to ASF outbreak.	Mitigate the risk of ASF spreading	Strategic ground and/or aerial baiting and permanent traps.	- Animal Health Australia (2011; W.A.R.S.)

After ASF introduction into Australia.	between feral pig populations Population density reduction.	Maintain population reduction until ASF eradicated from Australia. Monitoring (e.g. cameras) to assess the population. Aerial shooting is not recommended as it may increase dispersal and movement close to ASF area. Where there is a high risk of further spread of disease, removal of pig carcasses is essential (refer to DDD section, pg. 91).	- Choquenot et al 1996
High feral pig density close to ASF outbreak. After ASF introduction into Australia.	Mitigate the risk of ASF being introduced into or spreading though feral pig populations. Density reduction. Only recommended as part of an ASF outbreak control strategy (refer to DDD section, pg. 91).	Methods described in feral pig refer to DDD section (pg. 91). Where there is a high risk of further spread, removal of pig carcasses is essential (refer to DDD section, pg. 91)	- DDD section (pg. 91). - Animal Health Australia (2011; W.A.R.S.) - Choquenot et al 1996

If it is deemed appropriate to carry out a targeted pre-emptive cull extensive population reduction measures will be applied with the aim of reducing the feral pig population to zero, or by at least 70%-80% if the latter is not feasible (Table 1; Bengsen et al. 2013). In some situations, such as in close vicinity to domestic pigs or at garbage dumps, the desired outcome should be the complete eradication of feral pigs.

The ideal method to cull feral pigs is through a coordinated effort which may involve a combination of destruction methods (refer to DDD section, pg. 91). Destroy feral pigs in targeted areas following careful consideration of the advantages and disadvantages of available methods, including those described in Wild Animal Response Strategy for the given target area(s) (Animal Health Australia 2011; Table 8.1 p.72). Welfare must be a priority consideration when deciding on destruction techniques.

Multiple destruction events may be required to obtain and maintain the reduced population level while the risk of ASF is unacceptable. Exclusion fencing of high risk areas, such as domestic pig farms and garbage dumps may be a good, permanent solution to prevent feral pig recolonization and compensatory growth. It is essential to consider the financial implications of the ongoing maintenance and inspection of exclusion fencing as feral pigs will exploit any weaknesses (Negus et al. 2019).

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Biosecurity and Communications

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AUSVETPLAN (version 4.1; Animal Health Australia 2016, p.22) recommends “management of feral pig populations, and prevention of direct and indirect contact with domestic pigs.” This document outlines the principles and practices for Biosecurity and Communication in feral pigs. Where they have been required, variations from Animal Health Australia documents (AUSVETPLAN, Wild Animal Response Strategy, and the Biosecurity Incident Public Information Manual) have been identified.

Summary of African swine fever feral pig biosecurity and communications in Australia.

	Principles	**Practices**
Biosecurity	• Application of enhanced biosecurity measures to mitigate the risks of virus transfer from feral pigs to domestic pigs.	• Minimise the presence, proximity and access of feral pigs to managed domestic pigs. • Recommend reduced interactions of stakeholders with feral pigs to reduce anthropogenic spread.
Communications	• Implementation of targeted communication strategies for ASF in feral pigs to varied stakeholders.	• Identify and train 'champions' to develop and deliver targeted communications for stakeholders. • Release of consistent targeted messages to mitigate ASF risk by feral pigs. • Establish national repository on a website for communication tools accessible by all stakeholders

Stakeholders

Stakeholders with known and unknown interests in African swine fever (ASF) in feral pigs and their habitats are summarised in Table 1 and Figure 1.

ASF messaging to these stakeholders will need to take into consideration the significant variation between them including their;

- Perspective on feral pigs and ASF
- Understanding of feral pigs and ASF
- Motivation to support an ASF response
- Influence
- Preferred communication methods

The stakeholder list (Table 1) was generated from inputs within the Biosecurity and Communications sub-working group for ASF in feral pigs. Figure 1 is a demonstration of how the stakeholders could be arranged according to their role as content generators, gateways and recipients and applies a matrix of influence and perceived benefit/threat from ASF in feral pigs. Note: Figure 1 is not based on any data and will require inputs from all stakeholders. One approach may require a national knowledge, attitudes and practices (KAP) survey of all the stakeholders on their perception of feral pigs and ASF.

Table 1. List of stakeholders that utilise environments where feral pigs may inhabit or would otherwise be impacted by an ASF incursion.

Agricultural Industry	Non-Agricultural industry	Government	Recreation	Research	Other
Commercial pig Producers – Intensive	Tourist operators	Agriculture, Water and the Environment – Federal	Feral pig hunters	Field-based researchers – agriculture	Non-commercial pig owners
Commercial pig Producers – outdoor	Mining – workers and waste management	Department of Primary Industries – state/Territory	Hunters of other species	Field-based researchers – environment	Non-commercial livestock owners (including horse owners)
Forestry	Rural helicopter groups	Parks and Wildlife/Environment – state/Territory	Bushwalkers,	Field-based researchers - other	Non-Government agencies – AWC, Landcare, Bush Heritage, etc.
Other livestock producers where feral pigs may live	Hunting stores	Aboriginal and Torres Strait Islander rangers	Tourist – International (camping, tour groups)	Society/Associations for research (Ecological Society of Australia, etc.)	Traditional owners
State farming bodies		Local Governments	Tourist – Domestic (camping)	Citizen Scientists	General public
Peak Industry body - APL		Emergency services	Mountain bikers		Professional vertebrate pest management specialists
Peak Industry bodies – non-pig associated		Natural Resource Management groups	Rock climbers		Waste management services
Research and development organisations (including R&D corporations)		Catchment Management Authorities	Hunting associations and publications		Veterinarians – non-mixed practice
Grain producers			Sporting Shooters' Association of Australia		Australian Veterinary Association; Vet Practitioner Boards
Sheep and cattle producers					Media
Banana producers and employees					
Sugar cane producers and employees					
Other horticultural producers and workers					
Feral pig processing plants					
Game meat industry					
Abattoir - workers					
Veterinarians – industry, mixed practitioners					

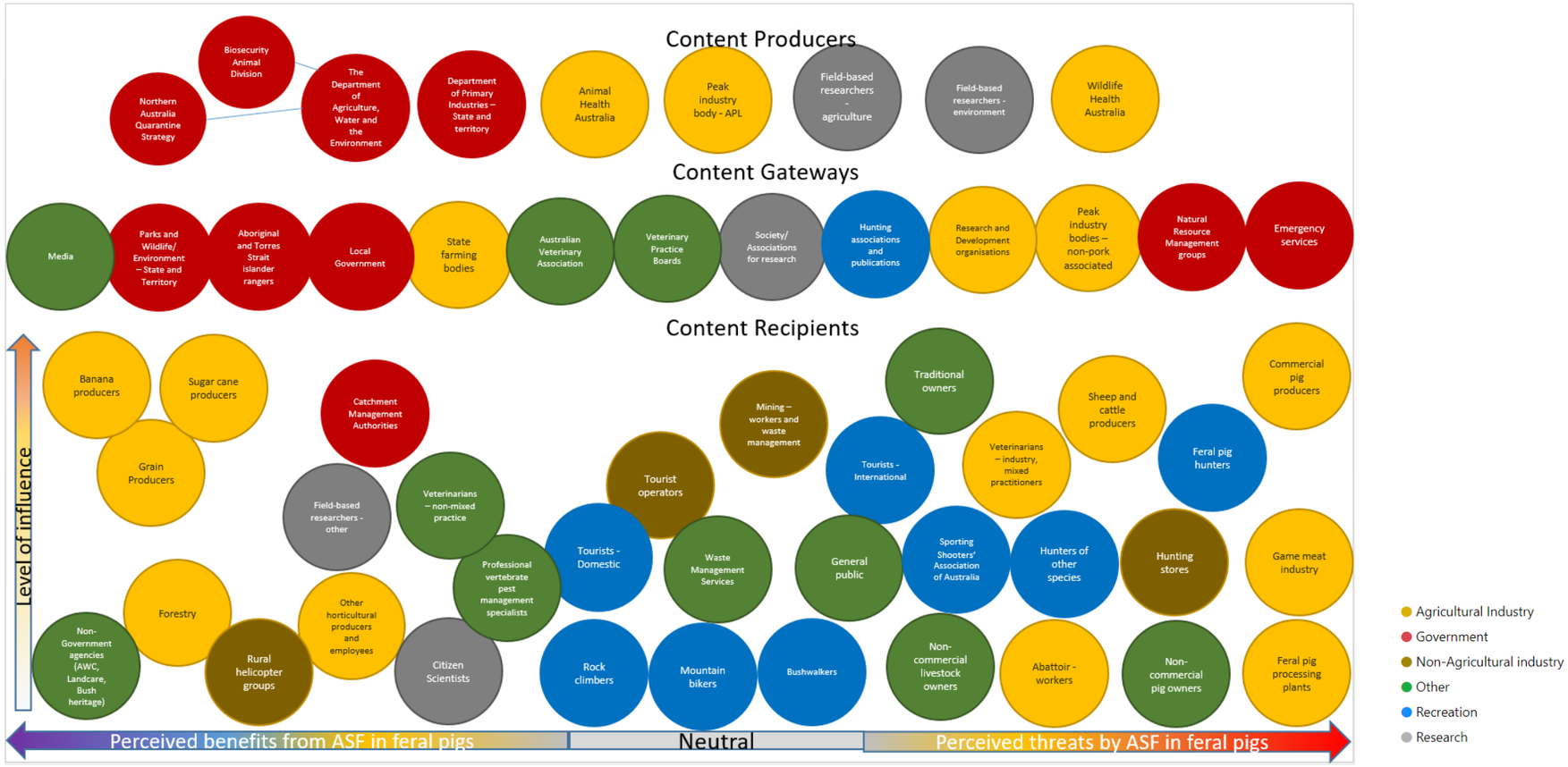


Figure 1. A demonstration of how different stakeholders that have direct and indirect interactions with feral pigs may be arranged. This matrix will require inputs generated from a knowledge, attitudes and practices survey to each of the stakeholder groups. Outputs would help identify which groups might require a more curated communication approach due to factors including stakeholder group's level of influence and engagement on the subject of feral pigs and ASF.

1. Biosecurity

1.1. Principles

- Application of enhanced biosecurity measures to mitigate the risks of virus transfer from feral pigs to domestic pigs.

1.2. Current Biosecurity-related challenges regarding feral pigs and ASF

1.2.1. Feral pigs (general)

1.2.1.1. Feral pig habitat

- Dealing with an environment that isn't easily demarcated like a farm.
- Biosecurity controls may be harder to implement.
- Wide range of stakeholders utilise the environment feral pigs inhabit.
- Early detection, reporting and testing of suspect animals (e.g. surveillance) inhibited by low density of people frequenting feral pig habitats, with a varied understanding of the disease and/or feral pigs.
- Uncertainties of feral pig disease dynamics and how ASF might behave given high mortality rate in European and Asian pig populations.

1.2.1.2. Time frames around early detection

- Variation in regions around levels of surveillance for suspect clinical/dead pigs. Some regions have better surveillance capabilities due to proximity to human population centres.
- Availability of sampling methods for simple application by lay group that have been trained in sampling procedures.
- Variations in surveillance capacity in remote regions.

1.2.2. Disparate stakeholders

- Variations in motivators due to range in value placed on, or perception of, feral pigs.
- Variations in how stakeholders view or understand disease risk to commercial pig industry and Australia.
- Lack of understanding of potential market access risks to other livestock products from Australia.
- Cultural factors in some stakeholder groups that limit awareness and/or uptake of biosecurity messaging and subsequent action.
- Poor awareness and understanding of the concept of swill feeding and the risks associated with it.
- Lack of awareness of the risks of feral pigs scavenging food waste and at refuse locations.
- Variation in awareness and perception of feral pig ecology and behaviour.
- Poor awareness of biosecurity reporting systems in certain stakeholder groups (e.g. non-agricultural associated groups).
- Variation in the saliency of a clinical/dead pig amongst the stakeholders; e.g. A dead feral pig found in the bush within 5km proximity to a commercial piggery will be more noticeable to a pig producer than to a non-agricultural associated member of the public.
- Perception of risk to personal safety for certain stakeholders in approaching a dead feral pig (either from physical harm or zoonoses).

1.2.3. Feral pigs and swill feeding

- Conceptually the term “swill feeding” may not be clearly defined or accessible to all stakeholders. Alternative terms – people food and waste; food scraps including meat and dairy products.
- Feral pigs are known to scavenge from and around carcasses as well as dead pits belonging to landholders, both commercial and non-commercial.
- Feral pigs are known to scavenge from rubbish bins and council tips.
- Feral pigs are known to scavenge from food and food waste of stakeholders who may be using the area for commercial and recreational purposes.
- Give consideration to utilising methods that work in national parks to preventing dingoes and wild dogs from accessing food.

1.2.4. Feral pigs and pig production

- Adequacy of current industry quality standards – APIQ®, National Farm Biosecurity Manual. These mention feral pigs, but there are gaps in the rigour of standards to manage the feral : domestic interaction.
- Collaboration between feral pig expertise and commercial pig expertise to achieve strategic feral pig control at the feral pig: domestic pig interface. There is currently some but limited operational engagement to achieve strategic biosecurity outcomes.
- Application of feral pig expertise to management of feral pigs at potential domestic : feral pig cross-over points.

1.2.5. Potential rate of spread from infected zone to uninfected zone

1.2.5.1. Slow spread through movement of feral pigs

- Refer to ASF feral pig Movement Control (Movement Control section, pg. 81) as well as the DDD Principles and Practices (DDD section, pg. 91).
- General ecology of wild pigs and ASF in Europe and Asia (Schulz et al., 2019, Gubberti et al., 2019, Thurfjell et al., 2013).

1.2.5.2. Fast spread over long distance

- By movement of contaminated carcass/meat.
- Fomite transfer on clothing, footwear, equipment and/or vehicles. This includes by stakeholders such as hunters, tourists, bushwalkers, researchers, rangers and departmental staff not associated with animal agriculture/biosecurity (Schulz et al., 2019).
- Seeding of pigs from infected areas into uninfected areas.

1.2.5.3. Uncertainties on how ASFv would behave with Australian feral pig population

- General pathology.
- Infectiveness and persistence of virus across the wide range of temperature gradients in Australia.
- Variations in epidemiology of the disease amongst the feral pigs.

1.3. Objectives

a) Prevent feral pigs from feeding on swill through improvement of understanding of swill and improved waste management practices by landholders, councils and stakeholders who utilise environments where feral pigs may live.

b) Facilitate earliest possible detection in sick and dead feral pigs through education, increased awareness and minimising barriers to reporting.
c) Prevent spread of ASF between feral pigs and domestic pigs (commercial and non-commercial) and vice versa.
d) Prevent spread of ASF into naïve feral pigs and domestic herds through the activities of agricultural and non-agricultural stakeholders that may conduct work or recreational activities in locations where infected herds may be.
e) Encourage collaboration and dialogue between feral pig stakeholders and domestic pig industry to achieve disease prevention, detection and control objectives.

1.4. Practices

1.4.1. At the farm level

There are a number of ways to minimise the likelihood of pathogen transmission from feral pigs to domestic pigs which can be applied to ASF (adapted from Pearson 2012; Pearson et al. 2016). These include the following recommendations:

- Establish and maintain exclusion fencing to prevent feral pig access to property.
- Outdoor piggeries should review if their fencing is suitable to prevent contact with feral pigs (Fila and Wozniakowski 2020).
- Identify knowledge gaps and develop extension advice and recommendations to protect farm properties and assets from contact with infected feral pigs.
- Restricting access of feral pigs to water sources such as dams and preventing domestic pig access to untreated surface water runoff sources.
- Strategic feral pig reduction guided by feral pig expertise to reduce likelihood of exposure (refer to Pre-emptive cull section, pg. 39). This may require community buy-in to enable appropriate asset and environmental protection at a regional level.

1.4.1.1. Personnel Protocols

- Strict employee, contractor and visitor biosecurity protocols to ensure personnel entering pig production areas are not interacting with feral (or other) pigs in any capacity.
- Risk assessment of all personnel entries to piggery production area to establish any contact with feral pigs.
- Hand washing and change of clothing and boots, or full shower and change of clothing on entry to piggery.

1.4.1.2. Equipment and vehicles

- Controlled entry of vehicles to piggery production area to mitigate risk of material contaminated by feral pigs/product entering.
- No entry of equipment or personal items to piggery production area without approval of farm manager and cleaning/disinfection if required.

1.4.1.3. Waste materials

- Controlled domestic and human waste disposal systems to exclude feral pig access.
- Controlled effluent, body and other piggery waste material disposal sites to exclude feral pigs.

1.4.1.4. Feral surveillance and monitoring

- Undertake surveillance activities for feral pigs (know your property).
- Program to necropsy and submit samples from feral pigs destroyed on farming properties to enable monitoring of health status and surveillance for endemic and exotic pathogens.
- Strategic control program developed in association with practical feral pig expert. Best undertaken as a community effort involving neighbouring properties.
- For ground-based management, engage with trusted trappers and/or hunters who have undertaken a biosecurity induction for your property.
- Enable provision for trappers and hunters to decontaminate prior to departure from property to reduce the risk of fomite transfer over large distances.

1.4.1.5. Quality Assurance accreditation

- The Australian pig industry quality assurance program (APIQ®) is the industry sponsored on-farm quality assurance program. It outlines minimum biosecurity standards and performance indicators within its framework.

1.4.2. At the feral pig habitat level

- National and state parks, indigenous lands, game reserves

1.4.2.1. Early detection of suspect cases outside of infected zone

- Encourage early reporting of sick and/or dead feral pigs by all stakeholders that are involved with managing and utilising habitats where feral pigs may be present.

  Requires communique to relevant stakeholder bodies regarding their role in managing the spread of ASF, their role in sharing messages and the importance of reporting and stamping out ASF. Refer to Communication section (pg. 62) for further details on specifics of stakeholders.

  Utilise the nationally consistent hotline (Emergency Animal Disease Watch Hotline).

  Note: States and territories may explore the establishment of a feral pig reporting pathway and data sources to facilitate, identify and raise awareness for ASF.

- Signage with simple icons and messaging to be erected at entrance roads/paths.

  Priority of signage use would be in neighbouring locations to infected zone.

- Accessible messaging in information centres and education/awareness activities with centre employees and volunteers.
- Awareness of the risks associated with failure to clean up food waste and/or feeding feral pigs.
- National Wildlife Biosecurity Guidelines (https://www.wildlifehealthaustralia.com.au/Portals/0/Documents/ProgramProjects/National_Wildlife_Biosecurity_Guidelines.PDF)
  The guidelines are intended for all people who work (or interact) with wildlife including wildlife managers, researchers, veterinarians, carers and others. All organisations that work with wildlife are encouraged to use the information in these guidelines to assess their own biosecurity risks and to develop and maintain an optimum level of biosecurity for their operations.

1.4.2.2. Acknowledge barriers that may prevent reporting

- Adapted from Gubberti et al., 2019.
- Lack of awareness of the need for action when a sick or dead feral pig is found.
- Perceptions of impacts to property or environment from government disease response.

- Illegal poaching activities.
- Not being in a location with phone and/or internet service.
- Perception of feral pigs as a pest and thus limiting the value of public reporting.
- Privacy concerns.
- Language barriers.
- A positive relationship and trust in authority will improve reporting. E.g. the Northern Australian Quarantine Strategy (NAQS) has developed strong relationships over three decades with indigenous stakeholders. Reporting to the EAD hotline could be done by NAQS on the behalf of these primary reporting parties that they have a rapport with.
- Lack of transparency or feedback once the report is received.
- Lack of awareness of the possibility of reporting.
- Lack of knowledge about how to report.
- Lack of a level of agreement that a reason for them to report a hunted feral pig is because it shows suspicious lesions or disease.
- Perception that the act of reporting is troublesome.

1.4.3. Long range transmission of virus through fomites

There are a number of methods that can be utilised to limit the spread of ASF over a long distance. A priority will be to identify those stakeholders who may utilise the infected zone/buffer zone.

1.4.3.1. Awareness and education

- General biosecurity messaging (see above Biosecurity section pg. 57);

  Pastoralists, landholders.

  Managers and authorities of feral pig habitats.

  Recreational users of feral pig habitats.

  Industrial users of feral pig habitats – mining, infrastructure development projects.

  Refer to stakeholder table (Table 1) for a more thorough list.

- Commercial industry insight and understanding.
- ASF impacts to Australia's agriculture, general awareness and what to look for.
- Signage;

  Fixed and portable signage could be developed with EAD hotline.

  Distributed to park rangers who may be able to place signage in appropriate locations for users to read upon entering zone.

  Roadways (e.g. relevant response zoning).

- Publicly available guidelines;

  Clear, concise and easy to follow biosecurity guidelines for vehicle, equipment, clothing, footwear and hunting dog decontamination to reduce the risk of virus transfer over long distances.

All guidance documents are to be written simply and consistent with the relevant legislation.

Dilution tables of APVMA-approved, ASF viricidal products are to use simple measurements that can be understood and replicated in any environment with minimal tools (e.g. half a cap of chosen product into a bucket of water). Some simple examples as seen with the 2020 COVID-19 pandemic include material provided by the Australian Department of Health's cleaning and disinfection for care facilities (https://www.health.gov.au/sites/default/files/documents/2020/05/coronavirus-covid-19-environmental-cleaning-and-disinfection-principles-for-health-and-residential-care-facilities.pdf) or the USA's Centres for Disease Control and Prevention's guidelines for household disinfection (https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/disinfecting-your-home.html).

Warnings should be clearly visible: any guidance documents and posters around safety and ways to minimise harm – for both humans and animals.

Bespoke messaging and guidance documents may be required for key stakeholder groups (e.g. decontamination guidelines for feral pig hunters' equipment and dogs).

1.4.3.2. Regulatory methods

- Signage and guidance supporting awareness of legislation relating to feral pigs, including breaches and fines associated for the relevant biosecurity act.

  Movement of live feral pigs.

  Movement of known infected material.

  Failure to meet general biosecurity obligation.

1.4.4. Awareness of and risk of swill feeding

- Poor awareness, branding or accessibility to the "swill feeding" term in the general public.

  Stakeholders may be unaware that swill feeding includes access to waste and rubbish that may be contaminated.

  Biosecurity Queensland have simplified the concept to "people food is not pig food".

  Awareness needs to also encompass feral pigs accessing rubbish and waste sites in camping grounds, communities, regional and peri-urban disposal locations, and on rural businesses and properties.

  Messaging around feral pigs accessing rubbish and kitchen waste will also be required for work site camps that are in feral pig habitats. This may include mining camps, infrastructure project camps and roadworks.

- Communication on feral pig access to waste/dead pits.
- Communication on feral pig access to food and food waste in the outdoors.
- Keep your pigs healthy and don't feed them people food.

1.4.5. Hunter-specific messaging

- Remain vigilant “You’re our eyes and ears in the field”.
- Follow any hunting restrictions.
- Awareness of EAD hotline.

1.4.5.1. Advice to give after each hunt

- Cleaning and disinfecting vehicles (inside and outside).
- Cleaning and disinfecting hunting dogs safely.
- Cleaning and disinfecting hunting clothing.
- Clean and disinfect all equipment on site.
- Clean and bag all carcasses before leaving the hunting area.
- Don't leave food scraps from your meals in hunting areas.
- Don't hunt wild pigs if you are in contact with domestic pigs.
- Don't move live animals to new locations (Movement section pg. 81).
- Don't travel with exposed carcasses in the back of a ute.
- Report any suspicious sickness or deaths.

1.4.6. Veterinarians

- Jurisdictional key points to be disseminated through respective veterinary surgeon’s board (not just in infected state/territory, but also national) and the Australian Veterinary Association.
- Feral pig hunters are known to travel interstate for weekend hunting trips.
- Biosecurity advice both to veterinarians directly and also for veterinarians to onward disseminate to stakeholder clients including owners of hunting dogs, pig producers and others.
- Opportunities to increases awareness through key stakeholder groups.
- Reporting pathways.
- Sampling methods.

2. Communications

2.1. Summary

- Have national, pre-prepared communications messaging and materials that can be used if there is an incursion.

    Early reporting for dead/sick pigs is essential for surveillance and response.

    Instigate methods to deliver the message during peacetime – EAD hotline + Feral Scan + anonymous reporting tool.

- Communications need to be tailored to key stakeholders and delivered through a variety of channels.

    During peacetime – good biosecurity messaging that is stakeholder specific, e.g. cleaning vehicles and equipment.

    During peacetime – prevent feral pig access to swill in the form of rubbish/food waste as well as active feeding.

- Develop a matrix that incorporates the perceptions and motivations of the various stakeholders who have direct and indirect interactions with feral pigs.

    Conduct a national knowledge, awareness and practices (KAP) survey to all stakeholder groups assessing perception of risk and benefit from ASF in feral pigs (refer to Figure 1 for a demonstration of what the output may look like).

2.2. Principles

- Implementation of targeted communication strategies for ASF in feral pigs to varied stakeholders.

An incursion of ASF within the feral pig population would be a crisis for a number of stakeholders including the pork industry and associated service providers, Commonwealth, State/Territory jurisdictions and the red meat sector (depending on market access requirements for country freedom of ASF). However, the general public and feral pig habitat-utilising stakeholders may not initially perceive the outbreak to be a crisis.

Non-agricultural stakeholders such as pig hunters and remote community members may also view the incursion as a crisis due to the respective loss of a recreational resource, income and/or alternative protein source. Some stakeholders may also have perceived benefits from an ASF incursion within the feral pig population, such as north Queensland banana farmers and sugar cane producers.

Furthermore, actions and policies enacted through the implementation of Biosecurity-response interventions may impact on government, industry, non-agricultural stakeholders and the wider community.

A recommendation out of this work may be a national pre-incursion survey of all stakeholders who utilise the environments that feral pig inhabit. Using a knowledge, attitudes and practices structured

survey, an output from this survey may identify where the stakeholder may sit in perceived benefit and threat from ASF in feral pigs and their level of influence to decision makers. This could help identify which stakeholder groups may require more targeted or curated communications to help them understand the impacts of ASF within Australia (regardless of feral or domestic pig carriage). Refer to figure 1 on a demonstration of how this output may look.

Targeted communication strategies for ASF in feral pigs will be required, along with broader biosecurity messages for the general public (Table 2).

2.3. Objectives of a communication strategy that incorporates feral pigs

a) Promote awareness and understanding of ASF, the role feral pigs could play and the impacts of an incursion across the spectrum of stakeholders.
b) Communications should use language or visuals that are easy to understand. Key messages could be delivered in other languages of groups that may keep pigs such as Mandarin, Vietnamese and Tagalog.
c) Prevent contact between feral pigs and commercial/non-commercial pigs;

    Specifically communicate principles of feral pig management to commercial piggeries in an accessible, operationally-relevant manner;

    i. Intensive piggeries.
    ii. Outdoor piggeries.

    Communicate biosecurity principles in relation to feral pigs to backyard/peri-urban/non-commercial pig keepers.

    Pig processing facilities and personnel – education, awareness and extension in relation to feral pigs and their role in ASF.

d) Reduce long distance spread;

    Disease transfer by agricultural and non-agricultural stakeholders through carriage of infectious material on clothing, vehicles, footwear and equipment

e) Reduce spread into new feral pig populations;

    Swill feeding – intentional and unintentional actions

        <u>Intentional</u>

        “People food and waste is not pig food.”

        “To keep pigs healthy they must not be allowed to eat food waste.”

        <u>Unintentional</u>

        “It is illegal to allow feral pigs to access rubbish and waste.”

f) Early detection outside of IP;

    Reporting clinically unwell or dead feral pigs promptly to EAD hotline.

g) Hunting;

    The positive role hunters may play in early detection and protection of the hunting resource.

Communication to hunters and hunting groups about banning access to zones that may be infected.

Develop consistent and easy to follow guidelines on how to decontaminate equipment, clothing, vehicles and dogs, and how they should handle carcasses and dispose of waste.

The delivery of any messaging should utilise popular hunting publications and social media sites. Some preliminary analyses will need to be conducted to identify publications and social media sites with the greatest readership and reach. Hunting associations may be the trusted source to this set of stakeholders and will understand the process of getting messages out to all hunters.

h) Pre-emptive cull;

Proactive and science-based communication on reasoning for culling to stakeholders as well as general public.

Considerate of pig welfare.

"There is no vaccine and there is no cure".

Key stakeholders (pig hunters, recreational users of feral pig habitats) to keep clear of IP.

i) Stakeholder cohesion;

Understanding of/engagement with commercial pig industry by hunters and trappers.

Understanding of/engagement with hunting industry by government and industry.

Facilitate trust and collaboration between all parties to enhance detection and response capabilities.

j) Consistent, nationally agreed messaging;

Sourced from a single source of truth.

Consistent messaging across jurisdictions and stakeholder-types. Consideration will need to be made around detail, content and format based on who is being engaged with.

Clear communication around levels of government and response roles (lessons from COVID-19)

k) General communication pieces need to be developed for general public regarding the impacts of an ASF incursion to domestic pork industry, hunting and recreation.

This is to address public concerns about mass culling events and the "why"

l) Non-pig industries;

Impacts from ASF in feral pigs.

People moving off zones.

How they must manage feral pig activities during a response.

Communication tools should be delivered by a wide range of stakeholders from diverse backgrounds, with consistent messaging to ensure there is buy in. These tools might be better delivered by parties more familiar to or trusted by these stakeholders. Communication tools to use language/visuals that are easy to understand, culturally appropriate and in a variety of languages that are region specific (refer to Appendix B for feral pig clinical sign images).

Table 2. Targeted communications on African swine fever for stakeholders who engage in environments that may have feral pigs – recreationally and industry

Target Audience	Guides to key messages specific to feral pigs	Desired outcome	Mechanisms of delivery
All audiences	• Do not touch the carcass. • Mark the spot where the carcass has been found or record the exact coordinates (any smart phone can be used). • Call the Emergency Animal Disease Watch Hotline on 1800 675 888. This will put you in touch with the local department of agriculture. • Do not swill feed/allow feral pig access to waste. • Do not contact domestic pigs after any contact with feral pigs.	1. Early reporting of sudden death or sick pigs 2. Prevent spread	NBCEN / all possible information modalities (that is, face to face meetings, mass media, posters, leaflets, radio and TV shows) Websites such as DAWE website https://www.agriculture.gov.au/pests-diseases-weeds/animal/asf#for-pig-and-livestock-owners
Commercial pig operations: Intensive and outdoor	• Practice good biosecurity regarding feral pigs • Ensure visitor to/workers on farm all practice good biosecurity (such as feral pig hunting) • EAD hotline • Do not swill feed/allow feral pigs access to waste • Define objectives of control activities • Implement adoption of co-ordinated best practice management practices • Monitor impacts from feral pig activity	1. Minimise spread to commercial piggeries and between premises 2. Awareness of the risk of feral pigs to property as well as industry 3. Rapid reporting of disease of feral pigs to appropriate authorities 4. Involvement in community-led groups 5. Use of FeralPigScan 6. Exclusion fencing erected and maintained 7. Minimum biosecurity standards in place to mitigate the risk of feral pig contact with domestic pigs.	Industry, State farming bodies; NRM/local/ Landcare facilitated groups; State/territory authorities; Face-to-face talks Webinars Articles
Non-commercial pig owners, e.g. pet pig owners	• Do not feed swill. • Do not allow any form of contact between domestic pigs and feral pigs. • Report any sudden illness to vet.	1. Minimise spread between feral pigs and domestic pigs 2. Early reporting of sudden death or sick pigs	- Social media, possibly through targeted advertising. - Private vets

	• EAD hotline.		- Need material in languages other than English. Material disseminated through channels including retailers of pig feed.
Agricultural producers for pig feed and bedding	• EAD hotline • Practice good biosecurity when moving between properties • Ensure food or bedding is processed appropriately to prevent disease transfer • Restrict feral pig access to feed/bedding source to the extent possible. • Control activities in place – adoption of best practice management practices. • Monitor impacts from feral pig control activities.	1. Minimise spread to commercial piggeries and between premises 2. Involvement in community-led groups 3. Use of FeralPigScan for reporting of feral pig activity 4. Knowledge of EAD hotline.	APL Industry associations – Stockfeed,; State/territory authorities; Face-to-face talks Webinars Articles
Forestry	• EAD hotline • Decontamination of equipment • Disposal of food waste / swill feeding. • Define objectives of control activities • Implement adoption of co-ordinated best practice management practices • Monitor impacts from feral pig activity	1. Early reporting of dead or sick pigs. 2. Prevent spread 3. Involvement in community-led groups 4. Use of FeralPigScan for reporting of feral pig activity 5. Awareness of ASF symptoms and signs 6. Knowledge of EAD hotline.	Peak bodies Employers Industry; NRM/local/ Landcare facilitated groups; State/territory authorities; Face-to-face talks Webinars Articles
Hunters	• EAD hotline • Basic clinical signs • Do not enter IP • Decontamination/ responsible hunting • Part of integrated control strategy	1. Awareness of ASF symptoms and signs 2. Early reporting of sudden death or sick pigs. Knowledge of EAD hotline. 3. Clean equipment/vehicles/footwear/ clothing/dogs to prevent spread 4. Prevent spread 5. Encourage collaboration and cooperation	Engagement with peak bodies Social media Industry association, APL, state/territory officers, Face-to-face talks Webinars Articles

	• Dispose of food waste carefully / swill feeding • Hunters role in early identification of ASF	6. Follow any hunting restrictions 7. Appropriate management of carcasses when hunting	Ads/Editorial in Australian hunting magazines
Recreational users of feral pig habitats: Bushwalkers, Mountain bikers Campers Tourists	• EAD hotline • Clean equipment • Do not enter IP- signage • Careful disposal of food waste / swill feeding • Don't touch sick or dead pigs	1. Awareness of ASF symptoms and signs 2. Early reporting outside of infected zone. Knowledge of EAD hotline. 3. Prevent long distance spread by cleaning and decontaminating equipment	Signs Articles in newspapers/magazines, websites, blogs, social media. Targeted advertising through social media.
Other departments – Environment, Forestry, National Parks	• A channel for sharing messages to other stakeholders • Do not allow pigs to access waste sites	1. Awareness of ASF symptoms and signs 2. Increase awareness for early detection. Knowledge of EAD hotline. 3. Enable delivery of communication tools through their respective pathways	Training days with State/territory veterinarians and industry
Veterinarians	• EAD hotline • Practice good biosecurity when moving between properties. • Do not contact domestic pigs after any contact with feral pigs. • Clinical signs. • Hygiene and disinfection (own and as a knowledge source for clients)	1. Awareness of ASF symptoms and signs 2. Early reporting of sudden death or sick pigs. Knowledge of EAD hotline. 3. Enable delivery of communication tools through their respective pathways 4. Clean equipment/vehicles/footwear/ clothing/dogs to prevent spread 5. Encourage collaboration and cooperation 6. Awareness of the threat posed by ASF to commercial pig industry and other livestock industries	Veterinary Surgeon's Board for states and territories The Australian Veterinary Association

Animal rights groups	• Culling events may be required to prevent the spread. • Welfare has been considered.	1. Prevent negative messaging from these groups around culling. 2. Prevent spread of disease through protest activities.	May be best to engage with the RSPCA to set up framework around animal welfare and need for culling
General public	• ASF is not harmful to humans. • Do not want this disease in the country. • Culling events may occur to prevent the spread of the disease. • Don't feed pigs people food • Don't feed pigs food that has come in contact with meat, meat products or dairy items. • Don't let feral pigs access your rubbish and waste.		

2.4. Practices

Within Australia, communication and engagement responses to biosecurity incidents are described in the Biosecurity Incident Public Information Manual (BIPIM) which supports the Biosecurity Incident Management System (BIMS).

The National Biosecurity Communication and Engagement Network (NBCEN) is a national group of communication managers from the Commonwealth, state and territory agriculture departments or biosecurity agencies, Animal Health Australia, Plant Health Australia, CSIRO, Commonwealth Department of Health and the Australian Local Government Association. Wildlife Health Australia and the Centre for Invasive Species Solutions are observers.

At the time of writing this report, Animal Health Australia maintains a portal with cross-jurisdictional advice for producers (https://www.animalhealthaustralia.com.au/asf/). The content provided is primarily for producers and does not specifically discuss feral pigs and their role in the disease, apart from a line to visit the respective state/territory Department of Agriculture websites.

Wildlife Health Australia web content on African swine fever specifically focused on feral pigs: https://www.wildlifehealthaustralia.com.au/DiseaseIncidents/OngoingIncidents.aspx#ASF

2.3.1. Global communication portals

A quick review was conducted of the different communication portals available globally regarding African swine fever (Table 3).

Table 3. Central repositories of key information from global animal health groups; web-portals from FAO/OIE/EFSA

Organisation	Title	Website	Resource
FAO	Global ASF situation update	http://www.fao.org/ag/againfo/programmes/en/empres/ASF/Documents.html	Global overview
	ASF Documents	http://www.fao.org/ag/againfo/programmes/en/empres/ASF/Documents.html	Various FAO documents
OIE	ASF portal	https://www.oie.int/en/animal-health-in-the-world/animal-diseases/african-swine-fever/	Landing page
	OIE Awareness tools	https://trello.com/b/GloiZoik/african-swine-fever-oie	ASF tools by OIE
	Global framework for the progressive control of transboundary animal diseases (GF-TADs)	https://web.oie.int/rr-europe/eng/regprog/en_ASF_depository.htm	Central depository of ASF content in Europe
	Guberti V et al 2019. African swine fever in wild boar ecology and biosecurity.	http://www.fao.org/3/ca5987en/ca5987en.pdf	NOTE: for the latest version – check the OIE ASF repository
	Joint government comms (APHA, DEFRA, etc.)	https://web.oie.int/RR-Europe/eng/Regprog/docs/docs/ASF%20Material%20campaign/United%20Kingdom/Advice_for_hunters.pdf	Advice for Hunters UK
	Joint Government Comms		Advice for Hunters Belgium (post-incursion)
EFSA	EFSA portal	https://www.efsa.europa.eu/en/topics/topic/african-swine-fever	
European commission	ASF portal	https://ec.europa.eu/food/animals/animal-diseases/control-measures/asf_en	
ASF-Stop Group	EU funded project	https://www.asf-stop.com/dissemination/	ASF content in Europe
	AS-Stop and Dutch Wildlife Health Centre	https://www.dwhc.nl/wp-content/uploads/2017/10/ASF_BIJ_WILD-african-swine-fever-2017-web.pdf	Info about ASF – wild board
American Association	Foreign Animal Diseases	https://www.aasv.org/aasv%20website/Resources/Diseases/ForeignAnimalDiseases.php	ASF content in the United States.

of Swine Veterinarians (AASV) And National Pork Board (NPB)		https://www.pork.org/production/animal-disease/foreign-animal-disease-resources/	
United States Department Agriculture (USDA)	African Swine Fever	https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/swine-disease-information/african-swine-fever/!ut/p/z1/04_iUlDg4tKPAFJABpSA0fpReYllmemJJZn5eYk5-hH6kVFm8Z5GRs6GhiaGPgZhjuYGgZ6B7r6OpgGGZn6G-l76UfgVFGQHKgIAieBELQ!!/	ASF content in the United States

*****The FAO and OIE websites are maintained for global perspective on the spread of the disease. The GT-TADs ASF portal is a depository of ASF content that is catered for policy makers (with technical documents) as well as a platform for member states to share ASF awareness campaign material.

2.3.2. *Australian communication portals*

ASF content examples as produced by Australian stakeholders (jurisdictions and industry) can be seen in Table 4.

Table 4. Current Australian ASF communications visible to public regarding feral pigs.

Organisation	Title	Website	Mention of feral pigs
The Department of Agriculture, Water and the Environment	Keeping African swine fever out of Australia	https://www.agriculture.gov.au/pests-diseases-weeds/animal/asf	mentions 'Wild pigs'
ACT Government	African Swine Fever	https://www.environment.act.gov.au/parks-conservation/plants-and-animals/Biosecurity/animal-health/pigs	Report any unusual deaths or behaviours in pigs, including feral pigs, to the Emergency Animal Disease Watch hotline on 1800 675 888. Note: Hunting is not legal in the ACT. This may impact the types of communication that is possible re feral pigs
Biosecurity Queensland	African swine fever	https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/livestock/animal-welfare/pests-diseases-disorders/african-swine-fever https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/livestock/african-swine-fever https://www.publications.qld.gov.au/dataset/african-swine-fever	"Prevent contact between farmed and feral pigs" Protect your farm from African swine fever Information for feral pig hunters

		https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/livestock/african-swine-fever/pig-hunters	
DPI NSW		https://www.dpi.nsw.gov.au/biosecurity/animal/info-vets/african-swine-fever	Social media tiles have been utilised regarding feral pigs to hunting groups Hunting articles DPI hunting newsletter
Agriculture Victoria	African swine fever	http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/animal-diseases/pigs/african-swine-fever	Information for hunters
Biosecurity Tasmania	Swine Fever - African swine fever (ASF) and Classical swine fever (CSF)	https://dpipwe.tas.gov.au/biosecurity-tasmania/animal-biosecurity/animal-health/pigs/swine-fever	Nil; Note: "**Feral pigs** are only found only on Flinders Island and are managed in accordance with the Feral Pig Management Plan Flinders Island. On mainland Tasmania, any pigs at large are considered to be domestic stock…."
PIRSA (South Australia)	African Swine Fever	https://www.pir.sa.gov.au/biosecurity/animal_health/pigs/african_swine_fever	Information for hunters
DPIRD (Western Australia)	Emergency pig disease: African swine fever	https://www.agric.wa.gov.au/livestock-biosecurity/swine-fever-classical-and-african	Information for hunters Information for campers/bushwalkers
The Department of Primary Industry and Resources (Northern Territory)	ASF portal	https://nt.gov.au/industry/agriculture/livestock/animal-health-and-diseases/african-swine-fever	Hunters: your responsibilities Details a number of key points for hunters. Comprehensive.

Animal Health Australia	Current situation with African swine fever	https://www.animalhealthaustralia.com.au/asf/	"Feral pig management – visit your State or Territory Department of Agriculture website."
Farm Biosecurity Website	OIE Awareness tools	https://www.farmbiosecurity.com.au/industry/pigs/ https://www.farmbiosecurity.com.au/wp-content/uploads/2019/03/National-Farm-Biosecurity-Manual-for-Pork-Production-2019.pdf	Advice given for managing feral animal interactions (page 17 of manual)
Australian Pork Limited	APL African swine fever resource	http://australianpork.com.au/industry-focus/biosecurity/african-swine-fever/	
Sporting Shooters Association Australia	SSAA in Swine Fever Frontline Fight	https://ssaa.org.au/members/member-announcements/ssaa-in-swine-fever-frontline-fight	
Australian Pig Doggers and Hunters Association	APDHA facebook post	https://www.facebook.com/207032965995827/photos/rpp.207032965995827/2978445692187860/?type=3&theater	Infographics and discussions on role of pig hunters against ASF
Wildlife Health Australia	Disease incident page	https://www.wildlifehealthaustralia.com.au/DiseaseIncidents/OngoingIncidents.aspx https://www.wildlifehealthaustralia.com.au/Portals/0/Documents/Ongoing%20Incidents/20200323_WHA_AfricanSwineFever_ExoticDiseaseUpdate_Mar2020_V1.2.pdf?ver=2020-03-23-110109-630	Links to above resources.

Much of the content related to feral pigs is focused on preventing contact between feral pigs and domestic pigs as well as information for hunters. Only Western Australia had content for other groups that utilised feral pig environments such as campers and bushwalkers, although the focus was more on limiting feral pigs scavenging rubbish and food.

According to the Biosecurity Incident Public Information Manual, the Outbreak website (outbreak.gov.au) is recommended as the key information portal, but questions arise as to how well-recognised this site is amongst all the stakeholder groups. Furthermore, it has been indicated that the "Outbreak" website is not to operate as a repository for stakeholder content, nor can it be operationalised prior to an incursion. It may be worth developing a demonstration ASF portal to identify and consolidate those resources that have been developed by the current content developers (jurisdictions and some stakeholders) as well as to identify what resources need to be developed moving forward.

As seen with the recent COVID-19 pandemic, stakeholders (and general public) appreciate data presented through simple visualisations. There may be benefit in providing stakeholders with live maps showing where feral pigs are distributed with positive and negative cases mapped out, to inform where restrictions are and support vigilant biosecurity behaviours. Agreement will need to be made on how granular the data is on any visualisation as well as what outputs should be visible to assist stakeholders with day-to-day operations.

2.3.3. Follow up communication considerations for reporting from all stakeholders

All reports of feral pig carcasses should be considered valid for follow up. Dismissing a report could mean the person will never report again (Gubberti et al., 2019).

Appendix

1. Key messages for stakeholder communication

Each ASF feral pig sub working group has provided a list of key messages that may be of use to Departmental and industry communications officers regarding ASF and feral pigs when communicating to internal and external stakeholders.

Communications/Biosecurity Advice

- Public – ASF is devastating our domestic and feral pig populations in Australia.
- ASF does not affect people.
- Management of an incursion will be through the implementation of AUSVETPLAN manuals and guidelines.
- There will be challenges in approaching this outbreak.
- Consistent communication about the disease as well as biosecurity advice should be stakeholder relevant.

Feral pig destruction, disposal and decontamination (DDD)

- An outbreak of African swine fever in feral pigs would be managed via intensive, strategic and localised feral pig population reduction techniques. This would isolate the infected population and reduce the risk of spread.
- Control of an African swine fever outbreak requires careful disposal of all feral pig carcasses and disposal of, or decontamination of response equipment where possible and following a risk assessment and a cost / benefit analysis.
- Implementation of an African swine fever outbreak control strategy in feral pigs will be difficult in parts of Australia and may require alteration.

Feral pig movement controls:

- Movement controls will likely be applied upon confirmation of ASF in feral and/or domestic pig populations.
- To address and mitigate ASF disease pathways, appropriate movement controls will likely be applied to pigs, pig products, people, vehicles, equipment and other risk items that may contribute to disease spread
- The movement controls will serve to minimise the spread of ASF between feral pigs and domestic pigs while minimising the risk of ASF spread within and between feral pig populations

Surveillance and tracing

- Passive surveillance is the recommended primary approach for the early detection of ASFV in feral pigs as it has a higher sensitivity and probability of detection relative to active surveillance. Serological surveys for ASFV in healthy feral pig populations are not recommended as they are inefficient and highly insensitive.
- If there is an incursion of ASF in feral pigs, Australia should consider having a policy to establish a containment zone to enable expedited recognition of freedom more quickly than the 12-month period mandated by the OIE.

- There is a requirement to collate data derived from feral pigs prior to, during and after an ASF incursion (e.g. latitude, longitude, pig age, sex etc.) from the individual jurisdictions into a cohesive national database.
- Where feral pig populations are identified, but where their densities and distribution are unknown, sampling by the use of a geospatial grid may be appropriate.

Diagnostics

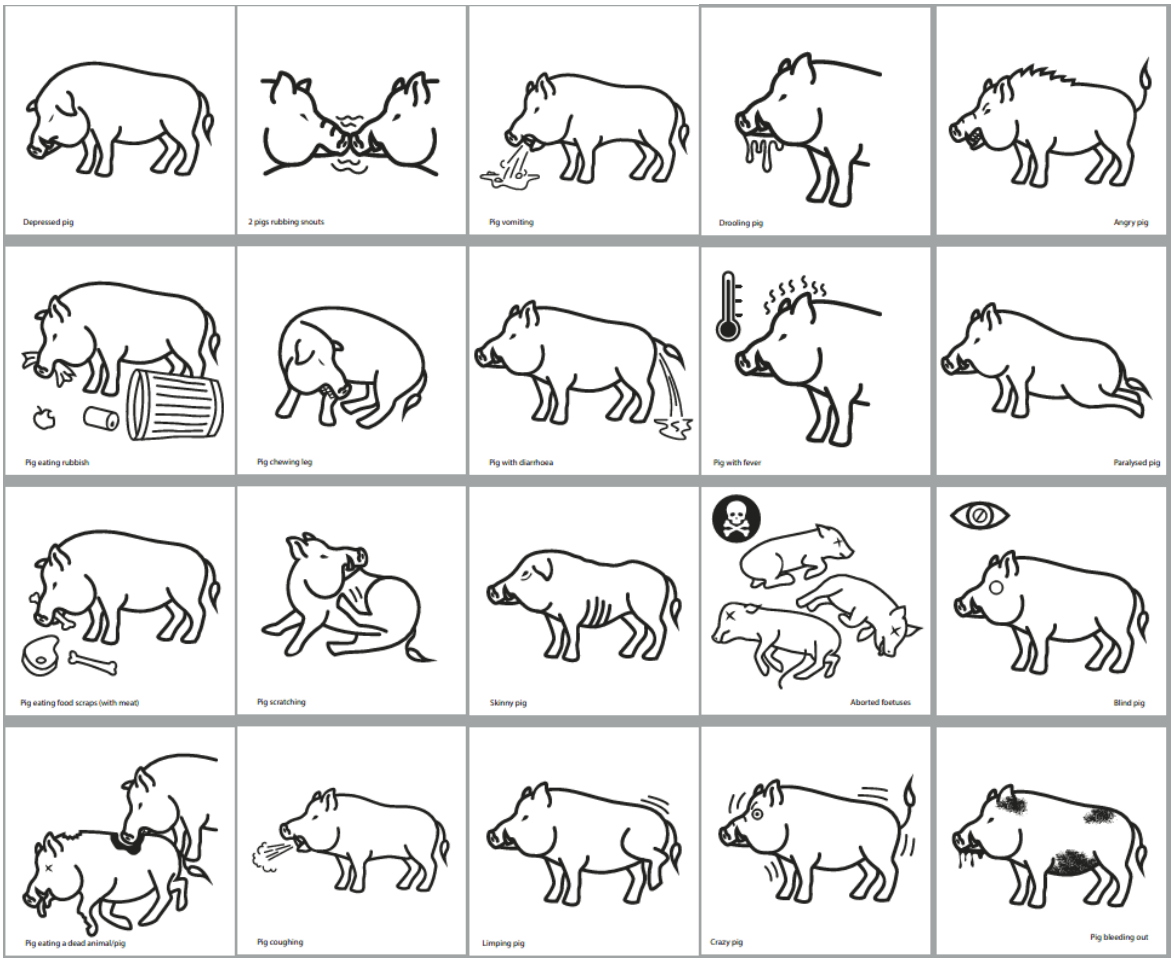
- ASF screening testing in field to support rapid response planning and decision-making
- (ASF point-of-care screening testing to support rapid response planning and decision-making)
- Diagnostic sample collection in remote locations using swabs without cold chain (refrigeration)
- Diagnostic sample collection by landholders, rangers and hunters for early detection and proof of freedom phases of response

Pre-emptive Culling position

- Evidence and expert opinion shows that complete eradication of feral pigs from Australia is not possible at this point in time due to economical, logistical and technical reasons
- Widespread pre-emptive culling of feral pigs is not an efficient strategy to prevent the introduction, establishment and spread of ASF prior to an incursion of ASF into Australia, or its establishment and spread post incursion.
- Targeted pre-emptive culling and exclusion is a potentially feasible option to assist in the prevention of the establishment and spread of ASF prior to, or following, an incursion of ASF into Australia. To be effective, the feral pig population reduction must be sustained while the risk of ASF is unacceptable.

2. Northern Australia Quarantine Strategy feral pig images available for use

Between December 2019 to February 2020, NAQS commissioned a graphic designer to design a range of feral pig clinical sign icons for use in public awareness material. NAQS are happy to share the images (as PNG, JPEG or PDF layer format) with collaborators. **Note: these clinical signs aren't solely designed for ASF.**



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Movement Controls

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AUSVETPLAN (version 4.1; Animal Health Australia 2016, p.22) recommends “management of feral pig populations, and prevention of direct and indirect contact with domestic pigs.” This document outlines the principles and practices for movement controls in feral pigs. Where they have been required, variations from Animal Health Australia documents (AUSVETPLAN, Wild Animal Response Strategy, Destruction of Animals manual, Disposal manual, Decontamination manual) have been identified.

Summary of African swine fever feral pig movement controls in Australia.

These movement controls should be applied to feral pigs upon confirmation of ASF in feral and/or domestic pig populations

Principles	Critical factor	Practices
Minimise the spread of ASF from feral pigs to domestic pigs and vice versa	Declared areas, including an infected area[1] (IA) must be informed through appropriate assessment of clear criteria	Assess and re-assess classified premises and declared areas (i.e. (IA/s), RA/s and CA/s) based on best available knowledge Apply a precautionary approach to defining these areas as there is likely to be uncertainty in distribution of ASF in feral pig populations Apply movement controls as per domestic pig commodity matrices and feral pig meat matrix
	Vehicles, equipment and people may serve as fomite vectors	Undertake appropriate decontamination of vehicles, equipment and people before moving from contaminated sites/areas to reduce spread
	Pig owners with poor biosecurity and free range/outdoor enterprises present an increased likelihood of interaction between domestic and feral pig populations	Domestic pig premises should apply biosecurity controls (e.g. fencing; removal of feed spills) to limit attractiveness and interaction between domestic and feral pig populations Equipment used in potentially contaminated areas (e.g. IAs) should be decontaminated before being moved from the IA
Minimise the risk of ASF spread within and between feral pig populations	As above	As above
	Human movement of infected animals is a significant means of long distance spread of the disease ASF virus is unlikely to be transmitted over long distances without human assistance or without	Prohibit feral pig movement/relocation (except under permit)

[1] This classification is not currently described in AUSVETPLAN. It is the geographic area expected to be contaminated by ASFv.

Principles	Critical factor	Practices
	significant time and overlaps in feral pig home range populations	
	Chasing and hunting feral pigs may lead to dispersal of feral pigs from their expected range	Prohibit feral pig hunting (except under permit) in specified areas
	Spread of virus through carcass movement rather than movement of infected live animals is more important for wild boar in Europe ASF virus is unlikely to be transmitted over long distances without human assistance or without significant time and overlaps in feral pig home range populations	Control movement of feral pig carcasses and meat/meat products as per the recommended movement controls of feral pig meat and meat products
		Where movement is permitted, carcasses should be transported to approved disposal sites in a biosecure manner Carcasses should be disposed of in a sanitary manner
		Prohibit feral pig hunting (except under permit) in specified areas

1.1. Background – risk pathways for introduction, establishment, and spread

Highly virulent ASFv is the context of this background information.

1.1.1. Introduction

The following were considered the more likely pathways for introduction of ASFv to feral pig populations:

a. From feeding contaminated pork or pork products
b. Allowing access (intentional or unintentional) to garbage with contaminated pork or pork products
c. From infected domestic pigs

1.1.2. Establishment

The following factors were considered for establishment of ASFv in feral pig populations:

a. Sufficient numbers of susceptible hosts/density (i.e. the host threshold density) and inoculum present within a population to allow disease propagation without ASF dying-out (i.e. death of the entire population)
b. Large unfragmented populations / communities of feral pigs

1.1.3. Spread

Spread pathways within feral pig populations was considered to occur by:

a. Direct horizontal transmission from other infected feral pigs

   - Guberti *et al* (2019) indicate natural geographical spread of ASF in the wild boar populations with density typical for northern and Eastern Europe occurs at the speed of about 1-3km/month resulting in a 12 to 36 km expansion of the endemic zone in a year

b. Local indirect transmission through contaminated environments

   - Infected carcasses
   - Remnants of infected animals (e.g. offal abandoned by hunters)
   - Contaminated soil/plant material
   - Excretions

c. Human assisted transmission

   - Through fomites and contaminated products (e.g. trophies) or items used in pig hunting
   - Through moving of live feral pigs

d. Animal dispersion from hunting, chasing etc.

   - AUSVETPLAN Wild Animal Response Strategy (2011) notes that temporary movements resulting from disturbance is 5km while the maximum is 55km. It is thought that this is indicative only.

1.2. Criteria for defining the infected area (IA), restricted area (RA) and control area (CA)

The following criteria for defining the IA, RA and CA where ASF is confirmed in feral pigs should be considered:

1.2.1. Infected Area (IA)

The IA is the geographic area where ASFv is thought to be present. The case initiating declaration of an IA must meet the case definition as described in AUSVETPLAN.

1.2.1.1. Considerations

When defining the size of the IA, the following should be considered:

a. Risk pathways above
b. Season (may influence movement; breeding activity)
c. Age and sex of animal/s infected
d. The feral pig home range (some occasional long distance movements (e.g. 100km in 6 months (Guberti *et al*, 2019), but mostly stay within a 50km^2 home range)
   NOTE: Some home ranges are well articulated in the literature and should be used as a source of more specific information where available
   NOTE: Sick pigs are unlikely to cross large distances if not disturbed
e. The expected silent spread phase

1.2.1.2. Minimum size

The minimum size of the IA should be the likely roaming range in the two days prior to becoming unwell.

a. Note: Animals can potentially shed virus 2 days pre-clinically and while unwell
b. Note: It is not expected that the whole home range/IA is decontaminated. Environmental decontamination should be undertaken on a risk-basis around carcasses.

1.2.2. Restricted Area (RA)

1.2.2.1. Considerations

When defining the size of the RA, the following should be considered:

a. Environment
   - Habitat suitability and expected range of animals
     - Feeding/watering/wallowing areas
   - Terrain and barriers to movement
     - E.g. geographical boundaries (water features, mountains, human population centres etc.), cover, feed and water supply
   - Density of feral pigs and potential to spread within and between feral pig populations
   - Active insect vectors

        - If *Stomoxys* or other biting flies are present (e.g. Tabanids), a minimum of 3.2km RA radius should be applied around the infected area (Bailey et al, 1973)
        - Role of ticks

- Proximity to domestic pig populations, including small holdings, free range piggeries and housed piggeries
- Production type in the area (e.g. commercial / smallholders, free range/housed etc.) and associated biosecurity
- Likelihood of interaction between domestic and feral pig populations

b. Movements

- Known movements of feral pigs (informed through radio collars; tracking; movement corridors; local knowledge)
- Seasonal movements
- Estimated natural rate of lateral spread
- Tracing data

c. Surveillance

- Known extent of disease
    - Surveillance data (passive and active)
        - Chiller boxes; abattoir/processors (where active)
        - Local government control programs (where active)
        - Road kills
        - Hunter shot (where allowed)
- Pig control in the local government area by local government area and landholders or in response to detection
    - Baiting, trapping, hunting etc.

d. Epidemiology

- Incubation period
- The expected silent spread phase
- Presence or absence of disease in domestic population serving as a nidus of infection
- Expected / estimated time the disease has been present (i.e. from European experience, estimated at 1-3km/month (Guberti *et al*, 2019))

1.2.2.2. Minimum size

The minimum size around the IA should represent the expected/estimated time the disease has been present. As a starting point, a 3km radius around the IA, representing a one month silent spread phase is recommended.

1.2.2.3. Expected size

The expected size of the RA should be informed by the factors above focusing on the likely roaming range in the predicted silent spread phase.

It is expected that detection would not have occurred for at least two months, therefore a 6km RA radius around each IA is recommended.

1.2.3. Control Area (CA)

1.2.3.1. Considerations

When defining the size of the CA, the following should be considered:

a. Considerations as per the RA
b. The maximum ranging distance around the confirmed case based on factors listed for the RA

1.2.3.2. Minimum size

The minimum size around the RA will represent the expected or maximum silent spread duration applying 3km for every month the disease is expected to have been present. Limitations on the size may be informed through the maximum ranging distances, habitat suitability and geographical factors.

1.3. Declared area review

Review of declared areas should be undertaken when:

a. Sufficient surveillance has been carried out to be appropriately confident (as agreed) that the disease has been delimited in feral and domestic pigs
b. It is considered shrinking or expanding the declared areas will not create undue risk to spread of the disease or to businesses, government, the wider community or environment.

1.4. Recommended policies

The following are recommended policies on movements and activities considered to contribute to ASF spread:

1.4.1. Movement controls on recreational hunters

a. Recreational hunting is banned in the IA and RA to limit dispersal of feral pigs. This will roughly equate to the infected zone, buffer and treatment area as described in the DDD sub-group's documentation
b. Biosecurity requirements will apply to recreational hunters
c. The following text is also provided in AHC38 OOS paper re: movement controls adapted from *AUSVETPLAN Disease strategy – African swine fever (Version 5.0)*, section 6.1.6

    - Movements of people and non-susceptible animals including hunting dogs off infected areas, IPs, DCPs, SPs and TPs will be controlled and subject to appropriate decontamination procedures to prevent mechanical spread of ASF. Within the RA, people who regularly travel from location to location and come into contact with domestic or feral pigs will be required to undergo appropriate decontamination of themselves, and their over gear, equipment and vehicles between locations, and keep detailed records of their movements. Unnecessary movements of people and non-susceptible animals, including hunting dogs, onto and off premises in the IA and RA should be discouraged.

- Further information is available in the NASOP: *Personal decontamination — entry and exit procedures and NASOP 26: Decontamination of groups of people — entry and exit procedures*.[2]

1.4.2. Movement controls on vehicles and equipment used by hunters etc. to destroy or transport feral pig carcasses

a. Biosecurity requirements will apply to hunters
b. The following text is also provided in AHC38 OOS paper re: movement controls adapted from *AUSVETPLAN Disease strategy – African swine fever (Version 5.0)*, sections 6.1.5 and 6.1.7:

- Section 6.1.5 - Empty livestock transport vehicles and associated equipment
    - Vehicles that have been used to transport live pigs or their products, and equipment used with live pigs or their products must be thoroughly decontaminated after use and between loads.
    - Decontamination applies to movements into, within and out of (IAs), RAs and CAs of vehicles and equipment that have had direct contact with pigs or their products, and movement of these vehicles and equipment should be as per the relevant movement control matrix.
    - Further information on decontamination procedures and site preparation is available in the **Decontamination Manual** and nationally agreed standard operating procedure (NASOP) *Decontamination of large equipment*.[3]
- Section 6.1.7 - Movement controls on vehicles and equipment used to destroy or transport feral pig carcasses
    - Biosecurity requirements apply to hunters and their vehicles. This will include items identified in sections 6.1.5 and 6.1.6

[2] www.animalhealthaustralia.com.au/programs/emergency-animal-disease-preparedness/nasops
[3] www.animalhealthaustralia.com.au/programs/emergency-animal-disease-preparedness/nasops

Attachment - Recommended movement controls of feral pig meat and meat products

Feral pig meat and meat products may include: whole carcasses, meat, raw offal, blood, bone, sausage casings, skin, fat, pig ears, snouts, trotters, trophies and skins.

Meat excludes any carcass or item that has not been passed for human consumption or that has been consigned for rendering or discarded as a waste product during dressing or processing e.g. hair, bone or trimmings.

Permit applications for movements of feral pig meat or meat products must consider: the likelihood that the product is contaminated with viable ASF virus, the destination or intended use of the product (including the potential for exposure of pigs) and biosecurity during transport. NOTE: once product is released into the market there are unlikely to be further restrictions on movement within or between disease control areas.

Table 1 Recommended movement controls for feral pig meat (includes carcasses)

To→ From ↓		**IA**	**RA**	**CA**		**OA**	
		All premises and locations	**All premises**	**APF**	**All other premises**	**APF**	**All other premises**
IA	**All premises and locations**	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
RA	**All premises**	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
CA	**All premises**	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited	Prohibited
OA	**Carcasses**	Prohibited (except under SpP conditions a, b, c, d, e, f)	Prohibited (except under SpP conditions a, b, c, d, e, f)	Prohibited (except under SpP conditions a, b, c, d, e, f)	Prohibited	Prohibited (except under SpP conditions a, c, d, e, f)	Prohibited
	APF	Prohibited	Prohibited	Prohibited (except under SpP conditions a, b, c, d, e, f)	Prohibited	Prohibited (except under SpP conditions a, c, d, e, f)	Allowed under jurisdictional and inter-state movement requirements. GP conditions c, d, e, f, g

IA = infected area; RA = restricted area; CA = control area; OA = outside area; APF = approved processing facility; GP = general permit; SpP = special permit

Conditions:

a) Documented risk assessment that indicates that the risk associated with the movement is acceptable within the response
b) For disposal or treatment (e.g. burial, composting, incineration, landfill, rendering).
c) Biosecure transport by approved routes only
d) The material is not brought into direct or indirect contact with susceptible animals.
e) Every precaution is taken to ensure that effluent, other fluids or materials do not leak/fall out of the transport vehicle.
f) Transport vehicles and containers are cleaned and disinfected after unloading. Drivers must shower, change and avoid contact with pigs for 24 hours post-delivery.
g) For personal consumption only

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Destruction, Disposal and Decontamination (DDD)

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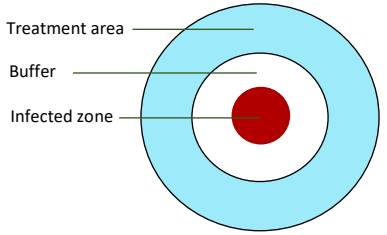
AUSVETPLAN (version 4.1; Animal Health Australia 2016, p.22) recommends “management of feral pig populations, and prevention of direct and indirect contact with domestic pigs.” This document outlines the principles and practices for control and eradication of ASF in feral pigs. Where they have been required, variations from Animal Health Australia documents (AUSVETPLAN, Wild Animal Response Strategy, Destruction of Animals manual, Disposal manual, Decontamination manual) have been identified

Summary of African swine fever control strategy (DDD) in feral pigs in Australia.

	Principles	Practices
Destruction	• Minimisation of the exposure of susceptible feral pigs by reducing direct and indirect contact of at-risk pigs with infected pigs, feral pig carcass reservoirs and contaminated environment. • Self-elimination of the infection by the protection of infected feral pig populations from disruption and rapid destruction of greater than 70% of feral pigs using a combination of lethal control methods in a treatment area ahead of the ASF advance front.	• Destroy infected populations via baiting (ground and aerial) and protect them from disturbance. Destroy 70-80% feral pigs in a treatment area ahead of the ASF advance front using the combination of baiting (ground and aerial), trapping and shooting (ground and aerial) in accordance with WARS (Animal Health Australia 2011; Table 8.1 p.72). • Collection of all carcasses in the Infected zone, Buffer and Treatment area (as far as practicable depending on terrain/conditions). 
Disposal	In accordance with AUSVETPLAN: • Reduction of infection pressure by prompt, sanitary disposal of contaminated pig products, substrate and fomites (as far as practicable depending on terrain/conditions).	Recommended deep burial or open-air burning in accordance with AUSVETPLAN Disposal manual (Animal Health Australia 2015). *Variation for deep burial pre-treatment
Decontamination	In accordance with AUSVETPLAN: • Elimination of infection by prompt decontamination.	In accordance with AUSVETPLAN Decontamination manual *Animal Health Australia 2007) and APVMA permit #88135. *Consideration required for specialised equipment, temporary wash down bays and run-off management

1. Destruction

1.1. Principles

- Minimisation of the exposure of susceptible feral pigs by reducing direct and indirect contact of at-risk pigs with infected pigs, feral pig carcass reservoirs and contaminated environment.
- Self-elimination of the infection by the protection of infected feral pig populations from disruption and rapid destruction of greater than 70-80% of feral pigs using a combination of lethal control methods in a treatment area ahead of the ASF advance front.

Note that the destruction principles for stamping out African swine fever (ASF) in feral pigs differ to conventional control programs where the objective is asset management.

1.2. Practices

The strategy described in this section for control of ASF in feral pigs is based on the model for management of ASF in wild boar that has been produced by the experience and research conducted in the European Union Member States (EFSA 2017, EFSA 2018, Chenais et al. 2019). The recommendation is to apply feral pig population reduction measures ahead of the ASF advance front and leave the infected population undisturbed, with the exception of baiting and continuous carcass disposal to reduce the chances of persistence and spread. An Appreciation Process has been undertaken to identify this preferred course of action and can be made available upon request as a separate document[4]. Fencing off an infected feral pig population has been considered as an option in the Northern Territory Appreciation. A fence is unlikely to be feasible unless the outbreak is very small in size and doesn't overlap properties.

The execution of the practices described in this section will depend on the epidemiological situation, and will need to be adapted to changing situations throughout the course of the outbreak. Additionally, the environmental conditions, ecology and behaviour of feral pigs in their local context will influence the size of a response and the efficacy of destruction methods. Eradication can only be achieved if resources are available to continually collect all carcasses in the Infected, Buffer and Treatment zones, and destroy 70-80% or more of the feral pigs in the Treatment area ahead of the ASF advance front.

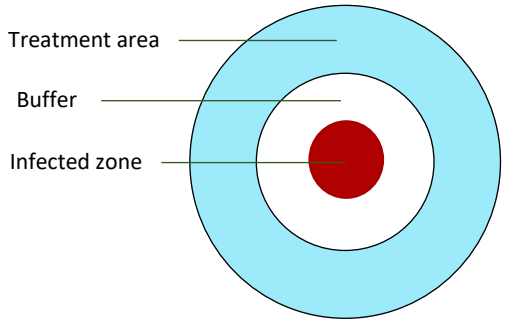


Figure 1. Model of the zones required for management of African swine fever in feral pigs in Australia.

[4] Contact Susanne Fitzpatrick, susanne.fitzpatrick@nt.gov.au to obtain a copy of the Appreciation: Hayley Pearson, "Appreciation - Disease Control options - ASF in feral pigs FINAL", approved 21st January 2020.

The size and boundaries of the Infected zone should be established via delimiting surveillance (refer to Surveillance section, pg. 101). The Infected zone and uninfected Buffer around this Infected zone (Figure 1) are to remain undisturbed with the exception of aerial baiting (cluster baiting at hot-spots) and ground baiting using sodium fluoroacetate (1080) or Sodium Nitrite (HogGone®) and continuous carcass disposal[5]. Carcasses must be disposed of and site of collection decontaminated where possible. The size of the Buffer zone will be approximately 20km wide, and is dependent on the ecology and behaviour of local feral pigs, taking into consideration artificial or natural barriers. The Infected and Buffer zones are to remain undisturbed until surveillance of collected carcasses are no longer testing positive for ASF.

Extensive population reduction measures will be applied in the uninfected Treatment Area (Figure 1) with the aim to reduce the feral pig population by greater than 70-80% (Bengsen et al. 2013). The Treatment area will be approximately 20km wide, as with the Buffer zone, and is based on the ecology and behaviour of local feral pigs taking into consideration artificial or natural barriers. A coordinated effort using a combination of destruction methods needs to be used to remove as much of the feral pig population as possible in the shortest possible time-frame. The available destruction methods are described in WARS (Animal Health Australia 2011; Table 8.1 p.72). In the absence of sampling and biosecurity training the use of recreational hunters in this disease response should be avoided to mitigate a potential source of anthropogenic spread (Chenais et al. 2019). Destruction methods need to be applied sequentially from the least to the most disruptive to target individuals susceptible to different methods and reduce avoidance behaviour (Bengsen et al. 2014). Multiple destruction events may be required to maintain the reduced population level over the duration of the outbreak.

Baiting and trapping provide minimal disruption and should be the first destruction methods employed. An initial free-feeding period is required, followed by the addition of poison bait, such as sodium fluoroacetate (1080) or Sodium Nitrite (HogGone®), to bait stations. Baiting methods and practices that minimise the impact on non-target species should be used in accordance with current best practice (example SOP - The Centre for Invasive Species Solutions 2014). Feral pig trapping should be carried out in accordance with current best practice (example SOP - Sharp 2012a). Camera traps may be used at bait stations to monitor control efficacy and assess the need for reapplication. More extensive camera trap arrays may be used to detect presence or absence of feral pigs after control activities have been conducted. Aerial monitoring transects should be the preferred technique to estimate population size and the percentage destroyed (personal communication Troy Crittle).

Aerial methods, including shooting and aerial 1080 baiting, should occur after these on-ground options have been in operation for 2-4 weeks to reduce avoidance behaviour in the population (Bengsen et al. 2014). The length of time that ground operations continue is determined by how spread out the feral pigs are and their readiness to consume bait which may necessitate baiting some sites multiple times. Feral pigs should be shot from a helicopter with a shotgun or semi-

[5] State and Territory baiting approval and availability needs to be ascertained. Stockpiles of bait, particularly HogGone®, need to be considered in advance of an outbreak.

automatic large calibre (.308) rifle by an accredited qualified marksman[6] (Sharp 2012b). Shooting should be applied from the innermost border with the Buffer zone outwards, to drive any survivors away from the infected zone. This will reduce hosts, decrease disturbance to populations in the Infected and Buffer zone, and decrease carcasses to be searched for in the Infected zone. Welfare must be a priority consideration when deciding on destruction techniques. The effort required to destroy greater than 70% of pigs will be influenced by site specific environmental and ecological conditions and should include advice from feral pig management experts to direct operations.

A proportion of carcasses in all three zones are to be sampled to detect the presence of ASF. Where feasible and following a risk assessment and a cost / benefit analysis, all carcasses need to be disposed of within the zone they are found to remove the ASF reservoir from the habitat. Confirmation of an infected animal in the buffer or treatment zone will require a review of the strategy, and potential expansion of Infected, Buffer and Treatment zones.

1.3. Feasibility

The current ASF situation overseas demonstrates the limited ability to eradicate the disease. The Czech Republic is the only country to successfully eradicate ASF in its feral pig population, 228 days after the first detection (SVA 2019). The situation in the Czech Republic differed from other countries in that the outbreak was confined to a small solitary area (57km^2) without direct connection to other affected localities (SVA 2019). Elsewhere, few effective results have been obtained and the disease continues to spread into neighbouring free areas, mainly along feral pig corridors (Gallardo et al. 2015).

1.3.1. Feral Pig ASF Control Difficulty Index (CDI) (Further work required)

Andrew Hoskins and Justin Perry CSIRO[7]

The decision on when to implement this proposed disease control strategy for ASF in feral pigs in Australia will be influenced by the following Control Difficulty Index map (Figure 2). The green areas on the map are locations that will present the least difficulty in implementing the control strategy described in this section, and the red areas presenting the most difficulty.

The Control Difficulty Index provides an estimate of the difficulty to undertake the feral pig ASF control strategy, including feral pig destruction, carcass removal and carcass disposal activities across Australia at a 1 km resolution. This index combines several factors that will influence the difficulty of undertaking control across Australia including; terrain ruggedness, road and track networks, land use type, canopy cover and remoteness from population centres. Specifically, the map uses the following layers;

1. Friction Index. The estimated time to travel across each 1km pixel given their specific land cover type.
2. Accessibility Index. Shortest travel time to the nearest population centre – this input includes roads and tracks among other input layers.
3. Terrain Ruggedness Index: Terrain Ruggedness Index (TRI).
4. Canopy visibility: Tree cover (%).

[6] It is recommended that human resources be pre-identified and certified to carry out these aerial operations. Additionally ammunition requirements may need to be assessed by states and territories and stockpiled in advance of an outbreak.

[7] Justin Perry: Email: Justin.perry@csiro.au; Ph: +61 (07) 4753 8554

There are many other local complicating factors in addition to those represented in Figure 2 that may influence the difficulty of control. The relative abundance of feral pigs and the compliance of stakeholders in destruction practices are two significant influences that could not be represented in Figure 2, but need to be considered prior to undertaking the control strategy.

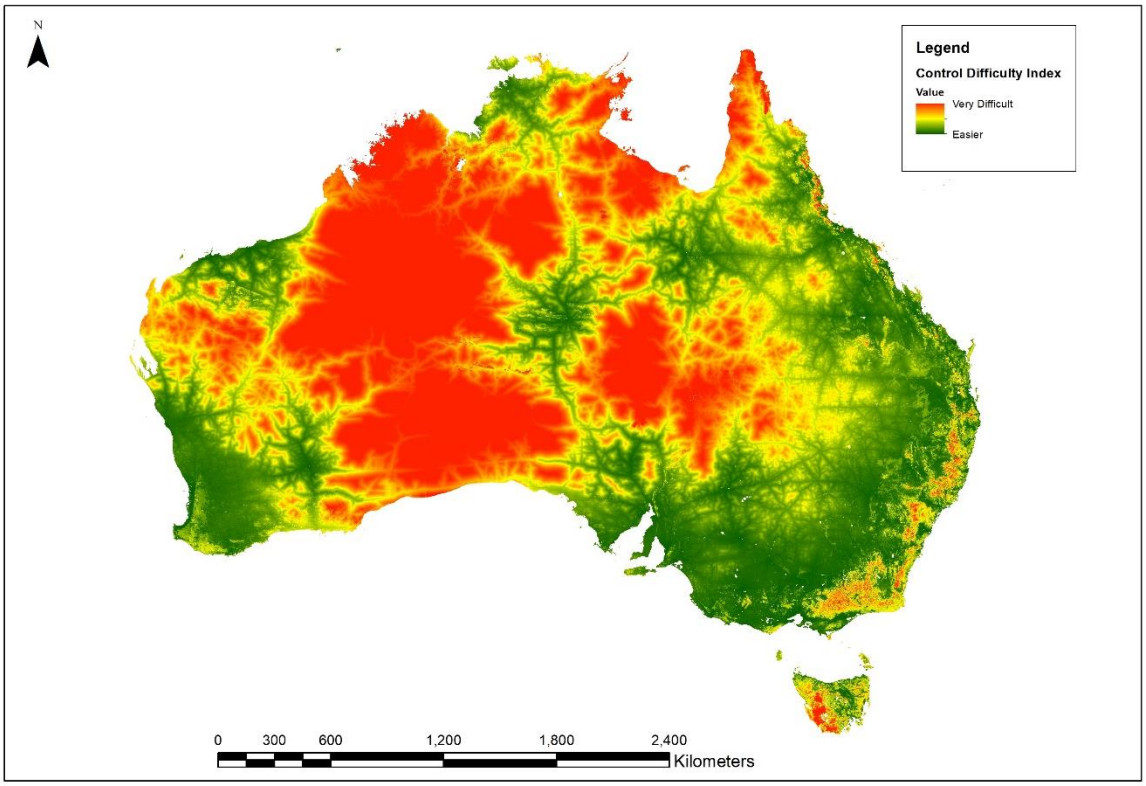


Figure 2. Map of Australia representing the Control Difficulty Index, those areas that present the least difficulty (green) graduating to most difficulty (red), for implementing an African swine fever outbreak control strategy in feral pigs, https://data.csiro.au/dap/landingpage?pid=csiro:44381. (Further work required on this map)

Areas which are closer to 0 (dark green in the attached map) reflect areas with many roads and tracks, flatter ground, open canopy and close to a city or town. At the other extreme, areas closer to 3 reflect rugged terrain, with closed canopy, limited access and further from built up areas. Each of the values are weighted to create the combined map so dark red areas can also reflect extreme values of one or a combination of the inputs.

Where difficulty is deemed to be high (red), the ASF control strategy may need to be enlarged to move the treatment area into locations with improved access or vegetation cover (yellow or green). Ultimately, decisions will need to be made about the individual outbreak event. The Control Difficulty Index as well as outbreak size and budget will all inform the response, whether it be implementation of the strategy described in this section, or a focus on asset protection of commercial pigs.

2. Disposal

2.1. Principles

- Elimination of infection by prompt, sanitary disposal of contaminated pig products, substrate and fomites.

Disposal principles for response to an ASF outbreak in feral pigs are consistent with AUSVETPLAN, however, it is acknowledged that it may not be practical or possible to find or eliminate all sources of infection in the feral pig environment.

2.2. Practices

2.2.1. Site selection

If the site is accessible, soil structure is ideal and isolated from waterways, and approvals/permits can be obtained, then deep burial should be used for disposal of feral pig carcasses. If deep burial is not possible due to restricted access by excavation equipment or unsuitable soil structure that could lead to leaching and contamination of waterways, open-air burning should be used. Ideally, it is preferable for carcasses to be disposed of in mass sites within the zone they were found. Biosecure transportation to another zone is possible if there are no ideal disposal sites.

2.2.2. Carcass retrieval

The Infected and Buffer zone are to be separated into transects for daily on-ground search of carcasses, with personnel situated 20 metres apart from each other[8]. ASF positive wild boar in the Czech Republic have a death bed preference for sheltered locations with higher vegetative cover and close to water sources when the temperature is warm (Cukor et al. 2020). Feral pig carcass searches in Australia should focus efforts in these types of habitats. GPS location of carcasses in the Treatment area are to be noted by aerial shooting teams for later collection via land. Where land vehicle access is not possible, helicopters may need to be used to airlift carcasses to disposal sites. The use of Unmanned Aerial Vehicle technologies may aid in the search and identification of feral pig carcasses in all zones. The feasibility of searching for and disposing of carcasses in different locations in Australia can also be described by the Control Difficulty Index map (Figure 2).

Prior to carcass disposal, samples must be collected for diagnostic analysis for ASF. Carcasses and contaminated materials must be immediately placed in leak-free containers or heavy duty bags at site of collection, tagged with identifying information and site of collection documented. Leak-free containers may include plastic tubs and heavy-duty plastic bags. If possible the site of carcass collection should have all contaminated materials, including obviously contaminated soil, immediately buried or removed and put in leak-free containers. Contaminated items can then be transported to disposal locations.

2.2.3. Deep burial

Deep burial is the recommended practice for disposal of ASF contaminated items, see the AUSVETPLAN Disposal manual (Animal Health Australia 2015, pp 28-36).

Burial sites need to be fenced off for the duration of disposal practices to prevent predation by wild animals, including dogs and feral pigs.

[8] Significant personnel resources will be required for carcass search and disposal activities. Identification of ground crew in advance of an outbreak is advised.

Pre-burial temperature treatment of contaminated materials, particularly carcasses, may be possible in Australian locations with high ambient temperatures. The ASF virus is inactivated by high temperatures of 56 °C for 70 minutes or 60 °C for 20 minutes (Williams 2003). Carcasses in hot climates can be placed in direct sunlight in leak proof containers on top of reflective thermal blankets and covered with heavy-duty clear plastic to raise the temperature (clear plastic is more effective at raising temperature than black plastic, Lalitha et al. 2010). Thermometers can be used to check the internal temperature of carcasses. Carcasses should be left for 70 minutes at 56 °C, after which time deep burial of carcasses should occur.

2.2.4. Burning

See the AUSVETPLAN Disposal manual (Animal Health Australia 2015, pp 37-45). Open-air burning has a high certainty of destroying the ASF virus, and will only require short term monitoring during the burning process.

Burning sites need to be fenced off for the duration of disposal practices to prevent predation by wild animals, including dogs and feral pigs. Complete carcass incineration by pyres and air-curtain incineration can take from 20 hours (Animal Health Australia 2015) up to 68 hours in European conditions (Guberti et al. 2018). This requires 24-hour operation to maintain burning through the application of fuel sources.

3. Decontamination

3.1. Principles

- Elimination of infection by prompt decontamination.

Decontamination principles for response to an ASF outbreak in feral pigs are consistent with AUSVETPLAN, however, it is acknowledged that it may not be practical or possible to decontaminate all sources of infection in the feral pig environment.

3.2. Practices

There may be specialised equipment used in feral pig operations that will require decontamination. Examples of these are:

- Helicopter sling or cargo nets for carcasses
- Waterproof carcass transportation containers
- Excavation equipment that have moved carcasses and contaminated substrate
- Vehicles transporting contaminated items
- Pig control equipment – traps, feed devices, cameras, firearms

Additionally, considerations need to be made for the management of run-off from decontamination practices in the absence of specialised water capture bays. Temporary decontamination bays may need to be established at defined entry and exit points during operations.

Critical considerations for control of ASF in feral pigs: unanswered questions.

The size of the ASF outbreak in feral pigs when first detected and the expense associated with the disease response strategy will influence whether eradication of ASF in feral pigs can be achieved. This threshold for outbreak size and budget is unknown. Similarly there may be a carcass collection threshold. Finding and disposing of ASF positive carcasses is a critical part of stamping out African

swine fever in feral pigs. It is impractical to assume 100% of carcasses will be found. However, the percentage of carcasses that need to be found and removed to sufficiently reduce the viral reservoir in the environment to stamp out the disease in feral pigs is unknown.

Identifying these thresholds around outbreak size, disease response budget and carcass removal will aid decision makers in their decision to implement the strategy described in this section to eradicate ASF in feral pigs or focus on asset protection of commercial pigs. A risk assessment and a cost / benefit analysis may also aid decision making.

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Surveillance and tracing

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AUSVETPLAN (version 4.1; Animal Health Australia 2016, p.22) recommends “management of feral pig populations, and prevention of direct and indirect contact with domestic pigs.” This document outlines the principles and practices for surveillance tracing in feral pigs. Where they have been required, variations from Animal Health Australia documents (AUSVETPLAN, Wild Animal Response Strategy, Destruction of Animals manual, Disposal manual, Decontamination manual) have been identified.

Document Title

African swine fever (ASF) disease surveillance and tracing policy and operational guideline for feral pigs in Australia.

Purpose

To describe the principles and current operational guidelines for ASF surveillance and tracing in feral pigs before, during and after a disease incursion in feral and/or domestic pig populations in Australia, as a proposed adjunct to the *AUSVETPLAN Response Strategy – African swine fever*.

Application/ Scope

This document is applicable to feral pig populations for the purpose of the rapid detection of the presence of ASF virus (ASFV) and to define the extent of spread of the disease, if present, in a feral pig population in Australia after a confirmed disease incursion. This document also outlines recommended surveillance activities in feral pigs to demonstrate disease freedom from ASF.

Acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AHC	Animal Health Committee
ALA	Atlas of Living Australia
ASF	African swine fever
ASFV	African swine fever virus
AUSVETPLAN	Australian Veterinary Emergency Plan
IA	Infected area
IP	Infected premises
DCP	Dangerous contact premises
EAD	Emergency animal disease
eWHIS	electronic National Wildlife Health Information System
LGA	Local government area
NAHIP	National Animal Health Information Program
NAQS	Northern Australia Quarantine Strategy
RA	Restricted area
SP	Suspect premises
WHA	Wildlife Health Australia

Summary of African swine fever feral pig surveillance and tracing in Australia.

PRINCIPLES	PRACTICES	REASONING/RECOMMENDATIONS
PRE-INCURSION SURVEILLANCE		
Passive surveillance is the recommended primary approach for the early detection of ASFV in feral pigs.	• Clinical syndromes in feral pigs consistent with ASFV should be investigated rapidly. • Where possible, samples should be collected during all disease investigations of feral pigs to enable ASFV confirmation / exclusion. • Where sample collection is not immediately possible from affected pigs, additional enhanced passive surveillance in the vicinity (e.g. looking for dead feral pigs) should be considered to actively monitor for further potential cases.	• Passive surveillance has a higher sensitivity and probability of detection relative to active surveillance. • Serological surveys for ASFV in healthy feral pig populations are not recommended as they are inefficient and highly insensitive.
SURVEILLANCE AND TRACING DURING AN INCURSION		
Surveillance during an incursion of ASF in domestic and/or feral pigs would include: • Detecting infection in feral pigs and feral pig carcasses • Delineating the temporal and geographical extent of infection in feral pig populations to identify the Infected Area • Measuring the incidence of infection over time to track the progress of control methods	• Options to achieve these objectives may include: - enhanced passive surveillance of sick/dead pigs - active surveillance using PCR and/or serological testing of samples from pigs killed as part of a population control program. • In a post-incursion scenario: aerial surveillance, tracking and shooting with subsequent carcass sampling is the most time-efficient and cost-effective method to delimit the spread of ASFV in a feral pig population where appropriate	

	• A specialised, targeted surveillance program may be required to measure the incidence of infection over time. • Use of non-government stakeholders to assist with sampling of feral pigs in remote areas.	
Tracing of transmission within feral pig populations is unlikely to be of value. Tracing of human-mediated movements of feral pigs and fomites may be important to identify potential long distance spread of infection.	• Tracing should consider long distance movements of: - Feral pigs (live or dead) - Feral pig products, waste material, vehicles, equipment and other contaminated material • Tracing would require effective engagement with feral pig producers and hunters and shooters who are more likely to be involved in movement of live and dead feral pigs, feral pig products and other potentially contaminated materials.	
POST-INCURSION SURVEILLANCE		
Post-incursion surveillance requires implementation of geographically targeted methodologies to confirm disease freedom from ASF.	• Scenario tree analysis (complex surveillance system analysis using multiple data sources) can be applied in southern states, utilising multiple data sources including: - Targeted surveillance in high risk areas - Representative surveillance in previously infected areas - Suspect case investigations and passive surveillance or clinical syndrome surveillance (as referenced above) • Targeted surveillance likely more appropriate in northern states.	• Policy for returning to freedom following an incursion in feral pigs should align with OIE code. • Require demonstration that there is no tick mediated transmission, and that infection was contained to a particular geographical region in accordance with Articles 15.1.6 and Article 4.4.7.
GENERAL		

Collation of data on clinical syndromes in feral pigs consistent with ASFV is valuable to correlate with similar domestic pig data and to support control activities.	• Requirement to collate data derived from feral pigs prior to, during and after an ASF incursion (e.g. latitude, longitude, pig age, sex etc.) from the individual jurisdictions into a cohesive national database. eWHIS database (Wildlife Health Australia) is the agreed national repository for feral pig disease data outside of an EAD response. A central feral pig data database formatted for an EAD incursion is not currently available.	• Optimal: during an ASF incursion to collate feral pig data in conjunction with an equivalent national-level database for domestic pigs (not currently available). • If eWHIS is to be used during an incursion, significant changes would be needed, including database expansion (e.g. new module) to accommodate feral pig ASF data. • Data standardisation needed. • Agreement needed from jurisdictions to share feral pig data nationally, including location data.

Stakeholders

- Commercial pig farmers
- Pig smallholders
- Hunting federations
- Game Management Authorities
- State/jurisdictional governments

1. Background

ASF is a notifiable emergency animal disease in Australia under individual jurisdictional-level legislation (see Section 2, pg. 108).

1.1. Disease Considerations

Refer to AUSVETPLAN Response Strategy – African swine fever (version 5.0) (2020): https://www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents/

1.1.1. Key facts:

- Australia has never reported an outbreak of ASF.
- Domestic and feral pigs (*Sus scrofa*) are the only susceptible species in Australia, outside susceptible species held in zoos.
- ASF is a contagious disease that may result in high or low case mortality rates, fever, hyperaemia of the skin and a variety of other clinical signs, including incoordination, diarrhoea and pneumonia.
- The incubation period for ASF is usually 5-15 days but may be as long as 20 days.
- ASF is clinically indistinguishable from classical swine fever (CSF), but the latter disease is also exotic to Australia.
- ASFV is stable at a wide range of pH levels (pH 4-10).
- ASFV remains viable for extended periods under most environmental conditions and is resistant to a number of commercially available disinfectants that readily inactivate other pathogens. ASFV is not inactivated by freezing and thawing.
- Transmission of ASFV is by direct or indirect means. Direct contact with infected pigs or ingestion of products from infected pigs are significant transmission pathways, though the virus may also be transmitted by fomites and some insects. Pigs with acute disease shed virus in high concentrations in all secretions and excretions that contain blood.
- Infection by the respiratory route can occur between pigs in close contact. ASFV can be spread by aerosol within a piggery but is generally not transmitted from one piggery to another.
- In Africa, the soft argasid tick (*Ornithodorus moubata porcinus*) maintains a source of ASFV in the warthog population by transovarial transmission. It plays a significant role in the transmission of ASFV between wild and domesticated pigs. The soft tick *O. erraticus* contributed to transmission of ASFV in outdoor pig production systems, resulting in the persistence of the virus for 5 years. The only *Ornithodorus* ticks present in Australia are the inornate kangaroo tick (*O. gurneyi*) and the seabird tick (*O. capensis*); neither of which is

known to feed on pigs. The potential role of other tick species in the epidemiology of ASF in Australia is unknown.

- Blood-sucking insects, such as mosquitoes and biting flies (*Stomoxys* spp., Tabanids) feeding on viraemic pigs can carry high levels of virus for two days and have been implicated in the mechanical spread of ASFV within and between herds.

1.1.2. Feral pig considerations relevant to surveillance and tracing

- Refer to *AUSVETPLAN Operational Procedures Manual – Wild Animal Response Strategy (version 3.3)* (2011).
- Documentation developed by other National ASF Feral Pig Sub-Working Groups

1.2. Feral pigs – key epidemiological parameters[9]

Feral pigs are widely distributed in New South Wales, Queensland, the Northern Territory and the Australian Capital Territory. Isolated populations also occur in Victoria, South Australia and Western Australia and on Flinders Island in Tasmania.

Feral pigs are omnivores, feeding on native vegetation, agricultural crops, refuse and carcasses. *Habitat:* Feral pigs need to live in moist areas that can provide adequate food, water and sufficient shelter to protect against extremes of temperature. Feral pigs are found in a variety of habitats that can provide these requirements: rainforests, monsoon forest patches, paperbark swamps, open floodplains, marsh areas, semi-arid floodplains, dry woodlands and subalpine grasslands and forests.

Home range: On a daily basis, feral pig ranges are small, although the seasonal or overall home ranges may be much larger. In western NSW, a boar may have a home range of 43 km^2, whereas in north-west NSW a boar may have a home range of 10 km^2.[10] Even if disturbed, feral pigs will not move far and will readily return to their home range.

Studies in Europe have shown that natural geographical spread of ASF in the wild boar populations with densities typical for Northern and Eastern Europe occurs at the speed of about 1-3 km/month resulting in a 12-36 km expansion of the endemic zone in a year However, differences among infected areas are observed and are probably determined by different population densities, timing of incursion, type of interventions and management activities put in place (Guberti et al 2019).

Feral pigs may become wary and nocturnal if they are subjected to intensive or prolonged disturbance. Under these circumstances, they may shift home range or disperse over large distances to remote areas, thereby complicating surveillance, control and containment operations.

[9] Key source: Department of Primary Industries; New South Wales

[10] https://www.dpi.nsw.gov.au/biosecurity/vertebrate-pests/pest-animals-in-nsw/feral-pigs/feral-pig-biology

Behaviour and social structure: Feral pigs restrict their activity to the cooler parts of the day. Feral pigs consistently use trails from one area to another, such as from shelter to a food supply or water. Sow and piglets run together as a group. At approximately 18 months, males become more solitary, re-joining a group only for mating or to feed on localised food sources. Group sizes vary depending on season and habitat – in forested areas of south-west WA, group sizes rarely exceed 12, whereas in more open country, up to 40 to 50 pigs may form a mob. In times of severe food and water shortage, large groups of 100 or more may gather around remaining waterholes.

Feral pigs have a potentially high rate of population growth where food, water and shelter are abundant which means that reducing and maintaining low population densities is difficult, expensive and ongoing. They are occasionally found in large groups, particularly in tropical Australia, but in more temperate habits smaller family groups of 10-20 animals are more commonly seen. Interactions between individuals from different litters early in life facilitate disease transmission at a local level.

Mortality: Adult mortality varies between 15% and 50% per year, with few feral pigs in western NSW living more than 5 years.

2. Legislation

2.1. Jurisdiction-level legislation

2.1.1. ASF as a nationally notifiable disease

There is a duty to notify of an awareness or suspicion of ASF to jurisdictions under the following legislation:

- Australian Capital Territory – *Animal Diseases Act 2005*
- New South Wales – *Biosecurity Act 2015* (sections 30 and 38); Biosecurity Regulation 2019 (clause 7)
- Northern Territory – *Livestock Act 2008*
- Queensland – *Biosecurity Act 2014*
- South Australia – *Livestock Act 1997*
- Tasmania – *Animal Health Act 1995* (sections 26-30); Animal Health Regulations 2016
- Victoria – *Livestock Disease Control Act 1994*; Livestock Disease Control Regulations 2017 (especially Schedule 2)
- Western Australia – *Biosecurity and Agriculture Management Act 2007*

2.2. Additional agreements/documents/programs

EADRA Response Agreement – a unique contractual agreement signed in 2002 that brings together the Australian, state and territory governments and livestock industry groups to collectively and significantly increase Australia's capacity to prepare for – and respond to – emergency animal disease (EAD) incursions (https://www.animalhealthaustralia.com.au/what-we-do/emergency-animal-disease/ead-response-agreement/).

AUSVETPLAN manuals – nationally-agreed (disease/pathogen-specific) approach for the response to EAD incidents in Australia

Nationally agreed Standard Operating Procedures – for use by jurisdictions during responses to EAD incidents and emergencies.

National Significant Disease Investigation (NSDI) Program – subsidises training of private veterinary practitioners in disease investigation and subsidises private veterinary practitioners to investigate significant disease incidents in livestock and wildlife.

National Animal Health Information Program (NAHIP) – ongoing collaboration between governments, livestock industries and Wildlife Health Australia to collate surveillance and monitoring data and provide an overview of animal health in Australia.

electronic Wildlife Health Information System (eWHIS) - ongoing collaboration between governments and non-government agencies collate free-ranging wildlife (native or feral species) and wildlife in captivity surveillance and monitoring data and provide an overview of wildlife health in Australia.

3. Statement of policy

To meet the initial goal of AUSVETPLAN to control and eradicate ASF in the shortest possible time while minimising socioeconomic impacts, using stamping out.

Surveillance for ASFV in Australian feral pigs should focus on four core goals:

1. Early detection of an incursion of ASF
2. Confirmation of ASF in a feral pig (if index case is in Australia as a whole or within a previously free geographic area within Australia).
3. Localised, intensive surveillance in high risk areas to determine the extent of disease distribution in feral pigs.
4. Widespread surveillance to exclude the possibility of ASF being widely dispersed across the feral pig population within the jurisdiction.
5. Surveillance to demonstrate freedom from ASF virus following an incursion.

Surveillance outputs should include an estimate of:

- ASFV incidence within feral pig population(s); and
- spread of ASFV within feral pig population(s) over space and time

in order to inform the most suitable strategies for control and eradication of disease within the feral pig population.

4. Case Definition

4.1. Feral pig

A pig that lives without direct human supervision or control[11].

4.2. Feral pig infected with ASFV

A feral pig or feral pig carcass with laboratory confirmed infection with ASFV.

Note: A case of ASF is defined as laboratory-confirmed infection with ASF virus in a pig. Positive serology in the absence of genome or antigen does not constitute a case but warrants further investigation to determine if there is evidence of infection.

Note: May change depending on the extent and length of outbreak.

5. Mapping

5.1. Mapping sources

- Can include national (ABARES; PigPass), state/territory, regional and/or local data.
- Maps may be limited to presence/absence of feral pigs or may include estimates of feral pig density.
- Where possible, data to describe other factors that will influence the population density and sub-structure should be taken into account (e.g. temporal; wet vs dry season), estimated home ranges, and genetic meta-population structure).

6. Surveillance

6.1. Pre-incursion Surveillance

6.1.1. Surveillance objectives

The primary objective of pre-incursion surveillance for ASF in feral pigs is to aid rapid and early detection of ASFV in the event that an incursion first occurs in feral pigs. A secondary objective of pre-incursion surveillance for ASF in feral pigs is to determine the population at risk of infection with ASFV.

Pre-incursion surveillance in feral pigs spans all surveillance for ASF up to the point when a case of ASFV is confirmed in feral *or* domestic pigs.

[11] Adapted from: https://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/current/glossaire.pdf

In the event of a limited ASF outbreak with a clearly defined containment zone (e.g. as defined by OIE Terrestrial Code Article 4.4.7; possibly infected zone in AUSVETPLAN), then the pre-incursion surveillance activities outlined below would also apply to locations outside the containment zones within Australia *with two key aims:*

1) Maintain early detection surveillance (e.g. detect another simultaneous incursion); and

2) to provide confidence that the containment zone has been appropriately defined

6.1.2. Surveillance outputs

For rapid detection of ASFV in feral pigs, surveillance outputs should include:

- Mapping of feral pig population distribution and density
- Rapid investigation of clinical syndromes in feral pigs consistent with ASFV

The State/Territory government is the party responsible for animal disease investigations. Collaboration with third parties may be appropriate to facilitate rapid investigation in some areas (e.g. Government and NGO invasive species groups, Northern Australia Quarantine Strategy (NAQS) etc).

Where possible, samples should be collected during all disease investigations to enable ASFV confirmation / exclusion.

Where sample collection is not immediately possible from the affected pigs, additional enhanced passive surveillance in the vicinity (e.g. looking for dead feral pigs) should be considered to actively monitor for further potential cases.

6.1.3. Recommended approach to surveillance

6.1.3.1. For rapid detection of ASFV in feral pigs

Passive surveillance is the recommended approach for early detection of ASF in feral pigs. Passive surveillance has a higher probability and sensitivity of detection compared to active surveillance (Guberti et al 2019; Gervasi et al 2020). To achieve the same level of detection, the number of apparently healthy feral pig samples would be challenging to achieve and could possibly be counterproductive (e.g. increasing animal movement due to disturbance) (Gervasi et al 2020). The OIE Terrestrial Code Chapter on Infection with African swine fever also notes that whilst serology is an effective and efficient surveillance tool, ASF serology is not suitable for early detection (OIE 2019, Chapter 15.1 Article 15.1.30-4).

Each state/territory should appraise their passive surveillance system's capacity to monitor feral pig health and take steps to improve the sensitivity of the system to detect ASFV in feral pigs as appropriate to their local context. The sensitivity of the surveillance system can be assessed using scenario tree modelling, as described in section 6.3 pg. 118.

Sensitivity of the passive surveillance system may be increased by:

- Public awareness campaigns aimed at disease recognition and reporting targeted at:
    - those most likely to see feral pigs

    - those in identified 'high risk' areas for an ASF incursion in feral pigs
- Supplementing passive surveillance with enhanced and/or targeted passive surveillance to address gaps (e.g. geospatial or demographic) or further target high risk areas (as described in Hoinville et al 2013) (e.g. completion of syndromic animal health surveys).
- Completion of field surveillance and sample collection from sick and dead feral pigs - potentially in collaboration with those most likely to come across these animals (e.g. Natural Resource managers, Vertebrate pest managers, hunters, etc) (see Feral pig data sources: section 7.4, pg. 123)

6.1.3.2. For determining the population at risk of infection with ASFV

Feral pig population density is dynamic, due to factors such as food and water availability and high fecundity of pigs. Although it is not considered cost effective to actively monitor feral pig population density specifically for the purposes of ASFV preparedness, it is recommended that the states/territories:

- ensure there is at least one feral pig population density dataset available for their jurisdiction (i.e. a baseline dataset to be used for this purpose in the absence of further detail);
- develop and implement a plan to periodically update their baseline population estimates; and
- identify key stakeholders for the collection of feral pig population density data (i.e. those that can assist with data collection and/or modelling), in preparedness for the need to rapidly gather further population density data in a specific area, in the event of a suspect or confirmed incursion of ASFV.

6.2. Surveillance during an incursion

This considers surveillance requirements within the following three incursion scenarios:

- ***Scenario 1:*** ASF detected in feral pigs, not detected in domestic pigs
- ***Scenario 2:*** ASF detected in feral pigs and domestic pigs
- ***Scenario 3:*** ASF detected in domestic pigs, not detected in feral pigs

6.2.1. Surveillance objectives

The objectives of surveillance during an incursion of ASF in either domestic pigs or feral pigs would be determined by the Local Control Centre based on the circumstances of the outbreak. These may include:

- Detecting infection in feral pigs and feral pig carcasses if present (or demonstrating freedom);
- Delineating the temporal and geographical extent of infection in feral pig populations to identify the Infected Area;
- Measuring the incidence of infection over time to track the progress of control methods.

Table 1: Recommended surveillance objectives based on three ASF incursion scenarios

Surveillance objectives	**Scenario 1:** ASF detected in feral pigs, not detected in domestic pigs	**Scenario 2:** ASF detected in feral pigs and domestic pigs	**Scenario 3:** ASF detected in domestic pigs, not detected in feral pigs
Detect infection in feral pigs and feral pig carcasses if present (or demonstrating freedom)			☑
Delineating the temporal and geographical extent of infection in feral pig populations to identify the Infected Area	☑	☑	
Measuring the incidence of infection over time to track the progress of control methods	☑	☑	

6.2.2. Understanding the feral pig population(s) at risk and defining the epidemiological unit

Surveillance managers, in collaboration with feral pig ecologists, should identify the initial area of interest for surveillance. This should include consideration of the home range of pigs in the region and areas of favourable feral pig habitat that are contiguous with the area of the index case detection.

Based on advice developed during classical swine fever surveillance in the Northern Territory as part of Exercise Wild Boar, the development of a grid of likely feral pig distribution should be considered as an epidemiological unit (Cowled B, *pers. comm.*). In the Northern Territory, Queensland and Western Australia, where widespread surveillance of feral pigs is required (e.g. if it is uncertain how widespread infection is), sampling points every 200km may be appropriate (Appendix 1). However, smaller jurisdictions may consider using a smaller grid.

Identification of these epidemiological unit grids should consider available information about the abundance, ecology and meta-populations of feral pigs in the areas at risk, through local knowledge, expert opinion, inferences about habitat suitability, past research, or population studies. Uncertainty about the distribution of feral pigs in the region should not delay the commencement of a surveillance and control program. Indeed, gathering information on the abundance of feral pigs can be integrated into a surveillance and control program. For instance, if aerial surveys are considered cost-effective in the region, estimates of feral pig abundance in the area around a detection of ASF, can be integrated into an aerial shooting program with subsequent carcass sampling. Such an approach could confirm local distributions and densities.

6.2.3. Detect infection in feral pigs and feral pig carcasses, if present

6.2.3.1. Passive surveillance

For virulent ASF viruses (e.g. genotype II viruses circulating currently in Asia), passive (general) surveillance is useful to detect active infection in a feral pig population. This may involve seeking

reports of sick or dead pigs from the general public accessing wilderness areas, local farmers, Indigenous communities and/or hunting groups (also see feral pig data sources: Section 7.4 pg. 123). Amateur or professional hunters may also be engaged to sample pigs in the area of interest if they are appropriately engaged and trained to take samples.

Engagement of these groups should consider and strive to meet participants' motivations to participate in the study. For example, previous studies have indicated that feral pig hunters may be reticent to voluntarily engage in sample collection possibly due to a mistrust of government and perceptions that the consequences of detections of exotic disease may be to eradicate the local feral pig population[12]. It is also possible that some members of the community may consider ASFV to be a potential biological control agent and may perceive disincentives in controlling ASF in feral pig populations. Where appropriate, bounties for reporting feral pig carcasses and educational awareness campaigns may be considered, and these strategies have been used in Europe.

Statistical methods are not typically used to determine the sample size for passive surveillance; rather the goal is to identify as many dead pigs as possible. In the European situation, targets have been used to assess the effectiveness of passive surveillance to detect pig carcasses. This is useful if the mortality due to ASF is expected to be relatively low (due to a low incidence of infection or due to infection with low or moderate virulent viruses).

This estimates the expected number of adult pig carcasses in a region by multiplying the incidence of mortality in adult pigs expected in an ASF-free population per year, with the estimated density of pigs per km^2 and the area of the region (Equation 1). Targets can be derived by multiplying the expected number of adult pig carcasses with a desired carcass detection rate (Equation 2). In the European Union, as a guide, it has been assumed that 10% of carcasses are detectable (Ilevicius, Z, *pers. comm*. 21 April 2020).

Equation 1: expected number of adult dead pigs per unit of time

$$E_{dead\ pigs} = I_{mortality} \times d_{pigs} \times a$$

Where:

$E_{dead\ pigs}$ *is the expected number of dead pigs per unit of time*

$I_{mortality}$ *is the incidence of mortality per unit of time*

d_{pigs} *is the estimated density of pigs per* km^2 *in the area*

a is the area of the epidemiological unit

Equation 2: target number of dead pigs identified per unit of time

$$T_{dead\ pigs} = c \times E_{dead\ pigs}$$

[12] Mason R & Fleming P (1999) Australian Hunters and the Surveillance of Feral Pigs for Exotic Diseases, Wildlife Society Bulletin 27 395-402.

Where:

$T_{dead\ pigs}$ *is the targeted number of dead pigs identified per unit of time*

c is the desired carcass detection rate

$E_{dead\ pigs}$ *is the expected number of dead pigs per unit of time*

6.2.3.2. Active surveillance

Active surveillance may also be undertaken using samples from dead pigs that have been culled as part of a population control program, through aerial culling, baiting, or other methods. However, a very low prevalence of infection would be expected in live feral pig populations if Australia experiences an incursion of highly virulent Genotype II ASFV as infected pigs are expected to die rapidly.

Evidence from the Baltic countries and Poland suggests that the apparent prevalence of ASFV-positive wild boar that have been shot by hunters (including recreational hunting and selective hunting program of females) can be low to very low (0.04 - 3.8%), even in situations where a moderate to high prevalence of infection was detected in feral pig carcasses (1.4 - 85.7%)[13] (Table 2), again due to rapid mortality of infected pigs. Apparent seroprevalence in wild boar in affected regions of Estonia was extremely low (<0.06%) demonstrating the difficulty in using this method for detecting ASFV infection. Given the low probability of survival of infection, this may reflect the false-positive rate of the test.

Table 2: Apparent virus (PCR) prevalence in wild boar in the Baltic countries and Poland, January 2014 to August 2016 (Source: https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2017.4732)

Country	2014		2015		2016	
	Wild boar found dead	Wild boar hunted	Wild boar found dead	Wild boar hunted	Wild boar found dead	Wild boar hunted
Estonia	29.8*	1.01*	71.41	3.8	85.7	3.0
Latvia	53.2	0.68	73.08	1.8	78.2	2.1
Lithuania	23.8	0.11	27.3	0.97	59.9	0.13
Poland	1.4***	0.04**	1.42***	0.1**	0.5***	0.0**

n/a: data are not available.
*: Samples from a period the infection was not detected in a country are included.
**: Most of the samples tested originate from affected administrative units (see Figure 3A).
***: A large proportion of samples tested originate from unaffected administrative units (see Figure 3B).

[13] https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2017.4732

Assuming random sampling and perfect test sensitivity and specificity, in a population of 800 feral pigs[14], a sample size of 760 would be required to have 95% confidence of detecting evidence of ASF in feral pig populations at a 0.05% design prevalence[15].

In practice, if a very low prevalence of infection is expected, census sampling of feral pigs killed in a control program (e.g. through aerial shooting) for testing by PCR may be required, particularly if moderate numbers of pigs are likely to survive infection. If there are large numbers of areas under surveillance, two-stage sampling (i.e. of a subsample of pigs in a herd unit) and/or pooled sampling may be considered to reduce costs. Such a program could involve amateur hunters, if it is safe and they are appropriately engaged, biosecurity is managed, and they are trained to take samples.

If there is evidence of *Ornithodoros spp.* ticks being involved in the transmission of ASFV, the OIE Code has a longer waiting period for countries or zones returning to freedom. This period is three years following the last case, and is reduced to one year if there is no evidence of these species being involved (Article 15.1.4)[16]. Although no known species of *Ornithodoros* ticks infest feral pigs in Australia, feral pig carcases should be inspected for infestation and any ticks should be sampled for identification. Virological surveillance of ticks may be considered if there is a strong suspicion of ticks being involved in the epidemiology of infection.

6.2.4. Delineate the extent of infection in feral pigs

Following detection of ASF in a feral pig population, surveillance objectives should then focus on delineating the geographical extent of infection in feral pigs. As ASF has been present in Asia for under two years (as of the date of this report version) and has been recorded as spreading about 8 - 20 km per year in feral pig populations in Latvia, Estonia and Lithuania[17], it is not expected that infection would be widespread in feral pigs in Australia unless human mediated long distance transmission (Section 6.2.6, pg. 117) or multiple incursions were suspected.

Surveillance to delineate infection should commence in epidemiological units that are contiguous to those where ASF has been detected, and should continue to expand outwards, as necessary. Passive surveillance, supported by active surveillance integrated in an ASF control program, should occur as described in Section 6.2.3 (pg. 113).

It is important to note that in addition to surveillance to delineate infection in feral pigs, widespread passive surveillance and enhanced passive surveillance should be considered to demonstrate freedom in other parts of the affected jurisdiction (See Section 6.3., pg. 118). Delineation of the extent of infection in feral pigs and demonstrating freedom in other feral pig populations will be

[14] This corresponds to a population density of 4 pigs per km^2 in an epidemiological area of 200km^2. This density can occur in riverine and swamp environments in Queensland https://www.daf.qld.gov.au/__data/assets/pdf_file/0010/57277/IPA-FeralPig-PSA.pdf

[15] https://epitools.ausvet.com.au/freedomss

[16] https://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/current/chapitre_asf.pdf

[17] https://www.researchgate.net/profile/Marius_Masiulis/publication/329301543_Epidemiological_analyses_of_African_swine_fever_in_the_European_Union_November_2017_until_November_2018/links/5c03ff18299bf1a3c15da8be/Epidemiological-analyses-of-African-swine-fever-in-the-European-Union-November-2017-until-November-2018.pdf

important to maintaining or regaining international market access for pig products. This surveillance may contribute to the development of a containment zone for the purposes of international trade[18].

6.2.4.1. Delimiting surveillance

Delimiting surveillance will take into consideration factors including: environment, pig movements, surveillance information to date and epidemiology of the disease.

- In a post-incursion scenario: aerial surveillance, tracking and shooting with subsequent carcass sampling is the most time-efficient and cost-effective method to delimit the spread of ASFV in a feral pig population where appropriate
- Where feral pig populations are identified, but where their densities and distribution are unknown, sampling by the use of a geospatial grid may be appropriate.
    - Firstly, surveillance for disease should focus on proving that ASF is present where feral pigs were identified as the index case.
    - Secondly, widespread low intensity surveillance should be undertaken to exclude the possibility of ASF being endemic or widely dispersed across the jurisdiction or greater Australian region. This will inform further decision-making around the feasibility of eradication.
    - Lastly, if eradication was indicated, localised, intensive surveillance of high-risk areas around the index case would follow.

6.2.5. Measure the incidence of infection over time

If infection becomes entrenched over a long period of time in a feral pig population then it may be necessary to measure the incidence of infection through ongoing passive surveillance and/or repeated cross-sectional surveillance to identify trends in ASFV prevalence and monitor the effectiveness of a control program. Such a surveillance program may be considered as part of a transition to management strategy.

In this scenario, it is expected that the epidemiological unit(s) of interest would be known and recent information would be available on the feral pig population, including the past prevalence of infection which could be used to design sampling. There are examples of the design and analysis of these studies from the Balkans[19].

Due to lower feral pig densities following culling, sampling feral pigs for surveillance may be difficult immediately after a control program. A specialised, targeted surveillance program may be required.

6.2.6. Tracing of human-mediated movements

Although tracing of the movements of infected feral pigs is unlikely to be of value to identify cases of infection, tracing of human-mediated movements of live pigs, pig products and fomites may be beneficial to manage the risk of long distance spread.

[18] https://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/current/chapitre_asf.pdf
[19] https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2017.4732

6.3. Post-incursion surveillance/disease freedom

6.3.1. Surveillance objectives

Post-incursion surveillance in feral pigs will be undertaken after the conclusion of a stamping out/disease eradication program to demonstrate that feral pigs in the country, zone or compartment are free from infection with ASFV or to detect the introduction of ASFV into a free population.

The surveillance framework must meet the requirements of the OIE (OIE Article 15.1.31) and provide sufficient evidence that there is no detectable ASFV infection in feral pigs at a selected prevalence of disease and statistical confidence limits that is robust enough to satisfy the OIE and trading partners.

The role of *Ornithodorus* or other soft bodied ticks in the transmission and persistence of ASF will need to be elucidated and explained in a dossier to demonstrate freedom. Currently the OIE requires three months of negative surveillance after the disinfection of the last infected premises. If ticks are involved this must be followed by use of acaricides and sentinel pigs for two months. Given this measure could only be used on domestic pig premises, there is a need for further research on the role of existing species of *Ornithodorus* and other soft bodied ticks in Australia in relation to feral pigs and potential ASF transmission.

Finding evidence of infection at any prevalence in the feral pig population automatically invalidates any freedom claim unless otherwise stated in the relevant chapters of the Terrestrial Code.

6.3.2. Recommended approach to surveillance in feral pigs

The OIE recognises that surveillance in feral pigs contains potential challenges associated with feral pig behaviour, habitat, accessibility and associated logistics. It recommends (OIE Article 15.1.32) that a passive surveillance programme should include feral pigs found dead, road kills, animals showing abnormal behaviour and hunted animals, and should also include awareness campaigns targeted at hunters and farmers.

There may be situations where a more targeted surveillance programme can provide additional assurance. However, the most suitable approach will depend on the size and type of disease outbreak and associated available response resources and budget but is most likely to consist of a surveillance system analysis using a scenario tree constructed from multiple surveillance types with associated sensitivity calculations.

6.3.3. Surveillance tools

6.3.3.1. Representative survey of feral pig population within country, zone or compartment.

The ability to complete a representative proof of freedom survey will depend on the cost and resources available and, by inference, will depend on the size of the area in question, the population of feral pigs and a number of logistical factors captured in the Feral Pig ASF Control Difficulty Index (CDI) map. The time taken to complete the survey and the time for which the survey will be relevant are also considerations, as a single survey only provides information about a defined period of time.

Unless the outbreak is relatively small and/or isolated, this method on its own is likely to be cost/resource prohibitive in Australia.

6.3.3.2. Complex surveillance system analysis using multiple data sources and scenario trees

Possible data sources include:

- Passive surveillance (e.g. samples from feral pigs found dead or sick, shot by hunters or land managers completing feral pig culls)
- Reports from hunters, land managers, general public
- Previous surveillance/samples from Infected Areas(s), restricted areas (RAs) and/or treatment zones
- Previous surveillance samples
- Historical records
- Environmental sampling (e.g. soil around feral pig carcasses, or faeces)
- Use of sentinel animals (e.g. collared feral pigs and subsequent sample collection)

6.3.3.3. Targeted surveillance programmes

Targeted surveillance programs can provide additional assurance and increase the sensitivity of a surveillance design. The criteria to define high risk areas for targeted surveillance include:

- Areas with past history of ASF, such as the Infected Area, RA and treatment zones
- Subregions with large populations of wild or feral pigs
- Border regions with ASF-affected zones
- Interfaces between feral pig and domestic pig populations
- Areas with farms with free-ranging and outdoor pigs
- Areas with a high level of hunting activity, where animal dispersion and feeding, as well as inappropriate disposal of waste can occur
- Other risk areas determined by the jurisdiction, such as ports, airports, garbage dumps and picnic and camping areas
- Arthropod surveys in areas of feral pig populations

6.3.4. Disease prevalence estimates.

Proof of freedom surveillance will require an estimate of disease prevalence in calculating the system sensitivity and associated confidence intervals. The disease prevalence estimate can provide important information about the success of disease control measures and the likely success of any eradication campaign versus a move to disease mitigation.

7. Data management

7.1. Pre-incursion data

7.1.1. Syndromic surveillance data

- Reports of sick and feral pigs may be submitted via various mechanisms and reporting pathways:
  - Animal disease hotline data (EAD/NAQS hotlines)
  - Feral pig reporting pathway data (Section 7.4., pg. 123). These could be enhanced hunter return data; e.g. tick box for observation of dead or sick pigs)
- Single or increased reports of sick or dead pigs; or absence of feral pigs may be a 'signal' of a potential incursion

7.1.1.1. Recommendations:

- Regularly evaluate reports via reporting pathways to identify "signals" (i.e. variations from the baseline data):
  - EAD and NAQS hotline data to determine level of use for reporting sick / dead feral pigs (e.g. number of calls per week/year/ by jurisdiction data downloadable in excel spreadsheet)
  - Feral pig reporting pathway data

Note: a lack of data could signify a lack of awareness and lead to a subsequent increase in communication activities to high risk regions.

- Audit reporting pathways in each jurisdiction to identify key sources to monitor and at which point EAD hotline is called.
  - Example: hunter informs regional ranger, with either calling EAD hotline.
- A single national repository for feral pig and domestic pig syndromic data is required. Options include:
  - eWHIS - would require significant adaptation
  - FeralScan – would require significant adaptation
  - NAHIP
  - AusPest*CHECK*

7.1.2. General surveillance

Free-ranging feral pig ASF laboratory-based exclusions and detections that are part of disease investigation are entered into the web-enabled database, eWHIS (electronic national wildlife health information system) administered by Wildlife Health Australia.

eWHIS data is entered on a monthly basis by WHA surveillance coordinators based in state and territory agricultural agencies and by NAQS (WHA Coordinators) and by non- government WHA Surveillance partner agencies/organisations (such as universities, zoo wildlife hospitals and private veterinary practitioners). ASF data would most likely be entered by WHA Coordinators.

eWHIS users determine the level of access for their data. All data are accessible to WHA staff and the majority are visible to WHA Coordinators. eWHIS data management principles are provided at https://www.wildlifehealthaustralia.com.au/DataManagementWildlifeDiseaseSurveillance.aspx

Note: Domestic pig AFS data is captured in NAHIS. WHA and AHA collaborate to ensure data is collected into the correct database.

7.1.2.1. Recommendation/Requirements:

- Obtain pre-approval from WHA Coordinators, AHC and other data contributors to share detailed feral pig ASF data with government agencies as required, potentially in combination with domestic pig ASF data (captured in NAHIS).

7.1.3. Targeted surveillance

Reporting of data into eWHIS from screening of healthy animals is optional. Testing of feral pigs as part of NAQS's targeted animal health surveillance program does not currently include testing for ASF.

7.2. During an incursion data (EAD data management)

7.2.1. Optimal

- Ensure a national data repository for all pig data (domestic / feral pig)
- At a minimum there would at least be a national dataset for feral pig ASF data
- Enable a national epidemiology group (ad hoc)

National minimum data standards have been developed for EADs.

All ASF positive data will be reported to the OIE and be made available via OIE WAHIS (e.g. public domain)

- New OIE WAHIS platform has map visualisation, but the level of resolution is unclear
- This may be the only source of information for the public to view ASF positive data.

7.2.1.1. Possible alternatives

- eWHIS – as above:
  - National sharing possible through WHA Coordinator database access and export of data.
  - Would need to be adapted to handle incursion data (e.g. new module with extra data fields).

- Other emergency management databases

Table 3. Minimum additional data requirements in eWHIS to enable the collection of feral pig ASF data.

eWHIS data field	Current	Enhancement *(NOTE: Funding and agreement required)*
Location	Nearest suburb	Latitude/longitude
Animal attributes	Species, Presenting sign	State of decomposition, age, sex, presenting clinical signs or findings etc
Test type		
Disease status		

        - Surge capacity considerations: resources, data load on database, ability to upload excel spreadsheets, automated SITREP reports

- AusPestCheck:
    - Options to automatically collate and visualise general surveillance data.
    - Would need to be adapted for EAD data

Note: Trial potentially underway to explore national collation of ASF data (e.g. NAHIS, eWHIS, etc)

- Jurisdictional EAD databases:
    - Examples: MAX (Vic, Tas, WA); BORIS (Qld), etc
    - Limited / no capability to share data between systems
    - Each database could be adapted for feral pig ASF data

7.2.1.2. Recommendations:

- Draft MOUs between bordering jurisdictions for data sharing
- Determine best platform for national ASF feral pig data repository before and during an incursion

7.2.2. Additional data ASF data field considerations

- Recommended feral pig ASF data (collection form):
    - Age
    - Sex
    - Fertility
    - How many other pigs
    - Decomposition
    - Presence / absence ticks and species
    - Clinical signs or findings (e.g. abnormal behaviours etc.)
    - Source: hunter killed, found dead etc?
- ACDP / AAHL data: Sample type, test type (virology/serology), result, genotype, etc

Note: Feral Pig ASF data considerations have been considered in the following two references:

- See **Chapter 6- Data collection** in Guberti V et al 2019. African swine fever in wild boar ecology and biosecurity. FAO Animal Production and Health Manual No. 22. Rome, FAO, OIE and EC.
- SIGMA Consortium. (2019). Scoping document on the integration of ASF data collection, analysis and reporting: OC/EFSA/ALPHA/2018/01. EFSA Supporting Publications, 16(7), 1676E.

7.3. Post-incursion data

- Pre-incursion and during incursion data will contribute to the post-incursion data
- Accumulation of ASF feral pig passive surveillance data may be sufficient for proof of freedom (from the feral pig compartment) if collated correctly
- Additional considerations for targeted surveillance data will be required (e.g. which may include large numbers of feral pigs tested via multiple modes of testing)

7.4. Feral Pig data types, sources and challenges

Feral pig population and/or density data is generated and collected by multiple agencies and organisations. This data is predominantly managed by each state and territory.

As part of the ASF Feral Pig Task Group work, ABARES has sourced and collated much of this feral pig data from across Australia to develop a number of national mapping layers to inform preparedness for surveillance and management of ASF in the event of an incursion in Australia.

However, given the variation in how, when and what feral pig population data is collected, it is recommended that any feral pig mapping for the purpose of risk assessment or to inform specific surveillance or communication activities also be undertaken at a jurisdictional level.

It is also recommended that any multi-jurisdictional mapping of feral pig population data pre-, during- or post- ASF incursion should be undertaken in collaboration with ABARES on the basis that ABARES can source any additional up-to-date data quickly from key sources and can incorporate the data into already developed mapping layers. It is acknowledged that individual jurisdictions may be able to source their own current feral pig data directly.

A current ABARES project ('National pests and weeds distribution') will aim to collate national data sets for a selected set of established pests (likely to include feral pigs) across Australia which will enable more accurate mapping at a national level.

The information below summarises feral pig data types, sources and challenges.

Note: It is not intended to be comprehensive.

Data types:

- Density data
- Point source data

Data sources:

- Density data:
    - Feral animal/invasive species management agencies (based in either Environment or Agriculture (jurisdiction-specific)
    - National-level data collation (National Land and Water Resources Audit) in 2008
- Point data:
    - Feral Scan (National)
        - Contributors: Members of the public, community groups

Note: Community group data is not accessible.

    - Atlas of Living Australia (ALA) (national)
        - Contributors: State environment agency-based species information databases (see above), citizen science projects (iNaturalist), museums data, members of the public
        - Data attributes enable filtering of data for high quality data sources

Note: ABARES has set up filters for any data extracted from ALA.

    - State environment agency-based control data including culling
        - Contributors: Land managers/rangers
    - State environment agency-based species information databases
        - Contributors: members of the public, rangers, contracted ecologists, students, possibly local/regional governments (see below)
        - Examples: NSW BioNet, Qld WildNet

Additional data which may feed into state environment agency-based species information databases.

        - Local/regional government data (800+ in Australia).
        - Land manager data (Private, public, commonwealth and state land)
        - Community and conservation groups (including natural resource management regional groups; e.g. National Landcare Programs, Catchment Management Authorities, Bush Heritage, other NGOs data).
    - Hunter returns: unknown if this data is collected and by whom.
    - Industry group data
    - Commonwealth Biosecurity survey data
        - Contributors: NAQS surveys
    - ABARES Pest and Weed Survey (2016) – provides information at NRM level for % properties in NRM who indicate awareness of feral pigs on property.
    - Other data

7.4.1. Challenges

- Purpose for collection differs depending on who is collecting the data
- Methodology for collection varies across jurisdictions and agencies (e.g. census data vs stakeholder consultation workshops)

- Spatial and temporal resolution of data varies by jurisdictions and agencies:
    - Density may be determined as *per 5km^2* or per LGA
    - Interval of data collection is variable (e.g. every 2 - 4 years)
- Not all jurisdictions collect density data (some have started to collect this data, while some have collected for years)
- Datasets may be biased for a variety of reasons:
    - Point data dependant on proximity to human populations and/or ease of accessibility of locations
    - Variation in purpose and manner of data collection
- Feral pig distribution and density is influenced by environmental factors (e.g. drought)

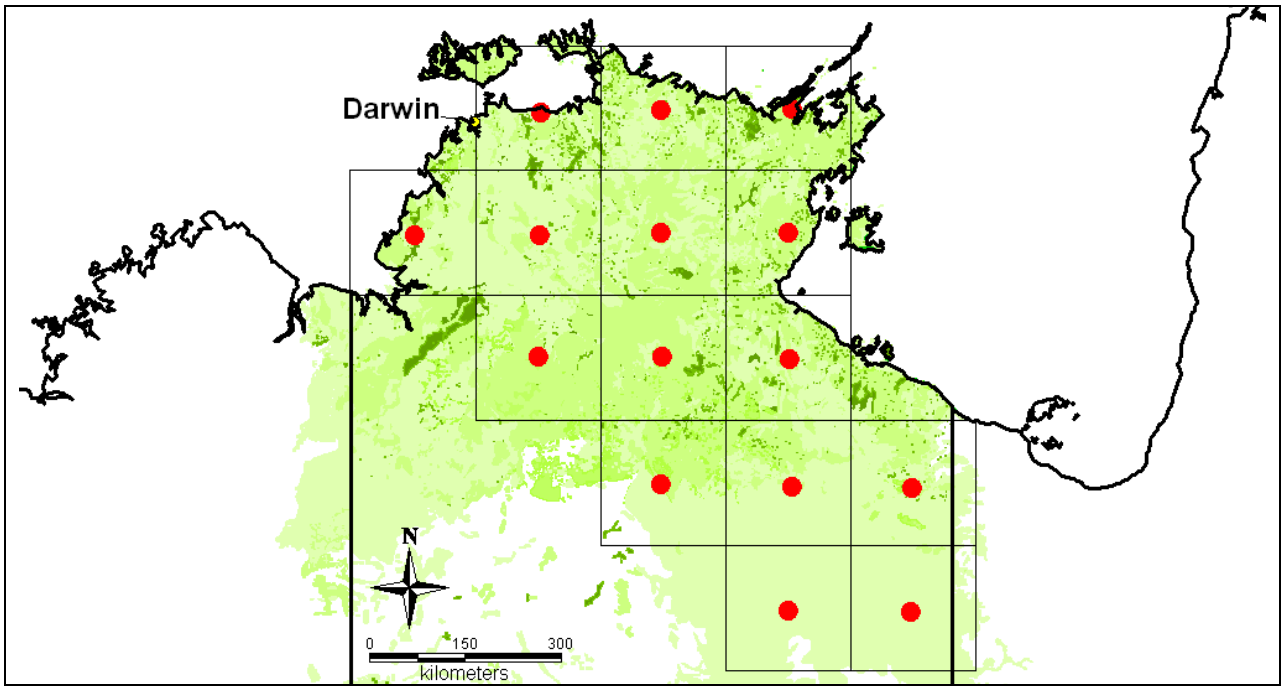
Footnote: ASF risk mapping could include an overlay of current surveillance effort (e.g. location of sources outlined, plus vet clinics) to explore possible surveillance gaps and areas for enhanced passive surveillance and communications.

Appendix

1. Broad-scale surveillance grid for ASFV in feral pigs across the NT

(Source: Cowled, B (2007) Exercise Wild Boar surveillance discussion paper)

Note: The red dots represent sampling points and are placed approximately every 200 km.



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Diagnostics

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AUSVETPLAN African Swine Fever (ASF) Disease Response Strategy (version 5.0; Animal Health Australia 2020, p.20) outlines the updated information in relation to the laboratory tests, samples required, transport of specimens and laboratory diagnosis for ASF and specifically the new recommended sampling for feral pigs (see attachment A). The purpose of this ASF Diagnostic sub working group is to review this information, develop general principles and practices and, where appropriate, provide additional/alternate recommendations relating to the sampling and diagnostics for ASF in relation to feral pigs.

This document outlines the principles and practices for sampling and diagnostics for ASF in feral pigs in Australia. This information will be used in the review for recommended variations to the Animal Health Australia documents AUSVETPLAN ASF Disease Response Strategy (version 5.0; Animal Health Australia 2020, p.20), (AUSVETPLAN, Wild Animal Response Strategy 2011) and (AUSVETPLAN, Laboratory Preparedness Manual 2013).

Additional input is required in this Diagnostics document from the Australian Centre for Disease Preparedness representative to support the recommended principles and practices. The general diagnostic principles and specific practices have been finalised, and supporting content will be revised when the COVID-19 research priorities have been delivered.

Summary of African swine fever Diagnostics in feral pigs.

	General Principles	Specific Practice for ASF diagnostics in feral pigs in Australia	References
		Surveillance, sampling and transport	
1	Current recommendations for emergency animal disease (EAD) diagnostic tests emphasise the importance of taking a surveillance system approach	Diagnosing ASF in feral pigs needs to consider all aspects of surveillance – purpose, availability and skill of resources to undertake surveillance and sampling, cost-effectiveness etc. – and not be narrowly confined to technical aspects of laboratory tests	OIE (2019a)
2	The primary objective of EAD surveillance in both feral and domestic animal populations in a country free from that disease is to achieve the earliest detection possible	Detection of ASF in feral pigs as early as possible following an incursion – when disease is localised - will make eradication much more feasible than a late detection	OIE (2019a)
3	Different diagnostic approaches may be required for different scenarios and the objective of the surveillance	There is a need to develop a diagnostic matrix for the preferred diagnostic system for the scenarios of infected vs. non infected areas, group vs. individual test, acute vs. chronic disease, screening vs. definitive test, proof of freedom vs. prevalence testing, etc.	Arias et al. (2018)
4	The principles of diagnosis in the context of a surveillance system needs to be wider than simply a laboratory test, and include *inter alia*, clinical observations and the analysis of available data to rapid field and detailed laboratory assays	Due to the scarcity of veterinary surveillance in many of the remote locations where feral pigs are most at risk of ASF, field observations and sample collection by landowners, rangers and hunters need to be considered a critical part of Australia's ASF feral pig surveillance system	OIE (2019a)
5	To achieve diagnostic test accuracy, the practicality of sample collection and transport needs to be taken into account when considering methods for collecting samples for diagnostic testing	For feral pig sampling, whole blood (EDTA and serum) and fresh and fixed tissues (tonsils, spleen, lymph nodes, lung, kidney and ileum) are the preferred samples, however for simplicity in collection and transport due to limitations in cold chain, training of sample collectors and to avoid spillage, the use of swabs for whole blood is a valid diagnostic sample method	Petrov et al. (2014); Beltrán-Alcrudo et al. (2017)OIE (2019b)
		Diagnostics	
6	Diagnostic test system accuracy can be enhanced by combining tests in series or parallel rather than individual diagnostic tests with imperfect test sensitivity (DSe) and/or test specificity (DSp)	Diagnosis of ASF in feral pigs in Australia should use screening tests in accredited state veterinary laboratories which provide maximum DSe (i.e. no false negatives) followed by confirmatory tests at the Australian Centre for Disease Preparedness (ACDP) on the positives to provide maximum DSp (i.e. no false positives)	
7	Point of care (POC) tests can support rapid response planning to implement control measures early in an EAD incursion, but should achieve comparable DSe to accredited state veterinary laboratory-based tests	Molecular POC tests based on mobile PCR or isothermal technology achieve comparable DSe and provide opportunity for field based screening of feral pigs for ASF early in a response	Gallardo et al. (2019)

		Serological POC tests based on lateral-flow detection of either antibodies or antigens does not achieve sufficient DSe to be used for early detection of ASF in feral pigs.	
8	State/Territory legislation should regulate the use of POC tests for EADs based on national policy recommendations from the Subcommittee for Animal Health Laboratory Standards (SCAHLS) and Animal Health Committee (AHC)	Legislative amendments are required for the use of POC tests for ASF screening in feral pigs across Australia	SCAHLS (2010) AHC (2010)

1. Background

1.1. Surveillance systems approach

Principle 1	Current recommendations for emergency animal disease (EAD) diagnostic tests emphasise the importance of taking a surveillance system approach.
Practice	Diagnosing ASF in feral pigs needs to consider all aspects of surveillance – purpose, availability and skill of resources to undertake surveillance and sampling, cost-effectiveness etc. – and not be narrowly confined to technical aspects of laboratory tests.

Diagnostic tools for ASF in feral pigs should be applied appropriately for different phases of the response, availability of appropriately trained sample collectors which are aligned with surveillance activity and epidemiological situations:

- Pre-incursion – early detection phase
- Incursion – delimiting surveillance phase
- Post-incursion – proof of disease freedom phase adhering to OIE requirements

See feral pig ASF Surveillance section (pg. 101) for further information on surveillance system.

2. Diagnostics to support surveillance objectives

2.1. Early detection focus

Principle 2	The primary objective of EAD surveillance in both feral and domestic animal populations in a country free from that disease is to achieve the earliest detection possible
Practice	Detection of ASF in feral pigs as early as possible following an incursion – when disease is localised - will make eradication much more feasible than a late detection

Diagnostics should support a surveillance system for the timely detection and identification of ASF in the feral pig population. An early detection system should be managed by the state/territory veterinary authority and include the following characteristics in-line with OIE recommendations:

- Representative coverage of the feral pig population by veterinarians, veterinary para-professionals or appropriately trained surveillance providers (landholders, hunters, rangers) for observation, reporting and investigation
- Knowledge of the feral pig population at risk
- Enhance passive surveillance to regions or areas of highest risk based on ABARES mapping e.g. feral pigs in locations close to airports or open landfill sites
- Ability to undertake effective disease investigation of reports of feral pig morbidity and mortality (including in remote regions)
- Access to accredited veterinary laboratories capable of performing screening and confirmatory ASF testing
- Training program for veterinarians, veterinary para-professionals and other surveillance providers (landholders, hunters, rangers) who access areas that feral pigs inhabit for observation, reporting and investigation
- Legal obligation to report suspicion of notifiable animal disease including ASF

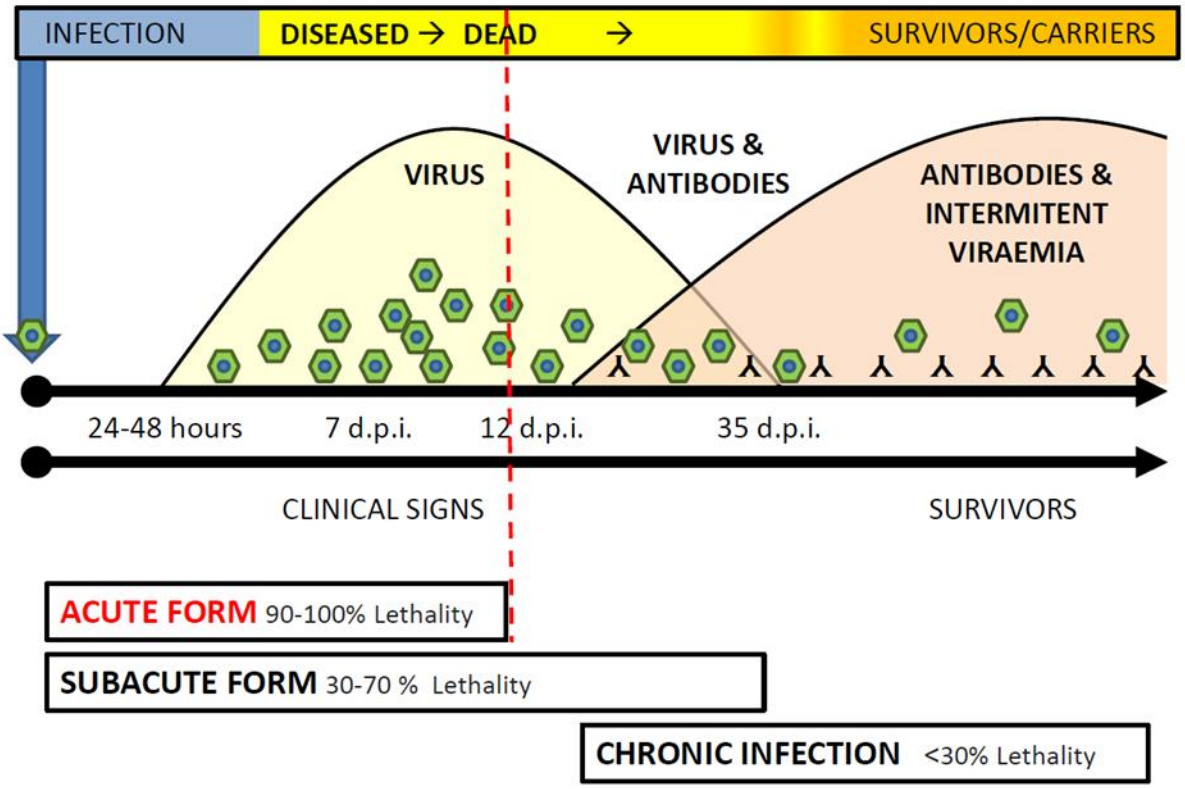
- Nationally agreed arrangements for responding to ASF incursion (AUSVETPLAN and EADRA)

2.2. Diagnostics system approach

Principle 3	Different diagnostic approaches may be required for different scenarios and the objective of the surveillance
Practice	There is a need to develop a diagnostic matrix for the preferred diagnostic system for the scenarios of infected vs. non infected areas, group vs. individual test, acute vs. chronic disease, screening vs. definitive test, proof of freedom vs. prevalence testing, etc.

The preferred diagnostic system should be applied to the range of disease scenarios. The appropriate sample should be collected from the appropriate group of feral pigs for the appropriate diagnostic test at the appropriate phase of the response. The clinical presentations and the transmission in the feral pig population are critical factors. The involvement of Australian feral pigs in the maintenance of viral circulation and infection is currently unknown but presumed to be significant. Figure 1. outlines the approximate ASF virus and antibody levels over time which can be used to guide the diagnostic approach.

Figure 1. ASF virus and antibody circulation in blood over time and in relation to the stage of ASF virus infection (EU domestic pigs)



Source: CISA-INIA and UCM

3. Surveillance and sampling in remote regions

Principle 4	The principles of diagnosis in the context of a surveillance system needs to be wider than simply a laboratory test, and include *inter alia*, clinical observations and the analysis of available data to rapid field and detailed laboratory assays
Practice	Due to the scarcity of veterinary surveillance in many of the remote locations where feral pigs are most at risk of ASF, field observations and sample collection by landowners, rangers and hunters need to be considered a critical part of Australia's ASF feral pig surveillance system

3.1. Field observations in remote regions

It is recommended the all stakeholders are provided with a clear and consistent message for reporting. The primary route for reporting is via the EAD hotline and / or Northern Australian Quarantine Strategy (NAQS) hotline or an alternative that is consistent nationally and can be incorporated into data generating reporting lines.

An agreed process for national ASF data management and the ability to provide information to key surveillance providers and stakeholders is yet to be determined.

Web-based citizen science systems designed to collect data on observations of feral animals currently exist and are accessible by stakeholders. The feral pig ASF surveillance sub working group has considered existing systems including feral scan, auspestcheck and atlas of living Australia. All systems have identified limitations. The electronic Wildlife Health information System (eWHIS) database is currently being considered as the most appropriate option for repository of data, but would require national agreement as the preferred system and minor investment in technological specifications to be fit-for-purpose.

See feral pig ASF Surveillance section (pg. 101) and feral pig ASF Communications and Biosecurity section (pg. 50) for further information on reporting and data management systems.

3.2. Sampling protocols for remote regions inaccessible or not resourced by government

It may not be feasible for veterinarians and para-veterinarians to undertake sampling of suspect cases in very remote locations. In these situations, landholders, hunters, rangers or other stakeholders may be available to collect samples under the guidance of government biosecurity officers. Options for feral pig sampling by trained personnel should be investigated and protocols developed. On-line training can be delivered to multiple providers in remote locations supported by just-in-time training and workshops as required.

It is recommended that a project plan be developed to trial the application of alternate sampling methods by alternate surveillance providers. The national Feral Pig Stakeholder Group may be a source to co-ordinate the network for the landholders, hunters and rangers for a trial.

4. Sampling methods and transport for early detection and delimiting surveillance in remote regions

Principle 5	To achieve diagnostic test accuracy, the practicality of sample collection and transport needs to be taken into account when considering methods for collecting samples for diagnostic testing.

Practice	For feral pig sampling, whole blood (EDTA and serum) and fresh and fixed tissues (tonsils, spleen, lymph nodes, lung, kidney and ileum) are the preferred samples, however for simplicity in collection and transport due to limitations in cold chain, training of sample collectors and to avoid spillage, the use of swabs for whole blood is a valid diagnostic sample method

4.1. Sampling methods for ASF in remote regions

- For feral pig sampling for ASF in remote regions, whole blood (EDTA and serum) and fresh and fixed tissues (tonsils, spleen, lymph nodes, lung, kidney and ileum) are the gold standard.
- However, in remote locations, sample refrigeration and maintenance of the **cold chain** may not be possible, and transport of samples to the laboratory may take several days.
- Proprietary swabs such as the *PrimeStore*, *COPAN eNAT, COPAN FLOQSwab* and *GenoTube* swabs or *Whatman FTA* cards provide a method for sample collection which may inactivate, stabilise and preserve viral DNA without the need for refrigeration of the sample.
- Some swabs are used dry and others contain a liquid chemical preservative.
- Manufacturer recommendations advise that Genotubes be stored between 15-30°C, which can be a challenge in field environments which temperatures consistently over 30°C.
- A trial has been undertaken at Berrimah Veterinary Laboratories (BVL) into the suitability of alternate sampling methods in tropical environments. Limitations to this study were that it was not undertaken in a controlled laboratory or in the remote field. Results are outlined in Attachment B
- A trial was planned to be undertaken at the Australian Centre for Disease Preparedness (ACDP) in March 2020 to examine the performance of different swab types subjected to different temperatures using ASFV under controlled laboratory conditions, however COVID-19 research priorities and a shortage of reagents has postponed this work.
- A field trail to compare the sensitivity of different swabs to the gold standard (whole blood) for detection of ASFV under tropical conditions was planned to be undertaken by the Australian Department of Agriculture, Water and the Environment in collaboration with ACDP in Timor-Leste in April 2020. This work has been postponed due to COVID-19 restrictions on travel. This trial would build on the work completed by BVL to determine the most sensitive swabs for ASFV (specifically) in environmental conditions similar to northern Australia.
- FLOQSwabs have been distributed in approximately 60 post-mortem kits to Parks and Wildlife Rangers across the Northern Territory, which could be used in a trial to test the swab under extreme environmental conditions for feral pig sampling
- Genotubes have been distributed in 10 post-mortem kits to Biosecurity officers and Parks and Wildlife Rangers working in remote regions of Queensland. These will be used in a preliminary trial to test the swab under extreme environmental conditions for feral pig sampling.
- WHS risks associated with the use of these methods needs to be considered when undertaking trials. Trained personnel should be used in all trials. Selection of the appropriate swab for alternate surveillance providers (landholders, hunters and rangers) should be considered in accordance with identified risks.

Table 1. Alternate sampling methods for ASF in absence of cold chain

Sampling Tool		Characteristics
PrimeStore swabs		• Expensive (Approx $9) • http://www.primestoremtm.com/ • Probably provides the best (most sensitive) material for ASFV detection • Worked well in diagnosing ASF in Timor-Leste
GenoTube swabs		• Middle range cost (Approx $4) • https://www.thermofisher.com/order/catalog/product/9062010#/9062010 • Dry sample – so no risk of spillage during transport • Worked well in feral pigs in eastern Europe • Distributed in post-mortem kits to Biosecurity officers and Rangers in Qld
Copan FLOQSwab		• Cheap (Approx $2) • https://www.copanusa.com/forensic-and-genetic/floqswab-hdna-free/ • Dry sample – no risk of spillage during transport • Distributed in post-mortem kits to Rangers in NT
Copan eNAT swab		• Cheap (Approx $2) • https://www.copanusa.com/sample-collection-transport-processing/enat/ • FLOQSwab with Guanidine-thiocyanate medium which stabilizes RNA/DNA of viruses • Wet sample – minor degree of risk of spillage during transport • Trialed in NT conditions for 4 weeks without refrigeration
Whatman FTA cards		• Cheapest option (Approx <$1) • https://www.sigmaaldrich.com/technical-documents/articles/biology/whatman-reliable-extraction-of-dna.html • Dry sample • Used to diagnose subclinical ASF in pigs in Africa • Finicky to use in field and lab

4.2. Transport of specimens to the laboratory and regulatory requirements

The states and territories regulate land transport, based on the Australian Dangerous Goods Code (Road and Rail), which is maintained by the Australian Government Department of Infrastructure and Transport. The Civil Aviation Safety Authority (CASA) regulates the transport of dangerous goods by air in Australia.

Dangerous goods classification:

- Category A (UN2814/UN2900)
    - *"an infectious substance which is transported in a form that, when exposure to it occurs, is capable of causing permanent disability, life-threatening or fatal disease in otherwise healthy humans or animals"*
- Category B (UN3373)
    - *"an infectious substance which does not meet the criteria for inclusion in Category A."*
- *"Dried blood spots, collected by applying a drop of blood onto absorbent material are not subject to dangerous good regulations"*

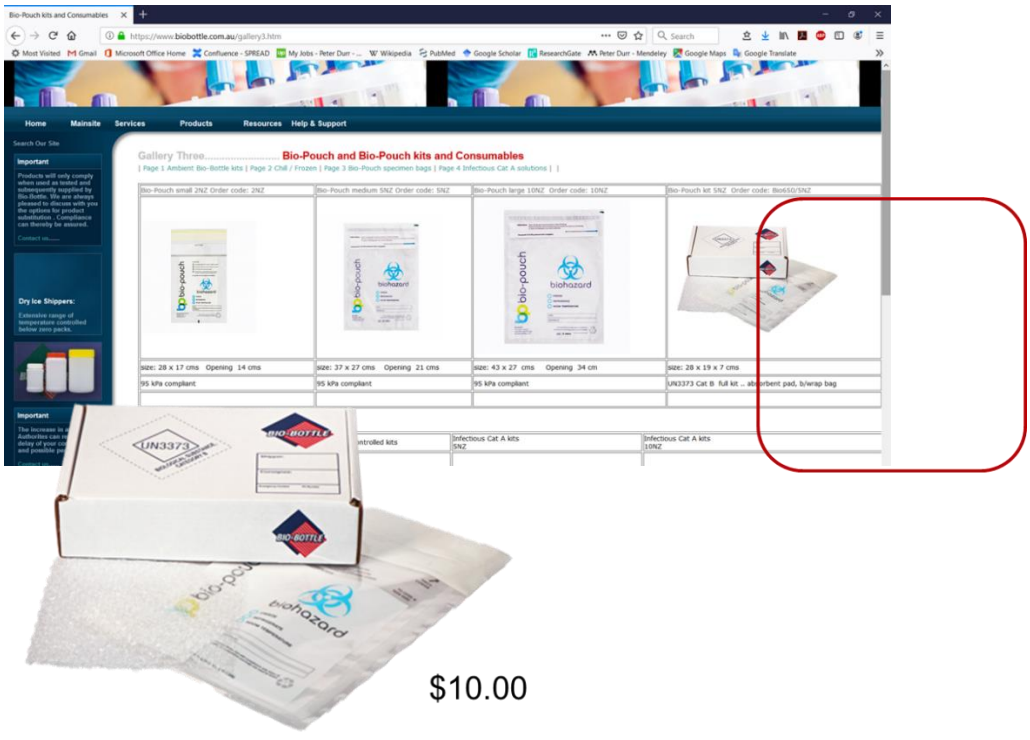
Classification of proposed alternate sampling methods:

- PrimeStore swabs from a suspect ASF are Cat B
- GenoTube swabs from a suspect ASF are Cat B
- Copan FLOQSwab from a suspect ASF are Cat B
- Copan eNAT swabs from suspect ASF are Cat B
- Whatman FTA cards are not dangerous good

The proposed swabs to be used for ASF sampling for feral pigs are not considered dangerous goods. The packaging identified in Figure 2. is suitable for sample transport and is commercially available to be included in sample collection kits for trained surveillance providers.

Specimens collected from feral pigs for ASF diagnostic testing should be submitted to the accredited State/Territory veterinary laboratory or equivalent. Biopouches can be posted as general mail.

Figure 2. Alternative sample packaging options for non-IATA accredited packers



5. Diagnostic tests

Principle 6	Diagnostic test system accuracy can be enhanced by combining tests in series or parallel rather than individual diagnostic tests with imperfect test sensitivity (DSe) and/or test specificity (DSp)
Practice	Diagnosis of ASF in feral pigs in Australia should use screening tests in accredited state veterinary laboratories which provide maximum DSe (i.e. no false negatives) followed by confirmatory tests at the Australian Centre for Disease Preparedness (ACDP) on the positives to provide maximum DSp (i.e. no false positives)

Diagnostic capacity can be provided through the use of diagnostic tools at four key facilities/locations including:

- Field (beside the animal)
- Field Laboratory (stable environment outside accredited laboratory)
- Accredited State/Territory Veterinary Laboratory
- Australian Centre for Disease Preparedness (ACDP) reference laboratory or equivalent

The suitability of a particular facility or location for application of a diagnostic tool will be dependent on the purpose of the test and the phase of the response.

5.1. Suitability of POC for different phases of Response

- Where simple and rapid screening of diagnostic samples may be required to support time critical disease response decision-making (e.g. delimiting surveillance for implementation of control measures), alternative diagnostic tests (also known as point of care (POC) tests, penside tests, portable tests, field tests or on-site tests) may be performed outside the centralised accredited State/Territory veterinary laboratory.
- These tests may also be considered for application during other stages of a response (e.g. early detection and proof or freedom).
- POC tests should be used as a screening tool to complement diagnostic testing performed at the accredited State/Territory veterinary laboratory.
- A duplicate sample should also be sent to the accredited State/Territory veterinary laboratory for definitive testing using accredited tests, and Australian Centre for Disease preparedness or equivalent for confirmatory testing as required.
- Table 2. Outlines the suitability of specific types of POC tests for different phases of response for different diagnostic capacity.

Table 2. Suitability of Point of Care Testing for different Phases of Response for different diagnostic capability

	Phase of Response		
Facility/Location	**Early detection (pre-incursion)**	**Delimiting Surveillance (Incursion)**	**Proof of Freedom (Post-incursion)**
Field		X (Immunoassays)	
Field Lab		X (Molecular tests)	
State Vet Lab	X (Screening)	X (Confirmatory)	X (Screening)
ACDP	X (Confirmatory)	X (New detections)	X (Confirmatory)

There are different benefits and limitations to POC tests when compared with accredited laboratory tests (Table 3).

Table 3. Benefits and Limitations of Point of Care Tests compared to Accredited Laboratory Tests

Point Of Care Test	Accredited Laboratory Test
Benefits	
Faster diagnostics (more rapid result)	Trained/proficient users
Robust in field conditions	High throughput capability
No safety/biosafety concerns	Established system with SOPs
Simple interpretation of results (positive/negative)	Accredited to QA standards
	Links to national reporting systems
Limitations	
Non-specialist users	Delays in transport and diagnostic time
Lower throughput capability	
Further analysis not available or limited (no or limited background to the read-out)	
Assay performance may not be equivalent to laboratory standard	
Lack of control of information flow in the majority of tests	
Validation	

5.2. Suitability of application for POC tests commercially available for ASF

A variety of POC tests are available for ASF which could be used by appropriately trained personnel. Molecular tests include mobile polymerase chain reaction (PCR) assays and isothermal tests such as loop-mediated isothermal amplification (LAMP). Immunoassays include lateral-flow devices and bio-sensors. Molecular POC tests are the frontline choice for ASF field based screening.

Principle 7	Point of care (POC) tests can support rapid response planning to implement control measures early in an EAD incursion, but should achieve comparable DSe to accredited state veterinary laboratory-based tests
Practice	Molecular POC tests based on mobile PCR or isothermal technology achieve comparable DSe and provide opportunity for field based screening of feral pigs for ASF early in a response Serological POC tests based on lateral-flow detection of either antibodies or antigens does not achieve sufficient DSe to be used for early detection of ASF in feral pigs.

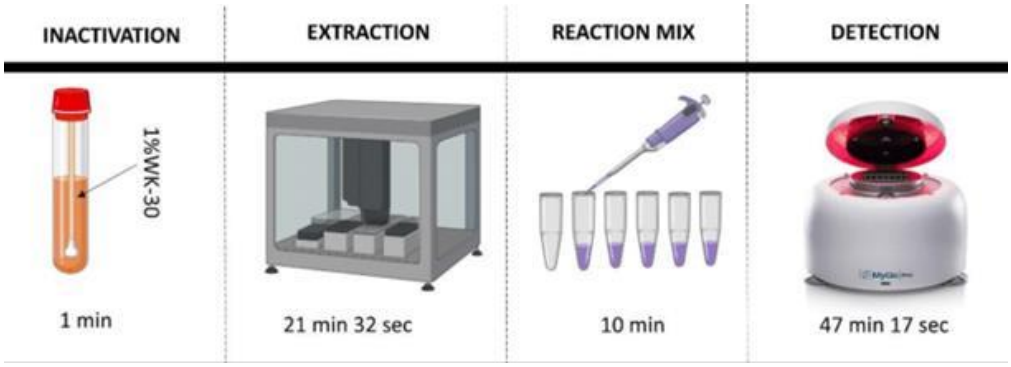
5.2.1. Molecular Tools

5.2.1.1. Mobile/Portable Polymerase Chain Reaction (PCR)

PCR is a widely used molecular technique used to amplify and detect DNA and RNA sequences. PCR is highly sensitive. Quantitative PCRs (qPCR) entail two steps of reaction which require separate manipulations making it more suitable for a mobile field laboratory with appropriately trained personnel rather than in a field situation. An extraction step is followed by the reaction step to yield the result. The extraction step is largely to remove interference for the final reaction and in field system often use a cartridge or multiple syringe system to purify the DNA/RNA from a field sample.

When the purification is finished, the reaction machine is loaded. This two stage methodology means a trained operator is needed, particularly to avoid cross-contamination when multiple samples are tested. Most machines are designed to test less than 10 samples at a time (Figure 3).

Figure 3. PCR Process Workflow



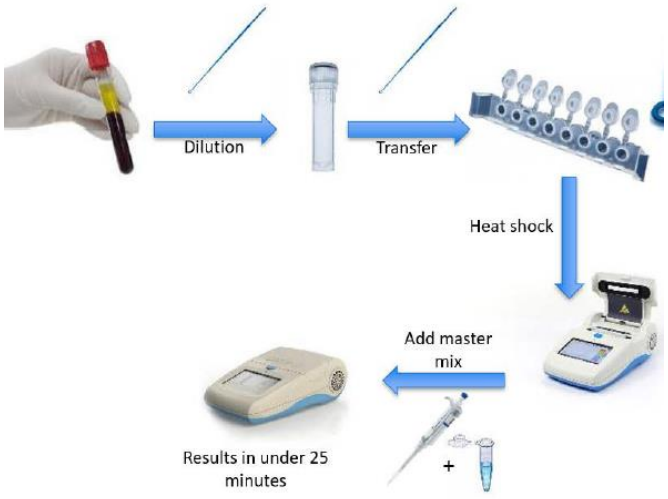
5.2.1.2. Loop-mediated isothermal amplification (LAMP)

LAMP is a method of detecting DNA or RNA of a target, so in concept is similar to qPCR. It is generally not as sensitive as a qPCR but there is less chance of interference by contaminants from the environment. It tends to be more specific and sensitive than an antibody based test.

Unlike PCR based tests, the reaction does not require any or minimal extraction procedures before running the reaction. The reaction runs at one temperature rather than cycling between temperatures so the machinery to run it is simpler than a PCR set-up. The overall preparation and run time is usually less than 30 minutes compared to 4 hours. Most field orientated machines are designed to test 3 to 6 samples plus controls (Figure 4).

The LAMP system is suitable for use by appropriately trained personnel and requires some initial and ongoing training. The machinery is specialised and expensive compared to a lateral flow device for example, so is likely to be limited in use. Some machines can give a positive/negative read-out or can communicate via a link to a telephone and relay all results back to a base so the entire reaction profile can be cross-checked by an expert in the technology. Victorian and South Australian government's currently use LAMP in the field for disease exclusions during disease investigations.

Figure 4. LAMP Process Workflow



5.2.2. *Immunoassays*

5.2.2.1. Lateral Flow Devices and Dip sticks

Lateral flow tests operate on the same principles as other immunoassays such as the Enzyme Linked Immunosorbant Assay (ELISA). The test runs the liquid sample along the surface of a pad with the reaction between the Antigen (Ag) and Antibody (Ab). The lateral flow device detects ASFV in blood samples (Figure 5). It is less sensitive than PCR and LAMP. Lateral flow devices have comparable performance to ELISA with low sensitivity (DSe 70%) for subacute and chronic cases of ASF due to the formation of Ab-Ag complexes in samples that interfere with assay. There are several commercial options available (PenCheckTest, Bionote, Ingensa). It is a very rapid test (10-20 minutes).

Figure 5. Lateral Flow Device Process Workflow

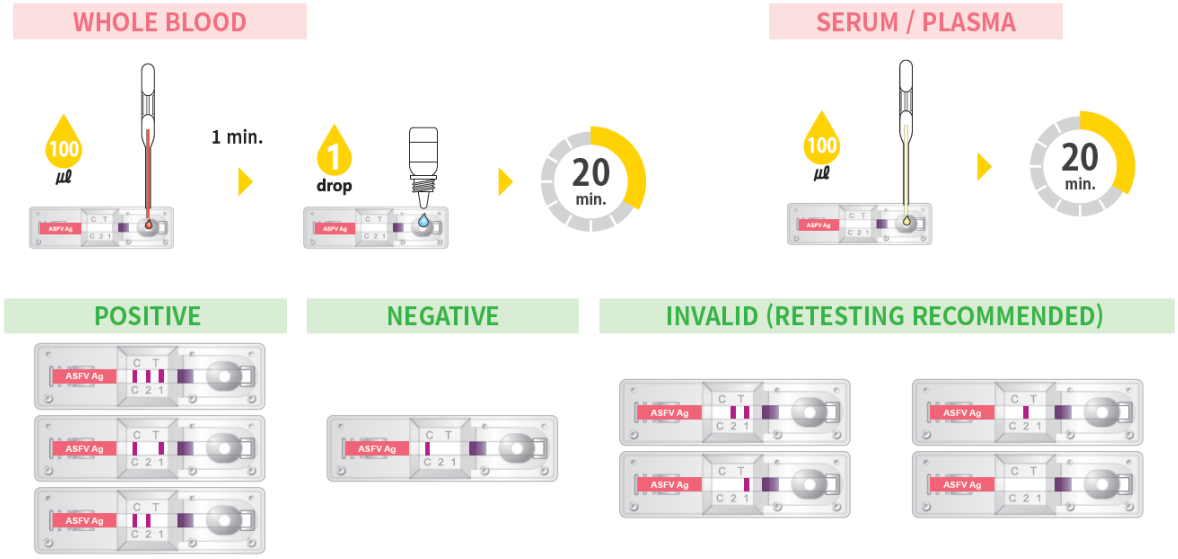


Table 4 Alternate POC Diagnostic Tests

POC Test	Specimen required	Test detects	Time taken to obtain result
PCR	EDTA blood/tissue	Virus	4 hours
LAMP	Unclotted blood/serum (saliva/rectal swab)	Viral genome (DNA/RNA)	30 min
Lateral flow device	Unclotted blood/serum	Antigen/Antibody	10-20 min

6. Legislative restrictions on application of POC tests

Principle 8	State/Territory legislation should regulate the use of POC tests for EADs based on national policy recommendations from the Subcommittee for Animal Health Laboratory Standards (SCAHLS) and Animal Health Committee (AHC)
Practice	Legislative amendments are required for the use of POC tests for ASF screening in feral pigs across Australia.

In Australia currently, a POC test should not be permitted unless it has been validated and assessed as fit for purpose. Generally, this will be on the basis of either the Subcommittee for Animal Health Laboratory Standards (SCAHLS) approval or adoption in the Australia New Zealand Standards Diagnostic Procedures (ANZSDPs). In some circumstances the CVO may approve a specific test that has not been assessed by SCAHLS on the basis of his or her assessment or that of Animal Health Committee (AHC) or the Consultative Committee on Emergency Animal Disease (CCEAD). There is an AHC Framework for the Regulation of POC Testing (2010) and a SCAHLS Policy for POC Testing (2010).

Given the rapid advancement in technology over the past decade and state and territory government legislative changes, SCAHLS undertook a review of the current legislative conditions for POC testing (2020). AHC committed to review the framework for regulation of POC testing in March 2020. SCAHLS is currently reviewing the policy for POC testing as part of this process. The guidelines for validation of POC tests under consideration by SCAHLS are based conceptually around sensitivity, specificity, repeatability and robustness between operators.

Table 5. Further activity required to support recommendations

	Recommended Practice	Variation	Current project/further activity
Selection of Specimens	Specimens collected from feral pigs for ASF diagnostic testing should be in accordance with AUSVETPLAN ASF Response Strategy or Section 3.1 AUSVETPLAN Management Manual Laboratory Preparedness (2013) In remote regions where cold chain (refrigeration or esky to maintain specimens <4°C) cannot be maintained, an alternate specimen collection method may be applied.	**Variation:** Where consistent cold chain not available • Insert swab (e.g. Primestore, Genotube, FLOQSwab. eNAT or other available alternate swab sample method) into blood of feral pig and place in tube sheath, capped and labelled for transport to Accredited State/Territory Veterinary Laboratory as soon as practicable.	Project 1 - Berrimah Veterinary Laboratories (BVL) – Optimising the field sampling for ASF (finalised February 2020) Project 2 - Australian Centre for Disease Preparedness – Swab temperature control study (scheduled March 2020 and postponed due to COVID-19 trials) Project 3 – DAWE (NAQS)/ACDP swab trial (2020) to compare the sensitivity of different swabs to the gold standard (whole blood) for detection of ASFV under tropical conditions (scheduled March 2020 and postponed due to COVID-19 travel restrictions Project 4 - New collaborative project proposed for NT wildlife rangers who have undergone training in disease investigation and have kits with FLOQSwabs located across the Territory. Project can be extended to other states and relevant stakeholders.
Surveillance observations, collection and documentation of specimens	The Laboratory Specimen Advice Sheet should be completed for all feral pig submissions	**Variation:** Alternate and complementary electronic data management should be considered, such as collation of data on feral pig morbidity or mortality reports in the absence of laboratory diagnostics.	Project 5 - eWHIS modification opportunity or alternate App. Stakeholder co-ordination available through through National Feral Pig Stakeholder group or other relevant stakeholders (Proposal)

Packaging and transport of specimens including Regulatory Requirements for transport of specimens	Specimens collected from feral pigs for ASF diagnostic testing should be submitted to the State/Territory Veterinary Laboratory or equivalent. Samples are usually dispatched using a courier.	**Variation:** • Specimens collected using alternate sample methods (e.g. Copan FLOQSwab. Genotube etc.) by trained surveillance providers (landholders, hunters, ranger) can be packaged in a BioPouch and sent via general mail (Australia Post) rather than a courier.	Project 6 - Co-ordinated trial of swab submissions from alternate surveillance providers using BioPouches
Diagnostic testing and Regulatory Requirements for POC tests	ASF diagnostic testing should be undertaken in accordance with AUSVETPLAN ASF Response Strategy	**Variation:** POC tests • Mobile/Portable PCR • LAMP • Lateral flow	Project 7 - Validation trial to support POC testing. Part 1 PCR (Proposal needs to be developed) Part2 LAMP A LAMP targeting ASF has recently been trialled in the face of an outbreak in Timor-Leste with promising initial results. A formal validation process is planned both in Australia and overseas. Part 3 Lateral flow – Testing method not recommended Project 8 - Animal Health Committee Task group (convened June 2020) – Legislative principles for Point of Care testing in Australia

Attachments

A – AUSVETPLAN ASF Disease Response Strategy

(version 5.0; Animal Health Australia 2020, p.20)

2.5.4 Laboratory tests

Due to the considerable overlap in the clinical and pathological signs seen in ASF with many other pig diseases, the diagnosis needs to be confirmed by identification and characterisation of the causative virus. Relevant laboratory tests should also be performed to exclude the principal differential diagnoses.

If an outbreak is confirmed to be caused by ASF virus, regulatory requirements (eg for handling and reporting) apply because this agent is classified as a security sensitive biological agent (SSBA). However, emergency situations, including emergency animal disease (EAD) outbreaks, can be exempted from some SSBA regulatory requirements.[20] Clarification should be sought from the SSBA officer at the facility concerned.

Samples required

Specimens required for detection and characterisation of the agent, serological testing and histopathology are as follows:

- identification of agent
  - whole blood from live, suspect animals in EDTA anticoagulant
  - unpreserved tissues collected aseptically at postmortem: tonsils, spleen, lymph nodes (gastrohepatic, mesenteric), lung, kidney and ileum
- serological testing
  - sera from animals suspected of having subacute or chronic disease
- histopathology
  - a full range of tissues in neutral-buffered formalin.

Tissue samples should be taken from affected pigs that have been killed and from pigs that have recently died. To minimise the risk of contamination, tissue samples should be taken as aseptically as possible and without delay during necropsy.

Sampling feral pigs

Sampling wild or feral animals can present a number of challenges that make the usual approach to sampling impracticable. Remote locations, lack of a cold chain, animals found dead and untrained operators are all potential limitations. A number of alternate approaches are possible to ensure testing can proceed under challenging circumstances.

Tube/swab based sampling systems such as PrimeStore or Genotube are available, as are paper based approaches such as FTA cards and 3-MM filter paper (Braae 2013). Sampling of blood or peritoneal fluid in animals found (recently) dead or shot is expected to be sufficient to detect acute infection.

[20] www.health.gov.au/SSBA

Conventional approaches to sampling, if possible, are always preferred. These alternate methods have been shown to perform adequately in surveillance of wild suids in a number of countries (Randriamparany 2016, Carson 2018), but lack the full validation of conventional methods and may lack some sensitivity in practice. Tube/swab-based approaches are considered preferable from the laboratory perspective, and card-based methods in particular are not well suited to high volume testing.

It is important to be aware that while some of these sampling systems claim inactivation of the agent (some do not), this capability should not be assumed to be 100% effective. Adequate biosecurity measures must be taken in transporting all samples, regardless of whether the sampling system claims inactivation.

Transport of specimens

Specimens should be submitted in accordance with agreed jurisdictional protocols. Specimens should initially be forwarded to the jurisdictional laboratory for appropriate analysis and assessment as to whether further analysis will be required by the CSIRO Australian Animal Health Laboratory (CSIRO-AAHL), Geelong.

If the jurisdictional laboratory deems it necessary, duplicate samples of the specimens should be forwarded to CSIRO-AAHL for emergency disease testing, after the necessary clearance has been obtained from the chief veterinary officer (CVO) of the state or territory of the suspect case, and after the CVOs of Victoria and Australia have been informed about the case and the transport of the specimens to Geelong (for the first case). Sample packaging and consignment for delivery to CSIRO-AAHL should be coordinated by the relevant state or territory laboratory.

For further information, see the **Laboratory Preparedness Manual**.

Packing specimens for transport

Blood samples and unpreserved tissue specimens should be chilled and transported with frozen gel packs. For further information, see the **Laboratory Preparedness Manual**.

Laboratory diagnosis

The initial approach to ASF diagnosis is screening by real-time PCR (qPCR) as this method is rapid and sensitive and can be scaled up readily if required. An antigen ELISA is also available, although rarely used. Virus isolation will be attempted. Further characterisation and genotyping by sequence analysis can be carried out on primary samples or on isolates.

Serology is also available. Although serology generally plays a minor role in the initial diagnosis, it likely to be used in defining the nature and extent of any outbreak, and in the proof-of-freedom phase.

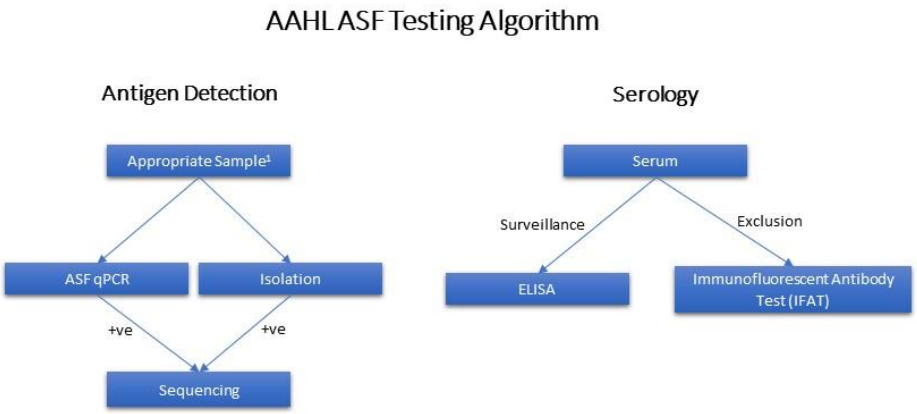
LEADDR

The role of the LEADDR network is to provide frontline screening capability at jurisdictional laboratories. The network will also play a role in reviewing initial and ongoing laboratory findings, including test results, and providing advice to the CCEAD and its other working groups on follow-up laboratory needs and strategies.

CSIRO-AAHL tests

The testing algorithm used by CSIRO-AAHL is shown in Figure 2.1. Further details of tests currently available at CSIRO-AAHL are shown in Table 2.2.

Figure 2.1 The current approach to diagnostic testing at CSIRO-AAHL



[1] Ideally EDTA Blood or postmortem samples (spleen, lymph node, tonsil, kidney). Other possible samples include tissue or swab based sampling systems such as PrimeStore or Genotubes, or paper based approaches such as FTA cards and 3-MM filter paper.

Table 2.2 Laboratory tests currently available at CSIRO-AAHL for diagnosis of the disease

Test	Specimen required	Test detects	Time taken to obtain result
Agent detection			
qPCR	EDTA blood/tissue	Viral genome	<1 day
Virus isolation	EDTA blood/tissue	Virus	1–2 weeks
ELISA	EDTA blood/tissue	Antigen	1 day
Agent characterisation			
PCR and sequencing (genotyping)	EDTA blood/tissue/virus isolate	Viral genome	2–3 days
Serology			
ELISA	Serum	Antibody	1 day
IFAT	Serum	Antibody	1 day

Source: Information provided by CSIRO-AAHL, 2019 (refer to CSIRO-AAHL for most up-to-date information). IFAT = immunofluorescent antibody test; PCR = polymerase chain reaction; qPCR = realtime PCR

B – Berrimah Veterinary Laboratories Copan eNAT Trial

[Title]

OPTIMISING THE FIELD SAMPLING PROCEDURE FOR AFRICAN SWINE FEVER

Experimental Design Contributors: Rachel De Araujo, Lorna Melville, Cathy Shilton and Ayrial Foster.

Laboratory Technical Contributors: Rachel De Araujo and Amanda Adams.

Background

An optimised method for sampling in field conditions is sought for the analysis of African Swine Fever (ASF). For both researchers and non-researchers, an ideal method for collecting samples and transporting to the laboratory for testing is required to ensure the integrity of the ASF DNA is maintained, as well as minimise the risk of viable virus being transported. Swab samples are the preferred sample type for processing samples in the laboratory, however, there are concerns with this method. When swabbing porcine samples in the field, there is not always the option of maintaining a cold chain, as well as transporting live ASF virus. The Copan eNAT swab claims to overcome these two issues. Literature states the eNAT as a versatile molecular medium specially designed to stabilise and preserve microbial nucleic acids (RNA/DNA) for prolonged time periods. For microbial preservation, eNAT Guanidine-thiocyanate based medium stabilizes RNA and DNA of Viruses, Bacteria, Chlamydia and Mycoplasma. eNAT contains a detergent and a protein denaturant that breaks open microbial cells to release DNA and RNA, while preventing bacterial proliferation. eNAT ensures optimal preservation of RNA and DNA at room temperature for up to 4 weeks and for up to 6 months at -20°C. These abilities of the eNAT swab seem ideal for sampling in the field, so the aim of this was to test the ability of the eNAT to preserve nucleic acid, as well as dry swabs at room temperature, compared to the gold standard of cold viral transport medium.

Methods

Three different swab types were analysed; Cultiplast Tampone swab in viral transport medium (VTM), Copan eNAT swab and Cultiplast Tampone swab stored dry. The swabs in VTM (PBGS) were stored in the fridge at 4°C as a gold standard, while the eNAT and dry swabs were stored in the Berrimah Veterinary Laboratory (BVL) garage at approximately 30°C. A selection of viruses were chosen for this study: ASF, BTV16, Crocodyline herpesvirus (CrHV) and BVD2. Unfortunately, there was insufficient BVD DNA present on the swabs to include this virus in the results. Tissue culture supernatant from BVL was used for both BTV16 (47907) and CrHV (V8008), while the LEADDR network quality control was used for ASF (19-1). A volume of 50µL of viral solution was added to each swab, along with 50µL of bovine blood (20190995 from DDRF). The swabs were stored at the appropriate conditions for three different times: 3 days (6.12.2019), 2 weeks (17.12.2019) and 4 weeks (31.12.2019). The ASF samples were only tested at 4 weeks, due to a lack of ASF DNA available. After each set time, the swabs were processed and viral DNA or RNA extracted and analysed by PCR. For the eNAT swabs as well as those in VTM, the tubes were vortexed for 10 seconds and 50µL solution used for extraction. Prior to analysis of the dry swabs, 3mL of PBGS was added to each tube and these tubes were incubated for 1 hour at room temperature before they were vortexed for 10 seconds and 50µL solution used for extraction. The samples were all extracted using the MagMAX protocol and the relevant PCR conditions were followed for each virus.

Results

The Ct values for BTV16 are lowest for the eNAT, followed by the VTM with the dry swab having the highest Ct values. This was observed for all storage times; 3 days, 2 weeks and 4 weeks (Table 1 and Figure 4). The eNAT swabs also performed the best with regards to the ASF DNA, with no detection of the DNA from the dry swabs (Table 1 and Figure 5). With the Crocodyline herpesvirus analysis, the DNA band intensity was the greatest for the eNAT swabs, at all storage times (Table 1 and Figures 1-3 and 6). The DNA intensity for both the eNAT and VTM swabs was maintained over the 4 weeks, while the dry swab DNA decreased over time (Table 1 and Figures 1-3 and 6).

Table 1. Average Ct values or DNA band intensity for the three viruses stored at different conditions for varying times.

	3 days			2 weeks			4 weeks		
Virus	VTM (fridge)	Copan eNAT swab	Dry swab	VTM (fridge)	Copan eNAT swab	Dry swab	VTM (fridge)	Copan eNAT swab	Dry swab
BTV16	23.51	17.49	27.39	23.73	20.28	28.69	24.81	18.87	27.46
ASF	N/A	N/A	N/A	N/A	N/A	N/A	36.82	32.05	-
CrHV	2	4	1	2	4	0.01	2	4	0.01

Figure 1. Gel image for Crocodyline Herpesvirus after 3 days.

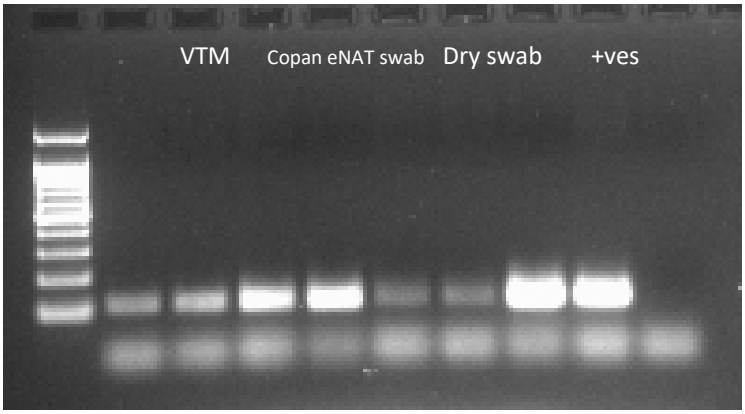


Figure 2. Gel image for Crocodyline Herpesvirus after 2 weeks.

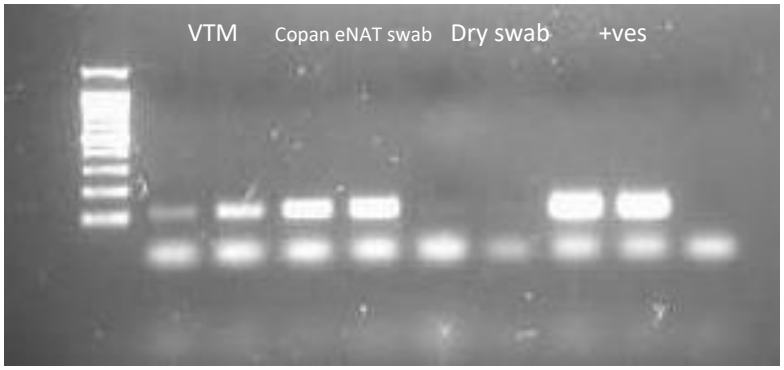


Figure 3. Gel image for Crocodyline Herpesvirus after 4 weeks.

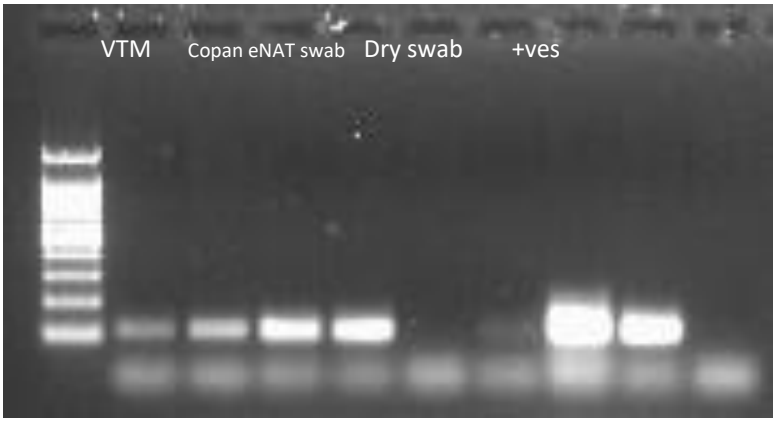


Figure 4. Graph showing Ct values for BTV16 RNA inoculated swabs at varying times.

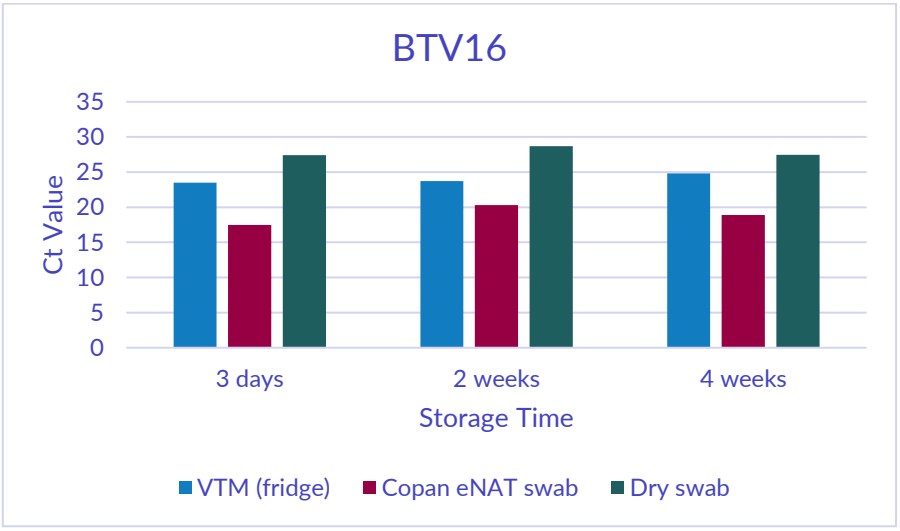


Figure 5. Graph showing Ct values for ASF DNA inoculated swabs after 4 weeks storage.

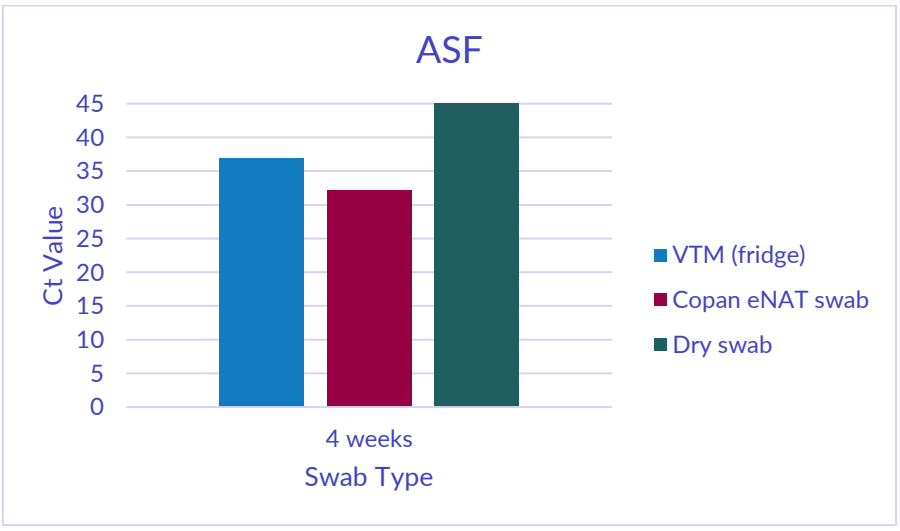
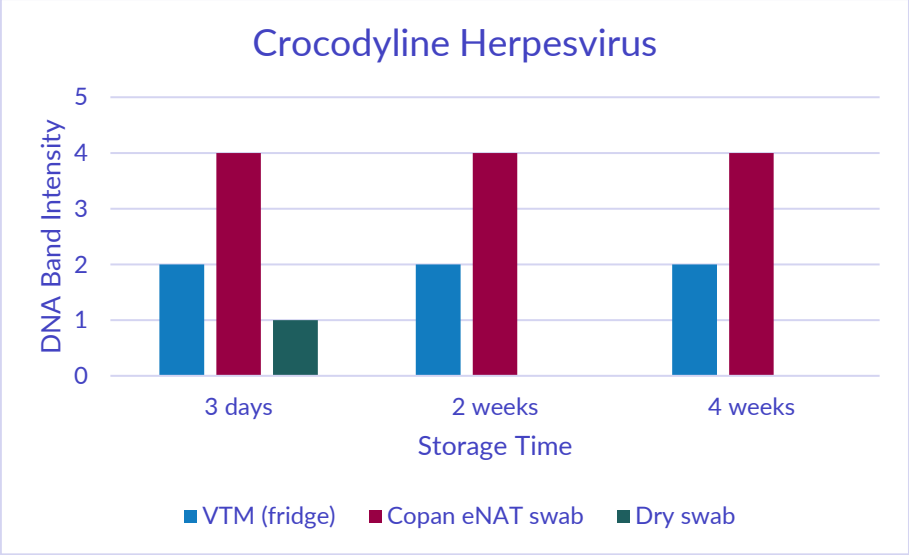


Figure 6. Graph showing DNA band intensity for Crocodyline herpesvirus inoculated swabs.



Discussion

The eNAT swab performed the best when analysed for the three viruses BTV16, ASF and Crocodyline herpesvirus, when stored up to 4 weeks at room temperature. For both the BTV16 and ASF, the Ct values were consistently lower across all time periods. While results from the swabs with Crocodyline herpesvirus show the greatest DNA was extracted from the eNAT swabs, with less from the VTM swabs, and almost no detectable DNA from the dry swabs after 4 weeks storage. Even after 4 weeks stored at room temperature, where the temperature would have reached over 30°C, the eNAT swabs performed better than the swabs in viral transport media stored at 4°C. Compared to other sample types, swabs are both easier to process in the laboratory as well as requiring minimal training for field collection of samples. Further testing could be performed to prove the ability of eNAT to inactivate pathogens, which could increase the benefits of this sample method, especially with regards to safe handling, transport and processing. These results demonstrate that the eNAT swabs are the preferred option with regards to nucleic acid preservation and retrieval.

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Appendix

1. Further research areas and unanswered questions

Pre-emptive culling

1. How do we effectively measure feral pig density?
    a. Develop methods (analytical and field based) to produce robust and repeatable population estimates of feral pigs in different habitat types with a specific emphasis in accounting for detection probability (e.g. places where you can see under the trees from above and places where you can't).
    b. Undertake aerial survey in different climatic zones across seasons and use ground-truthing to establish detection probabilities given different environmental covariates.
    c. Integrate the data from above to predict populations across environmental space in Australia and establish control effectiveness and risk indices given environmental constraints and human influence data.

2. How does ASF spread through feral pigs?
    a. Explore mixed technology solution to understand feral pig populations, behaviour and environmental constraints (i.e. drone, "the internet of things", motion sensor cameras with Artificial Intelligence, genetic methods etc.)
    b. Explore technology to support remote monitoring of sentinel animals in wild populations (measure heat, movement, behaviour etc.)
    c. Metapopulation studies
    d. Australian Ornithodoras spp. as reservoirs for ASF virus

3. How do we effectively control feral pigs?
    a. Evaluation of the field deployment of the newly licenced Hoggone® poison.
    b. Experimentally apply control methods to quantify feral pig population reduction and recovery in different habitat types. Systematic control should include consideration of shooting, trapping, baiting and combinations of these. Field work should include the implementation of a detailed mark recapture study and apply methods developed above to estimate populations and quantify variance of estimates
    - Include diet and genetic research in this element to develop links to robust environmental covariates to enable scaling of results.
    c. Establish detailed cost estimates for operations to achieve >70% reduction of the pig population (to reflect the AUSVET plan requirements) in different habitat types.
    d. Include social science / human geography dimensions to support more coordinated approaches to control in remote areas;
    e. Detailed assessment of skills, equipment, training and seasonal access for target areas. This will require interviews with regional organisations, councils, land councils, Traditional Owners and ranger groups.
    f. Participatory Action Research to design biosecurity response with land managers. Following planning and design of feral animal management strategy, implement the strategy and assess the effectiveness from biosecurity perspective and local perspective. Use the results to establish advice for local land managers, state and territory agencies responsible for control and federal policy.
    g. The Control Difficulty Index map requires further work to include additional factors that may influence difficulty of control. Additional difficulties to be considered are crocodile distribution, wet season versus dry season accessibility etc.

Biosecurity & Communications

Development of a communications modelling tool that feeds off stakeholder views, motivations and influence regarding feral pigs and African swine fever. Will a survey to all stakeholder groups as identified by the Biosecurity and Communications sub working group team. Suspect there will be variations of motivations and influence on perspectives of feral pigs and ASF based on geography and proximity of pig industry. One hypothesis is that there will be more people in northern Australia who would look favourably on an incursion of ASF into the feral pig population due to the impact of feral pigs on northern industries and environment. This will impact on this group of stakeholder's reception of communications that may be delivered for a "southern" audience.

If an incursion of ASF were to occur in feral pig population, would it fall under EADRA or NEBRA? Would this be consistent approach if the incursion were to occur in FNQ vs South East Australia?

Establish (in peace time) a single platform as a source of truth for general public as well as specific stakeholder groups to provide their relevant content. Again, who will set this platform up and resource the time and money to ensure the site is current and has infrastructure to present key information (like live maps)?

In the event of a feral pig incursion or spreading outbreak – who will be the single source of (scientific) truth? DAWE, AHC, NBCEN, APL?

Movements

Nil

Destruction, disposal and decontamination

The size of the ASF outbreak in feral pigs when first detected and the expense associated with the disease response strategy will influence whether eradication of ASF in feral pigs can be achieved. This threshold for outbreak size and budget is unknown. Similarly there may be a carcass collection threshold. Finding and disposing of ASF positive carcasses is a critical part of stamping out African swine fever in feral pigs. It is impractical to assume 100% of carcasses will be found. However, the percentage of carcasses that need to be found and removed to sufficiently reduce the viral reservoir in the environment to stamp out the disease in feral pigs is unknown.

Identifying these thresholds around outbreak size, disease response budget and carcass removal will aid decision makers in their decision to implement the strategy described in this document to eradicate ASF in feral pigs or focus on asset protection of commercial pigs. A risk assessment and a cost / benefit analysis may also aid decision making.

The Control Difficulty Index map requires further work to include additional factors that may influence difficulty of control. Additional difficulties to be considered are crocodile distribution, wet season versus dry season accessibility etc.

Surveillance

Further work needed to identify variable sequences in the ASF genome to allow phylogenetic inferences to be made about the potential circulation and time of introduction in a feral pig population.

Diagnostics

Validation of sterile swab sampling technique in absence of cold chain

Project 1 - Berrimah Veterinary Laboratories (BVL) – Optimising the field sampling for ASF (completed February 2020) – no field element

Project 2 - Australian Centre for Disease Preparedness – Swab temperature control study (scheduled May 2020) – no field element

Project 3 – Northern Australia Quarantine Strategy field trial (2020) – remote location field based

Surveillance observation, sampling and laboratory submission trial for landholders, rangers and hunters

Project 4 – Complementary data collection application (FERALSCAN or eWHIS modification opportunity or alternate App) through National Feral Pig Stakeholder group or other stakeholder (Proposal)

Project 5 - NT parks and wildlife rangers (who have undergone training in disease investigation and have FLOQSwabs located across the Territory) trial to undertake observation, sampling and submissions to State/Territory Laboratory (Proposal)

Project 6 - National Feral Pig Stakeholder group co-ordinated trail to undertake observation, sampling and submissions to Australian Centre for Disease Preparedness (Proposal)

Validation trial to support Point of Care molecular testing

Project 7 – A LAMP targeting ASF has recently been trialled in the face of an outbreak in Timor-Leste with promising initial results. A formal validation process is planned both in Australia and overseas led by Agriculture Victoria Research. (In progress 2020)

Regulation of Point of Care testing

Project 8 - Animal Health Committee Task group to review legislative principles for Point of Care testing in Australia (In progress 2020)