

A close-up photograph of a feral pig's face, showing its dark, coarse fur, a small eye, and a large, muddy snout. The pig is looking directly at the camera.

# **FERAL PIG CONTROL STRATEGY SOUTH-WEST WESTERN AUSTRALIA 2015-2020**

**Plan Prepared for South West Catchment Council  
by Bio Diverse Solutions and Python Ecological Services**

**Karlene Bain and Kathryn Kinnear**

**May 2015**

## Acknowledgements

This plan has been funded by the State Natural Resource Management Office through the South West Catchment Council and guided by the South West Feral Pig Control Project Steering Committee and the Southern Feral Pig Advisory Group. Steering Committee members who provided significant input into this plan include: Derani Sullivan and Mike Christensen (South West Catchment Council), Kathy Dawson, Jodie Quinn and Andrew Pound (Warren Catchment Council), Brad Barton (Department of Parks and Wildlife), Tim Thompson and Jason Dearle (Department of Agriculture and Food WA), Frank Camarri (Southern Feral Pig Advisory Group), Dr Peter Adams (Murdoch University) and Michelle Gooding (West Arthur Landcare).

Parks and Wildlife officers Alison McGilvray, Mark Virgo, John Carter and Clare Forward provided data and information relevant to pig control operations occurring within their Districts.

## Citation:

Bain, K., and Kinnear, K. (2015). Feral pig control strategy for south west Western Australia: 2015-2020. Plan prepared for South West Catchment Council, Western Australia.

## Copyright

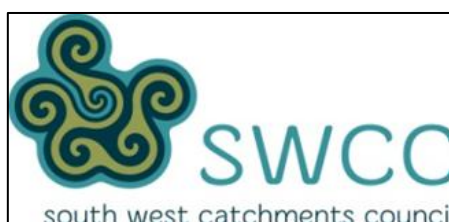
© Copyright. Bio Diverse Solutions, Albany Western Australia

April 2015

The information contained in this publication is based on knowledge and understanding at the time of writing (2015). The plan was written for South West Catchment Council by Kathryn Kinnear of Bio Diverse Solutions (lead consultant) and Karlene Bain of Python Ecological Services (lead author).



Feral pig management in Western Australia is a collaborative effort and this plan has had significant input from all major stakeholders.



## **Preface**

Given limited resources available and the multiple stakeholder approach to feral pig management in south west Western Australia, a strategic and coordinated approach is required to prioritise investment, justify expenditure, maximise the effectiveness of resource use and generate meaningful outcomes. The Department of Agriculture and Food Western Australia currently sets priorities for declared pests based on risk of impact on agricultural values and they involve community groups in a coordinated approach for widespread and established pests that transgress property boundaries. The Department of Parks and Wildlife sets priorities based on conservation values at risk from feral pigs and also work with community and other land managers to achieve a coordinated approach to pig management across tenure boundaries. These approaches are important in establishing direction, good working relationships and integration of resources and effort for feral pig control. However, there is a need for a strategic plan that sets direction and priorities, clearly communicates this direction and the measures required to be successful and subsequently allows use of resources more effectively and collaboratively to maximize success.

This plan reviews the strengths and weaknesses as well as threats to and opportunities for feral pig management in south west WA and identifies future strategic directions, priorities, desired outcomes and measures of success for feral pig management in this region. The document is consistent with objectives and strategies elucidated in the National Threat Abatement Plan (DoE 2005). While the plan primarily focuses on the geographical area administered by the South West Catchment Council (see Figure 3) the strategies are broad enough that they can be applied more widely should groups in areas outside of this region be interested in adopting a similar approach.

The development of this strategic plan is part of a broader project that was initiated by stakeholders in south west WA to collaboratively control feral pigs in this region. Other important initiatives that have arisen from the project include: accreditation of operational personnel to trap and remove feral pigs; establishment of four new community pig control groups; completion of control activities on private property and public reserves to conserve biodiversity and protect primary production from feral pig damage; and development of thermal imagery techniques to improve knowledge of feral pig abundance and habitat occupancy in this region.

## Table of Contents

<b>Acknowledgements</b> .....	ii
<b>Preface</b> .....	iii
<b>PART 1 – EXISTING KNOWLEDGE AND INNOVATIONS</b> .....	1
<b>1. Statutory framework for feral pig management</b> .....	1
1.1 Biosecurity and Agriculture Management Act 2007 .....	3
1.2 Animal Welfare Act 2002 .....	3
1.3 Wildlife Conservation Act 1950 .....	3
1.4 Country Areas Water Supply Act 1947 .....	4
1.5 Veterinary Chemical Control and Animal Feeding Stuffs Act 1976 .....	4
1.6 Exotic Diseases of Animals Act 1993 .....	4
<b>2. Feral pig distribution and abundance within south west WA</b> .....	5
2.1 National context.....	5
2.2 South west WA.....	6
<b>3. Biology and ecology</b> .....	8
3.1 Morphology.....	8
3.2 Habitat .....	8
3.3 Diet and Feeding .....	8
3.4 Wallows and rubs.....	8
3.5 Reproduction .....	9
3.6 Mortality .....	9
3.7 Movements and home range.....	9
3.8 Social structure .....	9
<b>4. Impacts of feral pigs in south west WA</b> .....	10
4.1 Conservation .....	10
4.2 Agricultural.....	12
4.3 Water Resources .....	13
4.4 Economy and Human Health .....	13

<b>5. Feral pig control options</b>	14
5.1 Shooting	15
5.2 Recreational Hunting	16
5.3 Bounties and commercial harvest	17
5.4 Dogging	17
5.5 Trapping	18
5.6 Judas Pig	19
5.7 Fencing and diversion	20
5.8 Habitat modification	20
5.9 Baiting and toxicants	21
5.10 Biological and fertility	23
5.11 Integrated pig management options in the South West of WA	23
<b>6. Threats to effective feral pig management</b>	24
6.1 Capacity and resources	25
6.2 Skills and training	26
6.3 Animal Welfare	28
6.4 Non-target impacts	28
6.5 Pig behaviour	29
6.6 Non-approved recreational hunting	30
6.7 Community Attitudes	31
6.8 Reducing impediments to effective feral pig control in South West WA	32
<b>7. Measuring success</b>	33
7.1 MERI Frameworks Available	33
7.1.1 Measuring damage	33
7.1.2 Activity or relative abundance indices	35
7.1.3 Abundance and density estimates	37
7.1.4 Occupancy modelling	37
7.2 Management and accessibility of data	38
7.3 Options for a central approach to data management	42
7.4 Approaches to evaluation, reporting and improvement	43
7.5 Opportunities for effective MERI frameworks for feral pig control programs	44

<b>8. Research and innovation</b>	45
8.1 Advancement in bait products	45
8.2 Bait delivery technologies	45
8.3 Pig ecology, impacts and controls	46
8.4 Thermal trials	46
8.5 Effective integration of research into feral pig control programs	47
<b>9. Stakeholder involvement</b>	48
9.1 Existing structure for integration of stakeholder activities	48
9.2 Liability, Insurance and community group establishment procedures	51
9.3 Pest Control Groups and Recognised Biosecurity Groups	52
9.4 Increasing opportunities for collaboration	56
9.5 Communication tools and messages	57
9.6 Opportunities for an improved approach to coordination of stakeholders	60
<b>10. Costs of feral pig control</b>	61
 <b>PART 2 – A FERAL PIG MANAGEMENT STRATEGY FOR SOUTH WEST WA</b>	 63
<b>11. Purpose and Scope</b>	63
<b>12. Objectives, Strategies and Performance Indicators</b>	64
12.1 Ensuring a collaborative and integrated approach	64
12.2 Increasing community engagement, awareness and education	67
12.3 Maximising cost-effectiveness and long-term operational support	68
12.4 Preventing the establishment of feral pigs in new areas	70
12.5 Reducing damage from established groups of feral pigs	71
12.6 Reducing the risk of disease	72
12.7 Minimising non-target risks	74
12.8 Monitoring, evaluation, reporting and improvement (MERI)	75
12.9 Innovation and research	77
12.10 Non-approved pig hunters	78
12.11 Summary of objectives strategies and performance indicators	79
<b>13. Strategic plan implementation, evaluation and review</b>	84
<b>14. References</b>	85
<b>ACRONYMS</b>	94

<b>APPENDICES</b> .....	95
Appendix 1: Legislation applicable to feral pigs in Western Australia .....	96
Appendix 2: Species of nationally listed threatened flora and fauna identified in the National Threat Abatement Advice (2013) as being adversely affected by feral pigs. Those that are shaded occur in south west WA.....	100
Appendix 3: State listed threatened and priority fauna species likely to be affected by feral pigs. ....	107
Appendix 4: Industry Code of Practice for Feral Pig Control (Trapping and Eradication) Southern Feral Pig Advisory Group Western Australia.....	109
Appendix 5: Memorandum of Understanding Trapper Agreement for south west feral pig project 2013-2015 (Warren Catchment Council).....	118
Appendix 6: Working Arrangements for the control of introduced animals for the Albany Branch of the Sporting Shooters Association Hunting and Conservation program Australia 127	
Appendix 7: Monitoring protocols implemented by Parks and Wildlife personnel (Stewart <i>et al.</i> 2011). ....	134
Appendix 8: Feral pig monitoring sheet used by South West Catchment Council field operators... ..	136
Appendix 9: Field operator data sheet used by Warren Catchment Council field operators.....	137
Appendix10: List of existing stakeholders and contact details .....	139

## **PART 1 – EXISTING KNOWLEDGE AND INNOVATIONS**

### **1. Statutory framework for feral pig management**

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's key piece of environmental legislation. The EPBC Act came into effect on 16 July 2000 and in 2002, predation, habitat degradation, competition and disease transmission by feral pigs was listed as a key threatening process (DoE 2014).

The listing of feral pigs as a threatening process led to the development of a National Threat Abatement Plan for Feral Pigs by the Australian Government, as per their obligations under the EPBC Act (DoE 2005). The National Threat Abatement Plan provides a consistent national and strategic approach to feral pig management to reduce their impact on the long term survival of native species and ecological communities (DoE 2005). At a State level the legislative and regulatory framework for feral pig management in Western Australia (WA) is administered through economic development and environmental protection agencies such as the Department of Agriculture and Food WA (DAFWA) and Department of Parks and Wildlife (Parks and Wildlife). At the local level, responsibility for pest management lies with the landholders and occupiers, whether government or private. The statutory framework is divided over six Acts and focuses on biosecurity, protection of ecosystems and threatened species, prevention of exotic disease establishment and spread, prevention of establishment and spread of pest animals.

A summary of the legislation that applies to feral pigs and their management in WA is provided in Table 1 and each of these is discussed briefly in Sections 1.1 - 1.6. More detailed extracts from the relevant legislation can be found in Appendix 1.



Table 1: Western Australian legislation its application to feral pig management

<b>Legislation</b>	<b>Administrator</b>	<b>Intent of document</b>	<b>Examples of use in WA</b>
<i>Biosecurity and Agriculture Management Act 2007</i>	DAFWA	Prevention of animal and plant pests and diseases from entering and becoming established in WA or minimising impact of those already present.	Feral pigs are listed as a “Declared Pest” with a requirement for landholders to control them.
<i>Biosecurity and Agriculture Management Regulations 2013</i>	DAFWA	The regulations define operational details via prescribed regulations established under the BAM Act.	Defines approved pig feed to ensure there is no transfer or infection from diseases in pigs. Lists “Schedule” substances.
<i>Animal Welfare Act 2002</i>	DAFWA	Ensures compliance with industry standards by people in charge of animals	Cruelty to animals when trapping, hunting or eradicating feral pigs.
<i>Wildlife Conservation Act 1950</i>	PARKS AND WILDLIFE	Protection of Threatened and Priority listed flora and fauna.	Protection threatened species by reducing the impact of feral pigs on habitat or populations.
<i>Country Areas Water Supply Act 1947</i>	WCWA and DoW	Management and protection of a public drinking water supply source.	Protection of water quality from the contaminating impacts of feral pigs and some control activities.
<i>Veterinary Chemical Control and Animal Feeding Stuffs Act 1976</i>	DAFWA	Definition of ‘animal feeding stuff’ and prohibition of certain prescribed substances, supplements and products from being fed to animals.	Inability to use any meat product as an attractant for pig control.
<i>Exotic Diseases of Animals Act 1993</i>	DAFWA	Detection, containment and eradication of certain diseases affecting livestock and other animals.	Inability to use meat or meat products as an attractant for pig control.

### 1.1 Biosecurity and Agriculture Management Act 2007

Introduced species may be categorised as declared pests under the *Biosecurity and Agriculture Management Act 2007 (BAM Act)*, which is administered by DAFWA. Prior to the *BAM Act*, the *Agriculture and Related Resources Act 1976* and its regulations provided for the protection of agriculture and related resources through the management, control and prevention of spread of certain plants and animals (WACA 2015).

The *BAM Act* and regulations came into force on the 01 May 2013. The Act and regulations establish a biosecurity regulatory framework to prevent serious animal and plant pests and diseases from entering Western Australia and becoming established, and to minimize the spread and impact of any that are already present within the state. Feral pigs are listed as a Category 3 Declared Pest, which is defined as a pest that is established in WA but it is feasible, or desirable to manage them in order to limit their damage (DAFWA 2015).

The *BAM Regulations* (2013) define “approved pig feed” to ensure there is control over diseases occurrence, spread and infection that can be found in pigs. The regulations define “Schedule” substances that are prohibited in animal feed. Regulation 35 allows for the Director General to give permission in writing for the approval of feed which contains or consists of the flesh, bones, blood or offal of a mammal as pig feed for baiting of feral pigs and research relating to pigs. Prior to this, there has been no opportunity for use of meat or meat products as attractants for the control of feral pigs due to the use of swill being illegal for this purpose in all states and territories of Australia (see Sections 1.5 and 1.6). The *BAM Regulations* also provide for establishment and funding of Recognised Biosecurity Groups (RBGs) in agricultural areas.

The *BAM Act* provides a modern approach to the control of declared pests such as feral pigs. Landholders have the responsibility of controlling declared pests on their land; however, the *BAM Act* enables landholders to work in cooperation with their neighbours and in partnership with others, including government agencies, using the additional mechanisms and resources available under the Act. For example, partnerships between private landholders and government can be achieved through using the community coordinated approach and the establishment and operation of an RBG (see Section 9.2).

### 1.2 Animal Welfare Act 2002

Administered by DAFWA, the *Animal Welfare Act 2002* is intended to provide protection to animals in WA. This includes not only pets but animals used commercially, livestock, and those used in research. RSPCA general inspectors work in partnership with DAFWA in the area of compliance and enforcement (DAFWA 2014). The Act paves the way for some of the harshest penalties in Australia, for offenders found guilty of cruelty to animals in WA.

### 1.3 Wildlife Conservation Act 1950

The *Wildlife Conservation Act 1950 (WC Act)* provides for the listing of threatened native plants and threatened native animals that need to be specially protected because they are under identifiable threat of extinction, are rare, or otherwise in need of special protection. The Minister for Environment may list an ecological community as being threatened. Parks and Wildlife administers the *WC Act* and uses International Union for Conservation of Nature (IUCN) criteria for assigning species and communities to threat categories (PARKS AND WILDLIFE 2014).

#### 1.4 Country Areas Water Supply Act 1947

Public Drinking Water Source Areas (PDWSA) is the collective name given to any catchment area declared for the management and protection of a public drinking water supply source. PDWSA include underground water pollution control areas, water reserves and catchment areas proclaimed under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947 (CAWS Act)* (DoW 2009). Water Corporation Western Australia (WCWA) and the Department of Water (DoW) administer the *CAWS Act*.

Feral pigs and some feral pig control activities pose a significant threat to the integrity of PDWSA. Feral pig control programs within PDWSA are important to manage animal population densities and reduce drinking water quality contamination risks however, control measures need to be planned and managed properly to avoid further contamination risks and contravention of PDWSA protection requirements.

#### 1.5 Veterinary Chemical Control and Animal Feeding Stuffs Act 1976

The *Veterinary Chemical Control and Animal Feeding Stuffs Act 1976 (VCCAFS Act)* regulates the sale and use of certain substances, sale of stock and the carcasses of stock, which have been or are declared not to have been treated with listed substances. It also regulates the production, importation, treatment, preparation for sale, marketing, storage, and sale of animal feeding stuffs (SLP 2006).

The *VCCAFS Act* applies to feral pig management in relation to the use of feed and attractants for the trapping or baiting of feral pigs. In particular, the Act precludes the feeding of any meat product to pigs. While this is intended to apply to the domestic pig industry, it does not specify an exemption for feral pigs. The *VCCAFS Act* defines appropriate “animal feeding stuff” and prohibits certain prescribed substances, supplements and products from being inserted into feed material for animals and the subsequent sale of the animal or carcass.

#### 1.6 Exotic Diseases of Animals Act 1993

The *Exotic Diseases of Animals Act 1993* provides for the detection, containment and eradication of certain diseases affecting livestock and other animals. The Act aims to safeguard the public from exotic diseases of animals. It allows for the destruction of animals suspected to be infected and prohibits and regulates the possession of any exotic disease agent (animals, land, and buildings). This act is relevant to feral pig control in WA because it also specifies that ‘swill’ cannot be fed to pigs. Swill is defined as ‘meat, meat scraps, meat trimmings, animal offal, blood, bones or any material which contains meat or any other waste or refuse not known to be free of meat or from contact with meat’ (SLP 2013b). This has implications for selection of pre-feed and attractants used in feral pig control where Director General of DAFWA has not provided written approval under the BAM Act for use of these products for feral pig control.

## 2. Feral pig distribution and abundance within south west WA

### 2.1 National context

There have been considerable efforts to capture knowledge of the distribution and abundance of feral pigs in Australia (Wilson *et al.* 1992; West and Saunders 2003; Woolnough *et al.* 2004) but significant gaps in knowledge still exist and perceptions vary between regions. It is generally agreed that feral pigs are established across 38% of the Australian continent and have been spreading since the nineteenth century (Hone 1990; Wilson *et al.* 1992; Choquenot *et al.* 1996; Long 2003). Large populations have been recorded in NSW, Queensland, the Northern Territory and the Australian Capital Territory, and isolated populations in Victoria, Western Australia, on Flinders Island in Bass Strait and on Kangaroo Island in South Australia (West 2008; Figure 1).

Estimates of pig numbers are subject to many sources of variation and the total number of pigs in Australia is unclear with estimates ranging between 3.5 million and 23.5 million (Wilson *et al.* 1992; Choquenot *et al.* 1996; West and Saunders 2003; Woolnough *et al.* 2004). Densities of feral pigs have been observed to vary significantly between different habitats with records of one pig per square kilometre in dry eucalyptus woodland, forests and grazing land and up to twenty pigs per square kilometre in wetlands and seasonally inundated floodplains (Choquenot *et al.* 1996).

Many feral pig populations in Australia are still expanding (Pullar 1953; Choquenot *et al.* 1996; Caley 1997; Spencer and Hampton 2005) and this is due to both natural dispersal (Caley 1997) and illegal translocations (Spencer and Hampton 2005).

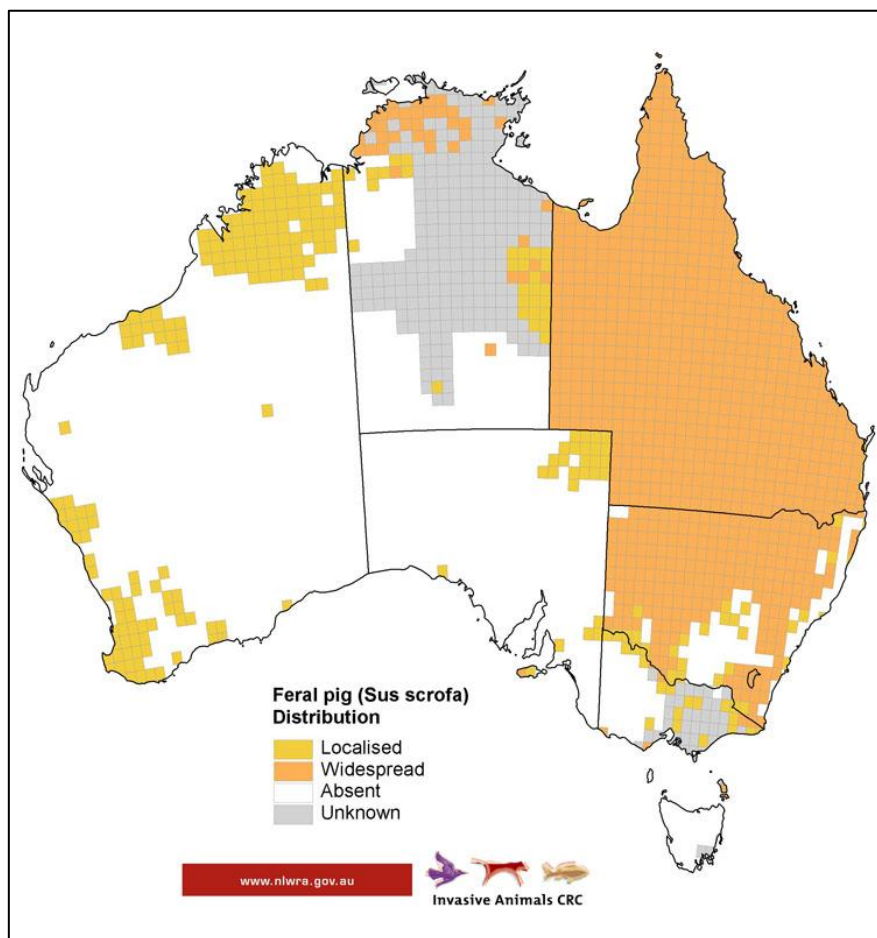


Figure 1: Distribution of feral pigs in Australia in 2007. Reproduced from West (2008)

## 2.2 South west WA

In biological terms, feral pigs have been relatively recently introduced to the south west of WA and appear to be expanding their range (Masters 1979; Woolnough *et al.* 2004; 2005). The area of suitable habitat for feral pigs in the region is much larger than the currently known distribution of feral pigs and it is logical to expect that feral pigs will continue to expand into the surrounding habitat where control measures are unable to prevent this and where the required movements from essential resources are not too great (Choquenot and Ruscoe 2003; Cowled *et al.* 2009).

In 1978, the estimated population size of feral pigs in the jarrah forests between Balingup and Jarrahdale was at around 10 000 pigs and intrusions of pigs into the forests south of Nannup were only just beginning to occur at this time (Masters 1979). Using feral pig sign and distance sampling analysis, feral pig density has recently been estimated for the jarrah forests between Collie and Jarrahdale at one pig per square kilometre with a population estimate of 11 837 individuals (Adams 2014). The same approach has not been used for the heavier jarrah and karri forests south of Nannup, but records of pig sightings, captures and dispatches from Department of Parks and Wildlife (Parks and Wildlife), South West Catchment Council (SWCC) and Community groups such as the Lake Muir Denbarker Community Feral Pig Eradication Group and the Northcliffe Declared Species Group suggests a substantial population now exists in this area.

The precise area of occupancy, abundance and distribution of feral pigs in the south west of WA is unknown due to difficulties in estimating population size and inconsistent approaches to recording feral pig presence and abundance. However, the distribution and relative abundance of feral pigs has been mapped for WA by the Invasive Animals Cooperative Research Centre (IACRC) and the National Land and Water Resources Audit, in collaboration with the WA Government (Figure 2). The mapped distribution provides a relatively accurate summary of the current known occurrence of feral pigs in south west WA.

While the feral pig populations in WA are beginning to garner attention nationally, there is still a tendency in national threat abatement strategies to underestimate the significance of the problem in this area. In particular, the pig population in the south west of WA is still not considered a national priority (see Threat Abatement Advice 2013), despite the extensive area now known to be occupied by feral pigs in this region and the diversity of threatened species, ecosystems, endemic and relictual taxa at risk from feral pig impacts.

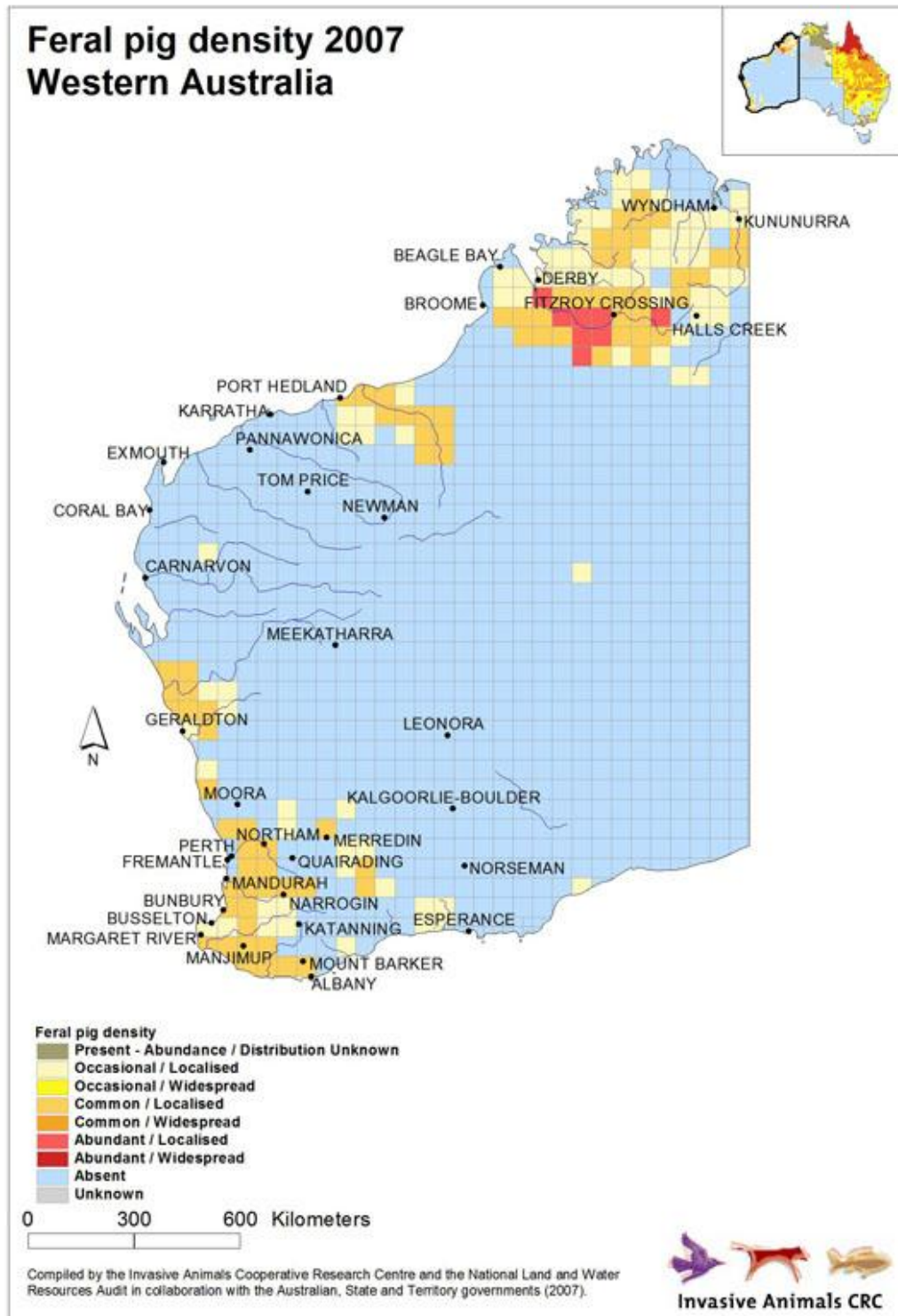


Figure 2: Distribution and relative abundance of feral pigs in WA in 2007. This map was compiled by the Invasive Animals Cooperative Research Centre and the National Land and Water Resources Audit, in collaboration with the WA Government. Accessed online at <http://www.pestsmart.org.au>.

### **3. Biology and ecology**

The size, omnivorous diet, adaptive activity patterns and high fecundity of feral pigs allow them to live in a wide range of habitats and quickly adapt to changing environmental conditions (Choquenot *et al.* 1996). This makes them particularly successful at establishing and maintaining wild populations, even in the presence of control operations.

#### **3.1 Morphology**

Overall, feral pigs are smaller, leaner and more muscular than domestic pigs, with well-developed shoulders, larger snouts and tusks, smaller ears and coarser hair (Masters 1979, 1981; Pavlov 1980, 1983). Males tend to be heavier than females with adults weighing up to 130 kilograms in comparison to 90 kilograms for females (Lake Muir Denbarker Community Feral Pig Eradication Group data). Lactating sows usually weigh less than non-lactating sows of the same age (Choquenot *et al.* 1996). Feral pigs weighing over 200 kg have been recorded in the temperate forests of New Zealand (McIlroy 1990).

Regional populations of feral pigs vary in physical size, shape and coat colour, depending on the domestic breeds from which they are descended. Black is the most common colour (Pullar 1953; Pavlov 1983) and some piglets are marked with dark longitudinal stripes, which disappear as they grow older (Wilson *et al.* 1992).

#### **3.2 Habitat**

In Australia, feral pigs are found in a variety of habitats including rainforests, forest, swamps, open floodplains, semi-arid floodplains, dry woodlands, open shrub and heathlands and grasslands (Giles 1980; Saunders 1988; Hone 1990b; Bowman and McDonough 1991; McIlroy 1993; Dexter 1995; Mitchell and Baloch 2007; TAA 2013). The availability of adequate food, water and shelter are important aspects of pig habitat throughout their distribution (Pullar 1950; Pavlov 1992). Temporal changes can occur in their use of habitats to satisfy these requirements, particularly to obtain shade and water and exploit seasonally abundant food sources (Choquenot *et al.* 1996).

#### **3.3 Diet and Feeding**

Feral pigs are opportunistic omnivores. They prefer succulent green vegetation, fruit, grain, and a wide variety of animal materials such as frogs, fish, reptiles, birds and small mammals (Giles 1980; Choquenot *et al.* 1996; Mitchell and Baloch 2007). They will also eat underground plant materials such as roots, bulbs, corms and fungi. Their requirement for protein and energy is high, particularly for breeding, lactation and rearing of young (Choquenot *et al.* 1996). Feral pigs use their keen sense of smell to search for food (Conover 2007) and can use their snout to root to depths of over 1m, where soil conditions permit (Mapston 2004).

#### **3.4 Wallows and rubs**

Wallows are depressions in mud, often filled with water, and are created by the loafing, rolling, and digging of feral pigs (Stevens 1996) and can be found in many low-lying, wet areas (Dickson *et al.* 2001). Feral pigs lack sweat glands and will visit wallows more than twice each day during warmer months to aid in their thermoregulation (Campbell and Long 2009). Feral pig rubs are frequently found in association with wallows in the warm months (Stevens 1996) and are characterized by wet or dry mud-coated surfaces. Rubbing functions to remove excess or dried mud, hair, and ectoparasites. Pigs commonly use trees, fallen logs, fence posts, and rocks as substrates on which to rub (Stevens 1996; Dickson *et al.* 2001). The height of the rub can be used to reveal the relative size of the animal that made it (Taylor 2003).

### 3.5 Reproduction

Feral pigs are able to breed throughout the year, but there are usually peaks in births coinciding with the seasonal abundance and quality of food in different habitats (Giles 1980; Saunders 1988; Caley 1993). Gestation lasts for 112 to 114 days, with a litter size of up to ten piglets in good conditions (Saunders 1993; Choquenot *et al.* 1996; Hone 2002). Litters are weaned after two or three months, and mating can occur again shortly after. Under favourable conditions two litters can be weaned in a period of 12 months. Female feral pigs reach sexual maturity once they reach a weight of 25 to 30 kg, which normally occurs between 7 and 12 months. Males become sexually mature at around 18 months old. Their breeding capability gives feral pigs the capacity to quickly recover from a population setback once conditions become favourable again (Choquenot *et al.* 1996; Mitchell and Baloch 2007).

### 3.6 Mortality

Mortality of juvenile feral pigs is highly variable and is strongly related to environmental conditions such as weather and food availability (Choquenot *et al.* 1996), hunting and predation from wild dogs and foxes (Saunders 1993; Mitchell and Baloch 2007). Starvation can affect feral pigs of all ages and lactation can cease in sows with low protein levels. Lack of appropriate nutrients also leaves feral pigs more susceptible to parasites and diseases (Mitchell and Baloch 2007). Few feral pigs live beyond five years of age (Choquenot *et al.* 1996).

### 3.7 Movements and home range

The size of a feral pig's home range is primarily determined by the abundance of food and is correlated with body weight and population density (Saunders 1988; Caley 1993; Choquenot *et al.* 1996). Where food supply is poor, average home ranges can be quite large. Boars have larger home ranges than sows, particularly recently farrowed sows which stay close to their young for the first two weeks or so after farrowing (Saunders 1988; McIlroy *et al.* 1989; Caley 1993). The home range of a recently farrowed sow may be as small as 0.16 km<sup>2</sup> (Saunders 1988), while mature males may have home range as large as 43 km<sup>2</sup> (Masters 1979; Choquenot *et al.* 1996).

Activity patterns of feral pigs depend on location, season, weather and degree of disturbance from people. Generally, feral pigs are nocturnal or crepuscular (Giles 1980; Choquenot *et al.* 1996; Saunders and Kay 1991; Mitchell and Baloch 2007). They are more diurnal in cloudy or rainy conditions, or in cooler seasons or areas, but are not usually active during the middle of the day (Saunders 1988; McIlroy *et al.* 1989; Saunders and Kay 1991).

While feral pigs generally do not move very far in response to minor disturbance, they can shift permanently if subjected to intensive or prolonged disturbance, such as large scale hunting or other control activities (Pullar 1950; McIlroy 1989; McIlroy *et al.* 1989; Caley 1993). The maximum linear distance known to have been travelled by a feral pig in Australia is 55 kilometres for a sow from one watercourse to another in New South Wales after a major control operation (Saunders and Bryant 1988).

### 3.8 Social structure

Although adult boars are solitary, and farrowing sows will temporarily separate themselves from other pigs, feral pigs are mostly social, gregarious animals (Masters 1979). The basic group consists of one or more sows and their piglets, but other groups consist of young females, bachelor groups of young males and other combinations (Masters 1979; Pavlov 1992). Group sizes vary depending on the season, habitat and conditions, and range between one and 100 pigs (Choquenot *et al.* 1996). Mobs of more than 100 can gather around remaining waterholes in dry seasons. In the forests of south-west WA, group sizes rarely exceed 12 pigs, but in more open country mobs of 30–40 have been reported (Masters 1979). Group sizes of up to 700 pigs have been documented in north Queensland (Mitchell and Baloch 2007).



## 4. Impacts of feral pigs in south west WA

The impacts of feral pigs in the south west of WA are not well documented, but are likely to be similar to impacts documented for other parts of Australia and fall into four main categories, including impacts on conservation, agriculture, water resources and human health. These are summarised below:

### 4.1 Conservation

The National Threat Abatement Plan for feral pigs identifies predation, physical modification of habitat, competition and disease transmission as key threatening processes that pigs contribute to in the Australian environment (DoE 2005). The plan states that the ecological parameters most likely to be affected by feral pigs are species composition, succession, and nutrient and water cycles. The main impacts that feral pigs have on conservation include:

- Direct predation on bird chicks, reptiles, reptile and bird eggs, frogs, soil organisms, earthworms and other invertebrates (McIlroy, 1990; Mitchell, 1993; Roberts *et al.* 1996; Fordham *et al.* 2006; Mitchell 2008), underground fungi, fruit, seeds, roots, tubers, bulbs and plant foliage (Choquenot *et al.* 1996; Laurance and Harrington 1997; Melzer *et al.* 2009).
- Physical removal of plants and altered floristics, vegetation structure and habitat quality as a result of digging, wallowing or feeding behaviours (Bratton 1977; Wood and Barrett 1979).
- Reduced regeneration of plants due to decreased seedling recruitment, survival and alteration of soil structure (Choquenot *et al.* 1996; Hone 2002; Adams 2014).
- Increased invasion and spread of weeds as a result of disturbed vegetation and movement of soil and weed material (Li *et al.* 2013; Lynes and Campbell 2000 Tierney and Cushman 2006).
- Increased soil friability due to digging activities and an associated reduction in the presence of invertebrates, microbes and bulb-producing plants (Hone 2002; Mohr *et al.* 2005).
- Altered soil and nutrient properties as a result of digging. For example, accelerated leaching of calcium, copper, magnesium, potassium, phosphorus, and zinc from the soil (Singer *et al.* 1984); negative impacts on soil building processes (Ford and Grace 1998); and accelerated rates of soil erosion (Sierra 2001). Feral pigs are estimated to turn over approximately 12.89 million tonnes of soil every 12 months in the northern jarrah forest, a figure which has been equated to a commercial mining operation (Adams 2014).
- Increased oxidation and acidification processes within organic, peat based wetland systems as a result of digging and wallowing, particularly following fire when the soil is more exposed and accessible (Burnside *et al.* 2012).
- Reduced quality of surface and ground water due to erosion, siltation and pollution through digging and wallowing (Statham and Middleton 1987; Choquenot *et al.* 1996; Fordham *et al.* 2006; Mitchell 2008).
- Creation of habitat suitable for disease vectors, particularly mosquitoes that breed in the shallow wallows where surface water is present (Choquenot *et al.* 1996).
- Actual vectoring of exotic diseases and pathogens such as *Phytophthora cinnamomi* (dieback) and *Batrachochytrium dendrobatidis* (frog chytrid fungus) in hooves or digestive tract (Kliejunas and Ko 1976; Masters 1979; Li *et al.* 2014). The spread of dieback has also been associated with soil disturbance and reduction of litter cover by pigs (Brown 1976). In addition, physical damage of plants can provide entry points for infection and increase susceptibility of flora populations to disease, parasitic and fungal attacks.
- Increased access for other introduced predators, such as feral cats and foxes, as a result of disturbed vegetation.
- Competition with native species for food, water and shelter (Taft 1999).

161 species of nationally listed threatened flora and fauna have been identified in the National Threat Abatement Advice (2013) as being adversely affected by feral pigs. 16 of these are found in south west WA and 12 of these are endemic to the region (Appendix 2). The TAA (2013) only includes species that are federally listed under the EPBC Act. There is also a large range of taxa listed as threatened or specially protected on State lists that are likely to be adversely affected by feral pigs. For example of the 442 state listed threatened and priority fauna species (Parks and Wildlife 2014), 55 are associated with sensitive riparian and granite habitats, are known to be dependent on a specific vegetation structure, or lay their eggs in the soil (Appendix 3). Similarly, many of the 2319 state listed threatened and priority flora species (Florabase 2014) and associated ecological communities are likely to be at risk from feral pigs, particularly where they occur in habitats favoured by pigs. Feral pigs cause their greatest damage in environmentally sensitive areas and other natural ecosystems of conservation concern (Chavarria *et al.* 2007; Engeman *et al.* 2007; Figure 4). In some cases, areas affected by feral pigs are showing no sign of recovery more than six years after pigs have been removed (e.g. Bain *et al.* 2015). Impacts of feral pigs are often more severe following fire or some other disturbance that opens up the understorey or exposes the soil (Burnside *et al.* 2012). Feral pigs may also have significant impacts on biodiversity through less direct effects such as impacts on non-target species from control measures such as dogging and poisoning.



Figure 4: Examples of feral pig damage to environmentally sensitive areas. Top left: sunset frog habitat; Top right: threatened *Caladenia* tubers dug out by pigs (Photographs Parks and Wildlife Frankland District); Bottom: quokka habitat with no observed recovery after six years and complete structural change left before pigs and right sustained pig damage post fire (Photographs K. Bain).



## 4.2 Agricultural

Feral pigs cause approximately \$106.5 million in agricultural damage in Australia each year (McLeod 2004; DoE 2005). The main impacts that feral pigs have on agricultural values include:

- Predation on newborn lambs (Pavlov *et al.* 1981; Mitchell and Baloch 2007)
- Reduction in yields of grain, fruit and vegetable crops by consuming or trampling plants or up-rooting vegetation (Tisdell 1982; Choquenot *et al.* 1996; Mitchell and Baloch 2007; Gong *et al.* 2009).
- Removal of plantation seedlings and predation on roots of recently planted trees (Lipscomb 1989; Campbell and Long 2009).
- Physical damage to fences and water sources, and fouling of dams and waterholes through wallowing and defecation (Tisdell 1982; Mitchell and Baloch 2007).
- Competition with livestock for pasture (Choquenot *et al.* 1996; Bomford and Hart 2002; Mitchell and Baloch 2007).
- Potential spread of infections and diseases to domestic livestock, including leptospirosis (*Leptospira interrogans*), brucellosis (*Brucella sp.*), melioidosis (*Burkholderia pseudomallei*), tuberculosis (*Mycobacterium tuberculosis*) and sparganosis (*Spirometra sp.*) (Choquenot *et al.* 1996; Heymann 2008). These bacteria and parasites have been directly linked to feral pigs in QLD and SA however the incidence of infection and disease is relatively low (Heymann 2008).



Figure 5: Examples of destruction of pigs in Agricultural areas. Top left: damage to private property Denbarker. Top right: feral pig damage on private property on Lower Blackwood River. Bottom: property damage from feral pigs adjacent to watercourses (left) and dams (right). (Photographs D. Sullivan SWCC 2015)

#### 4.3 Water Resources

Feral pigs can pose a significant risk to water resources, especially within PDWSAs. The main impacts that pigs have on water resources include:

- Degradation of surface water quality through wallowing and foraging (DoW 2009).
- Introduction of infectious waterborne pathogens into the water supply that may infect humans, such as protozoan parasites such as *Giardia*, *Cryptosporidium*, *Balantidium coli* and *Entamoeba histolytica* (DoW 2009). In some cases, these zoonotic pathogens can be life threatening (Hampton *et al.* 2006).
- Destruction and erosion of riparian vegetation, which provides important natural protection against contamination, erosion and turbidity from increased siltation (DoW 2009).
- Interference with chlorination and filtration treatment processes due to added particulates in the water, which can shield micro-organisms from effective disinfection and promote bacteria growth (WHO 2004).

In addition, feral pig control methods that require people to stay in PDWSA for long periods, can increase the risk of contamination to the drinking water source through direct introduction of contaminants into the water body from humans, dogs and vehicles; damage of protective vegetation and soil erosion by vehicles; or accidental fires. These risks can be managed for legitimate pig control activities by having policies and work instructions that actively mitigate the risks. Feral pig carcasses in the catchment, particularly those close to reservoirs, feeder streams or production bores also present a pathogen risk to drinking water quality (DoW 2009), as do native animal carcasses. Feral pig control activities can only occur within PDWSAs with the approval of the land manager. .

#### 4.4 Economy and Human Health

Feral pigs can act as hosts or vectors of several endemic and exotic diseases and parasites that affect humans and domestic animals. The major bacteria and parasites of concern are Q fever (*Coxiella burnetii*), leptospirosis (*Leptospira interrogans*), brucellosis (*Brucella sp.*), melioidosis (*Burkholderia pseudomallei*), tuberculosis (*Mycobacterium tuberculosis*) and sparganosis (*Spirometra sp.*). Of these, Q fever is the most commonly recorded disease presenting in humans following interaction with the body fluid and urine of feral pigs. However, the potential remains for the involvement of feral pigs in the transmission of a range of diseases due to their widespread distribution, their ability to act as hosts for a range of bacteria and parasites and their occurrence in habitats where these organisms are likely to be present. The involvement of feral pigs in an exotic disease outbreak could delay disease detection; increase the rate and extent of disease spread; make disease eradication measures expensive, time-consuming or impossible; and have severe repercussions for Australia's livestock industries (Choquenot *et al.* 1996).

The cost of feral pigs to the agricultural industry in Australia has been valued in excess of \$106 million each year (McLeod 2004; DoE 2005). These values do not include the potential economic costs arising from the loss of endangered and threatened species, damage to National Parks, water quality impacts and the transmission of diseases. The costs are likely to be substantially higher and if left unmanaged, feral pigs will affect local tourism, conservation, agriculture, water resources and human health.

In addition to the potential negative impacts of feral pigs on economy and human health, the increase in recreational hunting in some areas may equate to an economic benefit associated with equipment sales and marketing products.

## 5. Feral pig control options

Available control techniques for feral pigs are usually incapable of removing all individuals in a single event and require integration with other techniques, repeated applications of the technique or a sequence of techniques to maximise effectiveness. The advantages and disadvantages of each available control technique are summarised in Table 2, and a full discussion of each technique follows in Sections 5.1 - 5.10.

Table 2: Advantages and disadvantages of techniques available to manage feral pigs (see Sections 5.1-5.10 for full references).

Technique	Advantages	Disadvantages
Shooting	Useful for small populations or to protect small areas; Allows flexibility for nocturnal operations; Highly selective; May remove trap wary animals; Complements other techniques.	Often time and labour intensive; May be limited by access; Can disperse pigs or make them more wary.
Recreational Hunting	Provides sport hunting opportunities; Opportunities for cooperative approach; Highly selective; Complements other techniques where managed appropriately.	Removes only small numbers of pigs; Can disperse pigs or make them more wary; Can interfere with other control operations; Public risk from firearms.
Bounties and commercial harvest	Additional income for farmers; graziers and field operators; Data on distribution and numbers; Incentive to agricultural workers to become more involved in pig control.	Susceptibility to fraud (for example transfer of scalps from other areas); Deliberately spreading pigs or releasing females and young to provide future income; Expensive.
Dogging	Effective for pigs that have evaded other techniques; Many animals may be removed in a short time; Can operate in inaccessible areas.	Training is labour intensive; Dog and pig welfare risks; Non-target risks; Can disperse pigs or make them more wary; Dogs limited by heat stress in summer.
Trapping	Multiple animals can be captured at once; Non-target animals may be released unharmed; Indirect capture.	High cost and impractical in inaccessible areas; Pigs may become shy of traps; Must be checked regularly; May be cumbersome to transport.
Fencing and diversion	Effective for protection of or diversion around small areas; Non-lethal.	Resources may be damaged in adjacent areas; Expensive to build and maintain.
Habitat modification	Reduce pig habitat; Restrict access of pigs to essential food and water sources.	Often involves destruction of native vegetation; Non-target risks.
Baiting	Effectively reduce populations; Widely accepted; Can access remote habitat.	Bait shyness; Non target risks; Potential welfare implications; Unlikely to target all pigs in area.
Judas Pig	Multiple groups can be targeted; Can locate core refuge areas; Target shy or wary pigs.	Tracking can be time consuming and difficult in forested areas; Risk of Judas being killed by recreational hunters.
Biological and fertility	Species-specific control.	Repeat dosing often necessary; High lag time for population reduction; High cost of delivery by baits; More effective to bait with lethal poison; Risks to domestic pig industry.

## 5.1 Shooting

Shooting by skilled sharpshooters is considered to be one of the most humane techniques for killing feral pigs (Choquenot *et al.* 1996; DoE 2005; Campbell and Long 2009). However, ground shooting is often labour intensive and is considered to play an insignificant role in damage control except where it is intensively conducted on small populations, to protect small areas or used in conjunction with other control options such as trapping and baiting (Masters 1979; Choquenot *et al.* 1996; Mitchell and Baloch 2007). If undertaken effectively, ground shooting can be highly selective, provide added flexibility for nocturnal or less accessible targets and remove trap wary animals. There are multiple examples of coordinated ground shooting operations effectively protecting small sensitive ecosystems. For example collaborative pig control programs in plantation areas adjacent to a highly sensitive sunset frog swamp, the outcome of which was a number of selectively targeted pig removals in the open plantation that prevented these pigs from entering the dense swamp vegetation (Figure 6). The key to the effectiveness of such operations is collaboration and integration with wider efforts. If applied inappropriately, shooting can interfere with other control efforts by dispersing pigs or making them more wary (Choquenot *et al.* 1996).

Aerial shooting is an effective initial knock down for feral pig populations in areas without dense vegetative cover or rough terrain (Hone 1983; Mapston 2004). Removal rates of feral pigs range between 65 and 97 % from aerial shooting in Australia (Hone 1983; Saunders 1993). However, in NSW pig populations recovered to 77% of their original numbers within one year of aerial shooting, which reinforces the need for annual control to counteract immigration and reproduction (Saunders, 1993). Aerial shooting is likely to have limited application in the forested areas of south west WA, unless operations are able to target recently burnt wetland or heath systems where pigs are causing damage.



Figure 6: Example of effective collaborative pig control. Plantations Officer Trev Macmahon undertaking feral pig control activities in a plantation adjacent to a sensitive sunset frog swamp. Photograph: Bob Edwards (PF Olsen Limited).



## 5.2 Recreational Hunting

In many situations, public hunting has been found to be insufficient at reducing feral pig damage because only small numbers of animals are removed (Barrett and Pine, 1980; Tisdell 1982; Updike and Waithman 1996). In the United States, where hunting is a widely accepted recreational pursuit, hunters kill only 15-20 % of the feral pig population annually (Tisdell 1982). Main risks associated with use of recreational hunters are associated with their potentially counter-productive effects on other control techniques, public risk from use of firearms and impacts on non-target species.

Amateur hunters operating on their own have been known to reduce the effectiveness of trapping and baiting programs by disturbing pigs in control areas and contributing to more wary pigs that retreat to inaccessible refuge areas (Calenge *et al.* 2002; Sodeikat and Pohlmeier 2003). These pigs become the remnant breeders that repopulate areas following knock down each year. The movement and release of pigs for sport is also a significant issue associated with recreational hunting (Spencer and Hampton 2005). In addition, land managers have concerns with trespassing and property damage by hunters, stock harassment, and dogs left behind by hunters (Choquenot *et al.* 1996). Of additional concern are the potential breaches to animal welfare associated with illegal pig hunting activities (e.g. Figure 7). The potential threat to effective pig control from recreational hunting is discussed in more detail in Section 6.6 and is of particular relevance given rising pressure from gun groups for recreational hunting opportunities.

A two year trial of recreational hunting on crown land is currently being proposed by the WA State Parliament's Public Administration Committee. The trial if it goes ahead will use an online booking and GPS tracking system and hunting activities are intended to target feral animals (Kagi 2015). Recreational hunting by individuals or groups that are not operating within a collaborative and integrated feral pig management framework is not a supported approach for controlling feral pigs in this region, given the issues raised above.



Figure 7: Example of illegal pig hunting activity interfering with other control techniques and breaching animal welfare regulations. This pig was killed by an illegal hunter with a knife and its head coarsely hacked off. The carcass was left onsite near a free feeding Parks and Wildlife trap, which subsequently had no captures.

While illegal pig control is of concern, there are multiple examples of successful partnerships with recreational hunting groups and this success seems to stem from clear guidelines and codes governing their activities, active coordination and integration of activities with broader pig control efforts and encouragement of a conservation ethic that is respectful of environmental requirements such as disease management. The Albany Branch of the Sporting Shooters Association Hunting and Conservation program is an example of a recreational hunting group that is successfully integrating with pig control efforts in south west WA.

### 5.3 Bounties and commercial harvest

Bounties have been viewed favourably at various times in Australia and may be effective in managing feral animals if bounty payments increase in value substantially as the pest population decreases, thereby inducing hunters to seek out the few remaining animals before dishonest and fraudulent practices creep in (Rolls 1969; Smith 1990). However in order to be effective, bounties are an expensive option and are still likely to encourage a behaviour that perpetuates an ongoing source of income. Such behaviours are likely to include the deliberate spread of pigs or the release of females and young.

An alternative to bounties is coordination of pig control activities with commercial harvesters of feral pigs. There is a significant 'wild boar' export market in the Eastern States, with Australia supplying 20-30% of the total international trade in wild boar meat, worth \$10 million to \$20 million per annum, depending upon fluctuating market prices (Ramsay 1994). There is currently no formal market for 'wild boar' in WA possibly due to the economic viability of harvesting in this area. Important factors influencing viability include pig density, distance to abattoirs, ease of access for harvesters, disease and condition of the animals, and the attitude of landholders and land managers to their operations (Campbell and Long 2009). Should commercial harvesting of feral pigs become economically viable, this could be considered as one component of an integrated program where harvesting activities could benefit values being protected.

### 5.4 Dogging

Using dogs to locate feral pigs for subsequent removal can be effective at reducing damage where well-trained dogs and skilled hunters are employed (Barrett *et al.* 1988; Katahira *et al.* 1993; Mapston 2004). However, the actions of poorly trained dogs and owners can lead to considerable pain, suffering and distress to the hunted pigs and the dogs used (DLGRD 2003). For this reason there is considerable controversy surrounding this practice and the 'Feral Animals - Code of practice for the capture and marketing of feral animals in WA' (DLGRD 2003) states that the use of dogs to attack and bring down feral pigs is an unacceptable practice. This code sits under the *Animal Welfare Act 2002*, which carries penalties of up to \$50,000 and 5 years imprisonment for prosecuted cases of cruelty (Appendix 1). Some illegal hunters in south west WA are known for using their dogs to hold, attack and bring down pigs and these activities have been shown to alter movements, disperse and increase wariness of feral pigs (Calenge *et al.* 2002; Sodeikat and Pohlmeier 2003).

Where dogs have been used legitimately for feral pig control in the south west of WA, their role has been only for tracking and locating pigs. As with many of the other techniques mentioned, tracking feral pigs with dogs is best used in conjunction with other control techniques in an integrated management program. For example, use of dogs has been found to be most effective at locating residual feral pigs following reduction with other methods in Australia (McIlroy and Saillard 1989; Caley and Ottley 1995). The success of tracking with dogs seems to vary with the amount of vegetation cover, the previous history of the pigs with dogs and hunters, and the skill and experience of the hunters (DoE 2005).



## 5.5 Trapping

Trapping is a well-established control measure for feral pigs in Australia (Saunders *et al.* 1993; Caley 1994; DoE 2005; Mitchell and Baloch 2007) however, if used inappropriately pigs can quickly become trap-shy. There are three main live trap designs that are useful for capturing feral pigs: panel, silo and corral traps (Mitchell and Baloch 2007; Williams *et al.* 2011). The traps are made of steel mesh and incorporate a one-way entrance. In the south west of WA all three trap types are being used and a key component of some of the traps being used is their hinged spring gates which are successful in capturing multiple pigs in a single capture event (e.g. Figure 8). Studies investigating variable trap success have identified corral traps as being temporally and economically more efficient than other trap types because they are able to effectively trap more pigs per trap night at a lower overall cost (Williams *et al.* 2011). Intense trapping can reduce pig populations, at least in the short term (Mitchell and Kanowski 2003, McCann and Garcelon 2008) and non-target animals may be released unharmed.

Successful trapping of feral pigs involves initial free feeding at sites likely to have feral pig activity or near watering points. The most commonly accepted free-feed materials include fermented and sterilised cereal grains and fruit, which are widely used (Saunders 1988; Caley 1995). In Australia, researchers have found that feral pigs prefer free feeds containing creosote, fish stock, molasses, and vanilla attractants (Elsworth *et al.* 2004). Camouflaging traps with natural vegetation and masking human scent with molasses seems to increase success (Katahira *et al.* 1993; M. Sawyer *pers.com.*). In addition, trials of innovative attractants have increased trap effectiveness in some areas (Dorrington *et al.* 2001; McIlroy and Gifford 2005).

Trapping is likely to be more successful if alternative food is in short supply and disturbance to the area from hunters and dogs is minimised (Choquenot *et al.* 1996). The effectiveness of traps varies seasonally (Barrett *et al.* 1988; Saunders *et al.* 1993; Caley 1994; Wyckoff *et al.* 2006) and sex biases may occur (Choquenot *et al.* 1993; Williams *et al.* 2011) however, trapping has been shown to be more effective than other techniques in some instances (e.g. Sterner and Barrett 1991; Choquenot *et al.* 1993; Saunders *et al.* 1993). Animal welfare groups consider trapping to be humane where the trap is positioned in a sheltered area and checked frequently for the duration of the trapping period, as feral pigs are highly susceptible to heat stress (Dexter 1995). Checking traps often also enables non-target captures to be released, although doors can now be designed to be reliably target-specific. New advances in trap application such as auto feed and satellite signal traps in remote areas are increasing opportunities for remote checking of traps (DoE 2005).



Figure 8: Example of a trap design currently being used in south west WA (Photograph Department of Parks and Wildlife, Frankland District). A sow and three piglets captured in one trap event. The door is spring loaded to allow the animals to push into the trap, but they cannot push back out.

## 5.6 Judas Pig

An innovative technique that has been proposed to reduce feral pig damage involves placing radio transmitters on trapped animals and tracking them following release to reveal the location of other pigs in the area (Littauer 1993; McIlroy 1995; McIlroy and Gifford 1997; Wilcox *et al.* 2004). This method exploits the social attributes of feral pigs. Sows trapped locally have been found to make the best Judas pigs (McIlroy and Gifford 1997; Wilcox *et al.* 2004). On large tracts of land involving discontinuous populations, Judas pigs may provide information on where to target control efforts (McIlroy and Gifford 2005). For example, the Judas pig technique has been used successfully in the ACT to determine where to distribute toxic baits (McIlroy and Gifford 1997). Similarly, in the Walpole Wilderness Judas pig trials have been used in an attempt to locate core refuge areas (Bain *et al.* 2011; Figure 9). Success in the latter trial has been impaired by the activities of illegal recreational hunters who have killed all collared pigs to date.



Figure 9: Feral sow being collared in the Walpole Wilderness April 2012. Pictured: Dr David Edmonds (Veterinarian), Karlene Bain (formerly Parks and Wildlife) and Anthony Thomson (formerly Parks and Wildlife).

## 5.7 Fencing and diversion

Fencing has been used to either exclude feral pigs or inhibit their movements in an effort to protect ecologically and economically sensitive areas (Pavlov *et al.* 1981; Hone and Atkinson 1983; Choquenot *et al.* 1997; Reidy *et al.* 2008). Design of fences is critical for effectively restricting the movement of feral pigs. Hone and Atkinson (1983) evaluated eight fence designs, with and without electrification, under test conditions. Electrification significantly reduced the frequency of feral pig movement through fences. However, no 'exclusion' fence has been successful in keeping feral pigs out indefinitely. Breaches eventually result due to physical damage to the fence, electrical failure or lack of maintenance. The ineffectiveness of fences in the long term, and their relatively low adoption as a form of widespread control, revolves around their maintenance and the fact that if used alone they merely transfer the problem from one area to another (Allen 1984; McIlroy 1993). Fencing has been successfully used in the Walpole Wilderness to temporarily protect habitat of the EPBC listed Sunset Frog (*Spicospina flammocaerulea*) and *Reedia spathaceae* from feral pig digging and wallowing, following fire in these sensitive ecosystems (Figure 10).

Use of bait to divert feral pigs away from seasonally available resources is another diversionary technique and has been used to protect vineyards and crops by distributing corn or other palatable baits in the adjacent forests to divert feral pig activity away from production areas (Calenge *et al.* 2004). This approach has been relatively ineffective over long periods of time (Conover 2002; Geisser and Reyer 2004).



Figure 10: Fencing has been successfully used in the Walpole Wilderness to temporarily protect peaty wetland habitat of the EPBC listed Sunset Frog (*Spicospina flammocaerulea*) from feral pig digging and wallowing, following fire in these sensitive ecosystems. Photograph provided by Department of Parks and Wildlife, Frankland District.

## 5.8 Habitat modification

Habitat modification is not common since it often involves destruction of native vegetation (Choquenot *et al.* 1996). However, there may be opportunities to reduce pig habitat and facilitate trapping near point-source waters, especially during summer when water is scarce. Examples include preventing access to dams, closing off open bore drains and fencing off essential vegetated cover. There is also the potential to restrict access of pigs to essential food sources, such as crops, when natural food is depleted (Choquenot *et al.* 1996; DoE 2005).

## 5.9 Baiting and toxicants

Poison baiting is used to reduce pig populations and is a widely accepted method of control in Australia (O'Brien 1988; Choquenot *et al.* 1996). The negative aspects of poisoning are largely associated with its non-specificity and perceived or actual animal welfare implications (Choquenot *et al.* 1996). In addition, it is unlikely that all pigs in a baited area will encounter the baits. Adams (2014) found that 43.8 % of feral pigs in an area of the northern jarrah forest did not come into contact with the baits as a result of their transient behaviour or dominant boars consuming all available baits (Adams 2014). Baiting is likely to be most effective in conjunction with other control options such as trapping and shooting. Where a sustained baiting program is being implemented, active minimisation of non-target impacts and modification of bait delivery in response to target behaviour will help to increase long-term efficacy.

### *Bait Types*

Currently, sodium fluoroacetate (1080), warfarin and yellow phosphorus (sold as CSSP) are the toxins used to poison pigs in Australia. The use of warfarin and yellow phosphorus has recently been assessed as inhumane (Sharp and Saunders 2004; Cowled and O'Connor 2004) and these are likely to be banned in WA in the near future. 1080 is the most commonly used toxin for feral pig control, being added to various bait substrates, such as grain, pellets, meat and vegetables. The advantages of this toxin include: current registration; consistent field efficacy (Twigg *et al.* 2005; Cowled *et al.* 2006); and lower animal welfare considerations than other toxins currently available (Sharp and Saunders 2004; Cowled and O'Connor 2004). In recent years, concerns regarding the humaneness of 1080 have become more prominent and the welfare of target or non-target animals has been the subject of a number of publications (Saunders *et al.* 1995; Gregory 1996; McIlroy 1996; Marks *et al.* 2000; Sherley 2007, Twigg and Parker 2010). Humaneness concerns largely relate to the possible suffering of poisoned animals in baiting programs. Feral pigs poisoned with 1080 experience vomiting and undergo convulsions prior to death. Symptoms of 1080 poisoning have been described as being similar to epileptiform convulsions. Human patients exposed to 1080 did not perceive pain throughout the onset of poisoning and were unconscious during convulsions (Williams 1948; Gregory 1996), although some patients experienced mild abdominal discomfort when recovering after poisoning (Williams 1948; Burkhart 2001).

Strategies to address welfare concerns relevant to non-target species have included the development of more target-specific baits such as PIGOUT<sup>®</sup> baits, which are a factory-prepared bait containing 72 mg 1080 (Cowled *et al.* 2006). This product is reportedly more target specific for feral pigs than other commonly used bait types due to the size, flavour and bait core designed to minimise uptake by non-target species (Cowled *et al.* 2006). Non-target interactions with the bait have still been recorded, but most of these interactions have been restricted to superficial nibbling and typically have not penetrated the wax core containing the 1080 poison (Adams 2014). Occasional consumption of whole baits by non-target species such as kangaroos, possums and quolls has been recorded (Adams 2014). Non-target consumption of bait and secondary poisoning from carcasses and vomit are of concern for all 1080 based products (Cowled *et al.* 2006; Twigg *et al.* 2007).

Additional toxicants are being identified in an effort to continue trying to exploit the physiological vulnerabilities of feral pigs. An example is sodium nitrite, a common human food additive, which is highly toxic to pigs and acts humanely by preventing oxygen binding to haemoglobin (Cowled *et al.* 2008). A great deal of progress has been made towards refining the delivery of sodium nitrite as a formulated product and the result is a product trademarked as HOG-GONE (Lapidge *et al.* 2012). These baits have been extensively tested in the laboratory, in controlled pen trials and in the field for stability, palatability, persistence of the toxin in the carcass/ environment, efficacy and humaneness (Lapidge *et al.* 2012; Pest Smart 2013). Results seem encouraging, and suggest that the product is target-specific, humane and environmentally safe (Lapidge *et al.* 2012). However, sodium

nitrite is unstable and breaks down into products that are often unpalatable to pigs. In addition, a large quantity of the poison must be delivered quickly to push methaemoglobin levels above critical thresholds for a lethal outcome. These constraints are currently resulting in lower field efficacy in some areas (ACTA 2014). New microencapsulated formulations of sodium nitrite that might be more stable in bait substrates are being trialled in Australia and the United States (Lapidge *et al.* 2012; Pest Smart 2013; IACRC 2013).

#### *Minimising non-target impacts*

The LD50 of 1080 for feral pigs has been reported around 1.04 milligrams per kilogram (McIlroy 1983; Sheehan 1984). Due to the size of an average feral pig and the subsequently high dose of any poison required to achieve effective pig control, non-target species are invariably at risk from pig baits (McIlroy 1983 1986; Fleming *et al.* 2000; Martin and Twigg 2002; Adams 2014). The Pest Animal Control CRC in cooperation with several agencies is investigating strategies to improve the target specificity and effectiveness of feral pig baiting programs. Examples of their areas of research include target-specific delivery systems, development of additional feral pig baits and control strategies, and an evaluation of alternative feral pig toxins.

Measures that are currently available to minimise impacts on non-target species include: designing bait stations such that they exclude non-targets, e.g. through the use of HOG-HOPPERS<sup>®</sup> (Animal Control Technologies Australia), only placing poisoned baits where feral pigs have been consistently taking non-toxic pre feed (McIlroy *et al.* 1993; Cowled *et al.* 2006; Adams 2014) and monitoring bait stations to enable discontinuation of baiting should non-target bait uptake become an issue (Adams 2014).

Persistence of toxins in the carcasses of poisoned animals and the potential impacts of this on non-target species is also of potential concern. Location and disposal of pig carcasses following baiting programs is difficult to achieve and the dense vegetation and often remote access in forested areas makes this even more challenging (Cowled *et al.* 2006; Twigg *et al.* 2007). Adams (2014) found that in most cases non-target species that scavenged on pig carcasses were feeding on the invertebrates associated with decomposition of the carcass and didn't start feeding on the carcass for three to four days after poisoning, which would reduce the risk somewhat. However, this is still a significant management issue that requires consideration during planning, particularly where varanids and native carnivores such as dasyurids are likely to be present.

Multiple studies have highlighted the importance of pre-feeding in baiting programs to increase the uptake of bait by feral pigs (e.g. Saunders *et al.* 1993; Cowled *et al.* 2006; Adams 2014). Saunders *et al.* (1993) recommends pre feeding for at least 6-7 days to maximise bait consumption prior to introducing toxic baits. Pre feeding in conjunction with use of remote sensing cameras provides an opportunity to confirm that feral pigs are visiting bait sites, to assess dominance interactions between pigs visiting the station and to assess non-target interaction with pig baits (Adams 2014). Information obtained in this way allows modification of bait delivery to maximise efficacy. For example, introducing toxic baits only at stations where non-target species are not present; deploying baits over a wider area at bait stations to reduce consumption of baits by one or two dominant pigs (Adams 2014).

Choquenot *et al.* (1996) recommend baiting of pigs during late summer because more pigs are likely to be food and water limited and will more quickly find and eat greater quantities of bait. However, some studies have demonstrated that these environmental conditions also increase the likelihood of non-target species consuming baits (Adams 2014). In addition, some species such as ravens, quokkas, brush tail possums and brush tail wallabies have demonstrated a learned response to baits in bait stations, with animals more likely to take bait after a period of pre feeding and a more rapid uptake of bait in successive years (Adams 2014).

### 5.10 Biological and fertility

The development of immuno-contraceptive techniques to cause sterility in feral pigs has been investigated and found to carry an unacceptable risk to the domestic pig industry (Peacock 2003; DoE 2005). Use of a bait-delivered fertility agent is unlikely to be viable for wide-scale use due to the cost and difficulty of delivering the fertility agent in bait form, the need for re-dosing, and the likelihood that toxic baits may provide cheaper, more effective and more rapid population reduction (Bomford 1990; Choquenot *et al.* 1996). Use of live organisms such as diseases or parasites as vectors presents unacceptable risk of spread to the domestic pig industry and is likely to restrict access to the export pig market (Choquenot *et al.* 1996; Cowled and O'Connor 2004).

### 5.11 Integrated pig management options in the South West of WA

Integrated management using a range of control techniques is likely to be most effective in reducing the impacts caused by feral pigs, given their wide distribution and their ability to learn to evade capture or removal when one technique is used exclusively. Techniques likely to be most effective for feral pig control in the south west of WA include:

- Baiting programs that use the most humane, target specific and effective bait product available and actively plan to minimise non-target impacts through bait station design and bait deployment tactics. Pre feeding in conjunction with use of remote sensing cameras provides an opportunity to confirm that feral pigs are visiting bait sites, to assess dominance interactions between pigs, to assess non-target interaction with pig baits and to modify bait delivery accordingly. Baiting is most likely to be effective in conjunction with other 'mop up' control techniques such as trapping, shooting and dogging.
- Trapping in conjunction with other control techniques such as shooting, dogging and baiting.
- Ground shooting used in conjunction with other control options such as trapping and baiting, or to mop up remnant pigs that are averse to other control approaches. If undertaken effectively, ground shooting can be highly selective, provide added flexibility for nocturnal or less accessible targets and remove trap wary animals. Opportunities exist for cooperative approaches with recreational hunting groups where their activities are conservation focused and can be integrated into a coordinated control program that maximises their effectiveness, minimises public risk from use of firearms and minimises impacts on non-target species.
- Use of dogs to locate feral pigs where this is undertaken in conjunction with other control techniques in an integrated management program that targets activities where they are likely to be most effective and addresses skill requirements and animal welfare concerns.
- Fencing for exclusion of feral pigs or to inhibit their movements into high value ecologically and economically sensitive areas, where follow up maintenance and control of pigs in surrounding areas is undertaken.
- Use of Judas Pigs to locate core refuge areas or discontinuous groups of pigs as part of an integrated control program.
- Habitat modification in agricultural lands to prevent access to important sources of food and water.

Effective control will require a coordinated and cooperative approach between stakeholders across all tenures upon which the feral pigs occur, and control efforts will benefit from improved public awareness of the risks and impacts associated with feral pigs in this area. In addition the success of long-term reduction in impacts and damage from feral pigs will be dependent on sustained control, follow up monitoring and integrated control efforts.



## 6. Threats to effective feral pig management

Table 3 identifies key strengths, weaknesses, threats and opportunities, which apply to feral pig control now and in the foreseeable future. The threats are then discussed in more detail in Sections 6.1-6.7 and some potential solutions presented in Section 6.8.

Table 3: SWOT analysis for feral pig control in the south west of WA

<b>Strengths</b>  Availability of a National Threat Abatement Plan for feral pigs which provides overarching direction.  Dedicated, motivated, skilled and experienced operators.  A willingness to operate across all tenures.  Coordination of activities and information sharing between groups.  Significant knowledge of the impacts that arise from feral pigs.  Proactive research into controls, baits and impacts (target and non-target).	<b>Weaknesses</b>  Lack of strategic direction for local control efforts.  An inability to consistently measure outcomes or demonstrate management effectiveness.  Multiple data management systems and approaches to monitoring.  Lack of skills, experience and resources in some parts of the region.  Missed opportunities for capacity building through external partnerships and funding opportunities.
<b>Threats</b>  Funding constraints and budget cuts impacting on delivery of sustained pig control activities.  Capacity issues as skilled and experienced operators move on.  Animal Welfare.  Non-target impacts.  Illegal hunting.  Pig behaviour.  Community attitudes.	<b>Opportunities</b>  An integrated and coordinated approach to feral pig control.  A more adaptive approach to feral pig control that is linked to field outcomes, research and innovations.  Potential to expand capacity through partnerships.  A more focused and strategic approach to seeking and administering funding opportunities.  More informed community and growing awareness of environmental issues associated with feral pigs.  Involvement of indigenous communities.

## 6.1 Capacity and resources

Effective feral pig control outcomes are dependent on a secure, long term funding base and support from operational groups (Twigg *et al.* 2006). Where this is not available, care needs to be taken that cumulative outcomes are not lost through operational reductions arising from reduced budget capacity. Strategies to prevent this may include clear approaches to investment prioritisation; strong collaborations and partnerships; and proactive engagement with funding bodies and sponsors.

The use of tools such as the Investment Framework for Environmental Resources (INFFER; Pannell *et al.* 2012) can provide the ability to compare the feasibility and cost-effectiveness of competing projects and targets in a framework that can be adapted as knowledge improves or parameters change.

Key considerations during prioritisation processes include:

- Legislated responsibilities and statutory obligations;
- Key assets under threat (e.g. threatened species, sensitive ecosystems, high value stock or crops);
- The severity of damage;
- Important social values being impacted (e.g. visitor safety and enjoyment);
- Community concerns;
- Availability of partnerships and collaborative opportunities to increase capacity and effectiveness cross tenure;
- The likely impact of works on asset value (proportion of the asset's value protected or improved as a result of control);
- Technical feasibility (e.g. ability to maintain pig damage below the levels needed to protect or recover values);
- Influence of socio-political factors on control efforts (e.g. opposition from animal welfare groups, capacity);
- The time lag on benefits and recognition of the period of commitment required;
- Likely longevity of funding;
- Potential sources of funding for both immediate action and for future sustained control; and
- Availability of appropriate management techniques.



## 6.2 Skills and training

Development and maintenance of skills, access to training, ongoing mentoring and the attitudes of operational personnel present an ongoing challenge for pig control groups in the south west of WA. A diverse range of skills are needed for field operators to effectively deliver feral pig control outcomes and these include expertise in a range of control techniques, bush navigation and reconnaissance skills, safe and effective use of firearms as well as an increasing need for skills relevant to monitoring, use of GPS equipment, data collection, data management and communication.

Within WA, TAFE based training programs are available to provide key knowledge and skills as a foundation for development in these areas. The Southern Feral Pig Advisory Group (SFPAG) specify that field operators employed must be accredited through completion of Certificate III Rural Operations Feral Pig Training Course offered by TAFE WA and that apprentice field operators need to undertake the Certificate II Conservation and Land Management Course offered by TAFE WA (SFPAG 2010; Appendix 4). Both of these courses were updated in 2011 and the Certificate III Rural Operations was replaced with Certificate III in Vertebrate Pest Management.

In order to complete a Certificate III in Vertebrate Pest Management, participants are required to complete twelve units made up of three core units and nine elective units.

Core units available include:

- AHCOHS301A Contribute to OHS processes
- AHCCHM303A Prepare and apply chemicals
- AHCWRK313A Implement and monitor environmentally sustainable work practices

Elective units include:

- AHCCHM301A Conduct fumigation in enclosed spaces
- AHCCHM304A Transport, handle and store chemicals
- AHCCHM305A Conduct manual fumigation of vertebrate and invertebrate pests
- AHCVPT201A Clear features that harbour pest animals
- AHCVPT202A Muster pest animals
- AHCVPT203A Use firearms to humanely destroy animals
- AHCVPT302A Implement vertebrate pest control program
- AHCVPT303A Survey pest animals
- AHCVPT304A Conduct vertebrate pest activities from aircraft
- AHCVPT305A Tag and locate Judas animals
- AHCVPT306A Apply animal trapping techniques
- AHCEXP301A Handle and store explosives
- AHCEXP302A Identify and select explosive products
- AHCEXP303A Prepare and use explosives
- AHCMOM304A Operate machinery and equipment
- AHCMOM315A Operate chemical application machinery and equipment
- FPICOT2234B Operate 4x4 vehicle
- AHCWRK303A Respond to emergencies
- AHCWRK305A Coordinate work site activities
- AHCWRK310A Provide on-job training support
- CPPSIS4005A Collect basic GPS data
- FPICOT3202B Navigate in remote or trackless areas

In order to complete a certificate II in Conservation and land Management, 15 units must be completed, only four of which are directly relevant to vertebrate pest management. While this kind of training is likely to provide a solid foundation for development of expertise in feral pig control,

many operatives do not have the time nor inclination to attend this intensity of training particularly given a large proportion of the competencies are aimed at planning processes, which are less relevant for many field operators. Many important areas are not covered by the training package, such as use of poison baits; interpreting field sign; and the collection, management and evaluation of field data. In addition to the formal training requirements, field operators are also expected to complete a PARKS AND WILDLIFE firearms safety course where using firearms on Parks and Wildlife managed estate, and are required to obtain a Police Clearance and Senior First Aid certification.

There is scope to tailor the vertebrate pest management certificate training more toward pig control in south west WA and this is likely to substantially streamline the training process (A. Pound *pers.com*. 2015). In addition, experience has identified the use of remote service providers as a significant challenge to the completion of effective training packages. The use of local providers or independent Registered Training Organisations (RTO'S) who have the capacity to deliver these training packages may help to overcome some of these challenges (A. Pound *pers.com*. 2015).

In addition, the current cost of training a field operator is around \$2500 per head (A. Pound *pers.com*. March 2015) and current field practice is to employ trainees initially under the supervision of a qualified operator. The experienced operator can then provide third party evidence to the RTO to assist in the assessment of their competency when they come to complete their Cert III in Vertebrate pest management (A. Pound *pers.com*. 2015). Succession planning in the groups should be encouraged, with experienced trappers taking on trainees such that a long-term development cycle is initiated and ongoing capacity is possible.

Field exposure, mentoring and networking play a valuable role in the further development of skills and experience essential for feral pig control programs. This is currently achieved through informal inner or inter-community group arrangements, pre-season field operator workshops, organised field training days and formal topic specific training sessions, e.g. 1080 baiting. Formalisation of such mentoring and networking links could easily be achieved through the encouragement of groups to become members of the SFPAG. These arrangements also provide an opportunity for groups to share information, build cross-regional relationships with other more experienced field operators and to discuss joint innovations and training opportunities. In addition to operational mentoring, groups would also benefit from having a government or NRM representative to provide advice and guidance in the areas of governance, sourcing and applying for grants and funding and managing and reporting on funding (A. Pound *pers.com*. 2015).

### 6.3 Animal Welfare

Public opposition to some feral pig control operations is based on a belief that the animal welfare costs of the control operations are often unjustified (Wirth 1995). Feral pig management programs should ensure that techniques selected are target specific and humane, and that control efforts are likely to result in long-term reduction in environmental or agricultural damage from feral pigs. This helps to demonstrate that the benefits of preventing damage caused by feral pigs outweigh the ethical costs of control.

The need to consider the welfare of animals is widely recognised. Within WA, pest controllers are required to adhere to the *Animal Welfare Act 2002* and associated regulations (*Animal Welfare General Regulations 2003*). In addition there is a national code which has been adapted for use in WA 'Feral Animals - Code of practice for the capture and marketing of feral animals in WA' (DLGRD 2003). This code states that the following activities are unacceptable on animal welfare grounds:

- Poisoning using unregistered poisons which cause severe and prolonged pain;
- Denial of water without provision of alternate sources as a means of killing animals;
- Wounding of animals so that they will die some distance from the shooting area;
- Trapping without prompt destruction or removal of animals;
- The use of dogs to attack and bring down feral pigs.

The code also states that control methods which in themselves are acceptable, such as shooting become unacceptable if they are not carried out properly. For example:

- The shooter lacks expertise;
- The calibre or type of weapon is inadequate;
- The nature of the terrain predisposes to many wounding shots;
- Humane and prompt despatch of wounded animals is not possible.

The code is adopted at a state level as a defence against alleged breaches of general animal welfare offences under the state legislation (DLGRD 2003) and is supported by the livestock industries and the DAFWA. Penalties under the *Animal Welfare Act 2002* range between \$2 000 and \$50 000, with some penalties also including imprisonment for up to 5 years (Appendix 1).

### 6.4 Non-target impacts

Secondary poisoning risks (carcass and vomit) as well as direct impacts of control efforts on non-target species are significant considerations in any feral pig management program and may present challenges for effective outcomes. For example, targeting baiting and trapping programs for pigs in dry conditions where natural food availability is lowest is expected to maximise bait uptake and capture rates of feral pigs but may also increase the likelihood of non-target impacts as native species are also food limited at these times (Adams 2014). In addition, bait uptake by ravens, quokkas, brush tail possums and brush tail wallabies has been observed to increase with the time that baits are present in the environment and habituation to baiting programs occurs between seasons for these species (Adams 2014). This has potential implications for pre feeding activities and the subsequent effectiveness of recurring pig trapping and baiting programs in areas where these species are present.

The choice of control technique for feral pigs needs to actively minimise impacts on non-target species. The most effective way of achieving this is through understanding the non-target species present onsite that are likely to be at risk from control activities. Once again, the use of remote sensing cameras provides an opportunity to assess not only the activity of feral pigs in the area in relation to selected control techniques, but also to assess the non-target risks and modify activities prior to lethal action being taken.

## 6.5 Pig behaviour

An understanding of feral pig ecology and behaviour is essential to effective control (see Section 3). Behavioural aspects such as the dominance of one or two individuals in a group and the social hierarchy of the group influencing bait and trap interactions, movements and learning behaviour needs to be considered during planning of pig control activities. For example, dominant individuals are likely to have primary access to bait and pre feed and this could reduce the effective number of pigs targeted by control efforts unless baits are deployed over a wide enough area at each control site that the feeding behaviour of the dominant individuals does not preclude subdominant individuals from accessing the feed (Adams 2014).

In many cases it has been suggested that the solution to this problem is to remove the dominant pigs first. However, death of the dominant pig(s) in the group often results in the remaining pigs becoming disassociated with their normal movements and behaviour. In some cases poisoning, trapping or shooting the dominant pig(s) in a group may constitute a negative experience that results in the remaining pigs learning to avoid the control measure (Adams 2014). It seems that control techniques that target social groups of pigs as an entity are likely to be most effective. In addition, the use of a range of control techniques in an integrated approach is most likely to overcome pig cognisance in an area where control has been occurring over a long period. The control program needs to be adaptable to changing pig behaviour and movement patterns.

## 6.6 Non-approved recreational hunting

Illegal hunting is persistent throughout the area covered by this plan and brings with it risks of theft, destruction of baits, destruction of or tampering with traps and monitoring equipment and the subsequent requirement for bait stations, traps and monitoring sites to be kept as inconspicuous as possible. Introduction of hunting also brings with it the inherent risk of injury or death to hunters, dogs that are used for hunting as well as to other recreational users. There are more than seven million visitors to state forest and national park areas in WA each year for outdoor pursuits that do not involve hunting (CC 2014). Combining conflicting activities on public land is not supported by political groups such as Outdoors Australia due to the increased risk of tragedy (e.g. Leask 2010).

In addition to the direct effects of illegal hunters, feral pigs have been reported to become more nocturnal and wide ranging under hunting pressure (Calenge *et al.* 2002) or to retreat to core refuge areas (Calenge *et al.* 2002; Sodeikat and Pohlmeier 2003). This has implications for the effectiveness of other control efforts that may be operating in the area. Spencer and Hampton (2005) have also demonstrated that recreational hunters are likely to be responsible for the movement and release of pigs to facilitate continued hunting opportunities. Illegal movement of pigs adds to the natural expansion of the species and further complicates local pig control efforts (Saunders and McLeod 1999, Hone 2002).

There are however multiple examples of successful partnerships with legitimate recreational hunting groups, where the groups are incorporated, have strict codes governing their activities and work closely with community control groups and government agencies to target their activities in a manner that complements broader pig control efforts. For example, the Albany Branch of the Sporting Shooters Association Hunting and Conservation Program operates across much of the Walpole Wilderness in close association with Parks and Wildlife and the Lake Muir Denbarker Community Feral Pig Eradication Group. The Sporting Shooters Association provides insurance for all its members and all members operate under strict standard operating procedures as well as abiding by working arrangements established by Parks and Wildlife for work on conservation estate (Appendix 6). The group maintains close communication with the feral pig control groups operating in this area and performs a mop-up and reconnaissance role, working in areas where their activities won't disturb active trapping or baiting programs and will achieve maximum benefit. The presence of members of this group in the field on weekend expeditions often results in reports of illegal hunting activity observed during their work as well as valuable feedback regarding feral pig activity and damage.

Options available for managing the threats from illegal recreational hunting include:

- Prosecution of hunters caught transporting and releasing pigs; found to be in possession of firearms and dogs on government lands; or found to be using dogs to attack and hold feral pigs (e.g. those with body armour) or other unacceptable practices identified under the *Animal Welfare Act 2002* and associated codes of practice. Offences under the *Animal Welfare Act 2002* carry penalties of up to \$50 000 and 5 years imprisonment.
- On farm inspections by DAFWA Officers for illegally kept pigs.
- Behavioural change through education and increased public awareness of feral pig impacts, the detrimental role of rogue amateur hunters and the need for this behaviour to be reduced. Encouragement of community involvement in policing this activity may result in higher report rates for illegal activities and give the activity a negative stigma rather than the hero status it currently garners in some areas.
- Behavioural change through increased remote surveillance in affected areas and publication of offences in the local media, particularly where this has occurred within dieback risk areas where ecological values are significantly compromised by illegal vehicle access.
- Collaborative arrangements between agencies and Police to encourage effective management of the illegal hunting and distribution of feral pigs

### *Case studies for behavioural change*

Due to decreasing budgets and the associated reduction in field based law enforcement, the use of behavioural change models is an attractive option, particularly where members of the community can help to facilitate implementation of such a model. There are documented cases in other parts of the world where the behaviour of illegal hunters has been influenced by community pressure, increased presence of legitimate land users or increased remote surveillance. For example some people living around the greater Kruger area in South Africa no longer kill lions even when they suffer economic losses, because of cultural intolerance to hunting activities in this area (Lagendijk and Gusset 2008).

In the United States proactive liaison with the official hunting body resulted in support from this group, strengthening of legislation and in-house policing of activities to ensure pigs were not released by recreational hunters (Adams *pers.com.* 2014). While there is no governing body for hunting in WA, this approach still has potential application through conservation hunting groups that have formal arrangements with government agencies and community groups to assist with pig control efforts in south west WA. The activity of illegal hunters potentially affects the legitimate access of these groups to areas for conservation control activities. The main issue with this approach is the stigma associated with reporting illegal activities where individuals are known to each other. However, if broader community attitudes are opposed to illegal hunting, some of this stigma may be reduced and illegal hunters may be encouraged to join legitimate groups to pursue their sport in an ethical and conservation-minded manner.

Closer to home, observations in the Walpole Wilderness suggest that wide use of remote cameras to monitor feral pig activity and illegal hunting has reduced the incidence of illegal activity within these areas. The main issue with this approach is the risk to surveillance equipment that is not concealed adequately and the emerging trends of vehicle registration removal. Joint patrol efforts with WA Police currently overcome some of these issues. There is significant opportunity for behavioural change associated with illegal pig hunting if community attitudes can be swayed to oppose this activity and support legitimate approaches to feral pig control.

### 6.7 Community Attitudes

The attitude of the community to feral pigs can vary with location, time and observer perception, which could lead to conflict in developing and implementing control programs (Choquenot *et al.* 1996).

Inaccurate or a poor understanding of issues surrounding feral pigs and their control can lead to:

- Unrealistic and inappropriate expectations regarding control efforts;
- Misconceptions about feral pig damage and risks; and
- Poorly directed support and pressures, which can detract from effective management.

For example, the general acceptance of illegal feral pig hunting by many communities in the south west of WA is due to a misconception that this is contributing to effective pig control and is a legitimate recreational pursuit. Another example is the general lack of awareness of coordinated and cooperative pig control programs occurring in this region, which affects the level of support for these programs and community pressure for ongoing funding of on ground works.

There is a need to build community awareness and support for coordinated feral pig control programs through targeted communication packages. Special attention needs to be given to the key communication messages such as the impact of feral pigs, management actions, issues with illegal hunting and measures for effective behavioural change. Community pig control groups, natural resource management groups, industry groups and associations, animal welfare societies, hunting groups and conservation associations can play an important role in the dissemination of key messages (see Section 9.4).

## 6.8 Reducing impediments to effective feral pig control in South West WA

Sections 6.1 to 6.7 have outlined a range of existing threats to the implementation of an effective feral pig control program in south west WA. Table 4 presents potential solutions that could be applied to overcome these threats.

Table 4: A brief summary of solutions identified to overcome threats to effective pig control programs in south west WA.

Threat	Potential Solutions
Capacity and Resources	Clear approaches to investment prioritisation; Strong collaborations and partnerships; and Proactive engagement with funding bodies and sponsors.
Skills and Training	Identify skills needed to support feral pig control efforts; actively address skill and experience shortfalls through training, mentoring and long term capacity building; Use multiple approaches for delivery of training and information packages such as internet, field days, workshops, conferences , formal and informal training.
Animal Welfare	Consider animal welfare issues as an integral part of feral pig control planning; ensure all activities comply with the 'Feral Animals - Code of practice for the capture and marketing of feral animals in WA' and the <i>Animal Welfare Act 2002</i> .
Non-target Impacts	Ensure that techniques selected for feral pig control are as target-specific as possible and actively build in approached for minimising impacts on non-target species. Understand the non-target species present onsite that are likely to be at risk from control activities through remote surveillance or monitoring.
Recreational Hunting	Behavioural change through education and increased public awareness of feral pig impacts, the detrimental role of rogue amateur hunters and the need for this behaviour to be reduced; increased remote surveillance in problem areas; involvement of legitimate conservation shooter groups in reporting illegal activity; media promotion of initiatives targeting illegal hunting activities.
Pig Behaviour	Develop an understanding of local pig ecology, behaviour and population dynamics; ensure control approaches are adaptive to changing pig behaviour, group structure and levels of cognisance
Community Attitudes	There is a need to build community awareness and support for coordinated feral pig control programs; develop appropriately packaged and targeted information; build partnerships to increase capacity for communication; refine key messages such as the impact of feral pigs, management actions, issues with illegal hunting and measures for effective behavioural change.

## 7. Measuring success

Monitoring, evaluation, reporting and improvement (MERI) frameworks are essential for the demonstration of management effectiveness, justification of financial investment and provision of support for decision making processes. Monitoring and evaluation provide the basis for assessing whether goals, objectives and strategies specified for the program are being achieved; reporting processes allow communication of successes and areas requiring improvement; and an improvement component allows the program to adapt to changing knowledge, field and political conditions to remain relevant and effective. Since implementation of a MERI plan requires significant commitment of resources, it is important that the plan is practical and can be resourced sustainably. The monitoring design for feral pig control needs to be clearly linked to program objectives, performance indicators and measures and must contribute to evaluation of the program's progress against each of the target objectives.

### 7.1 MERI Frameworks Available

There are a number of approaches currently being used for measuring the effectiveness of feral pig control efforts. These will be presented here with a brief discussion of their relative merits.

#### 7.1.1 Measuring damage

One approach to feral pig management is to measure patterns and trends in feral pig damage over time (Choquenot *et al.* 1996). The information collected can provide a spatial and temporal assessment of damage levels at a property, local or regional scale and can help to target control efforts more strategically and assess the effectiveness of control activities. Evaluation of damage patterns can also help to identify correlations between particular areas, habitat types and pig activity.

Examples of damage measures include:

- Area of digging and wallows in sensitive habitat (Stewart *et al.* 2011);
- Frequency of digging and wallowing (Hone 2002);
- Predation levels on lambs, where this is a direct result of pigs (Choquenot *et al.* 1996); and
- Differences in yield between cropping paddocks over time (Wilson *et al.* 1992).

Masters (1979) completed damage measurements using a system of transects throughout the forest where he recorded pig disturbance within 1m of transects and mapped the areas of damage, giving them a rating of <20 m total disturbance (along transect), 2-20 m and <2 m. A similar approach is applied in the south west.

Parks and Wildlife personnel survey sensitive habitats such as peat wetlands, riparian systems and granite outcrops prior to summer and following summer to enable comparison of damage levels from feral pigs and assessment of the effectiveness of control efforts surrounding these areas (Stewart *et al.* 2011). The surveys are area specific and each time the area is visited the following information is recorded (see Appendix 7 for full details):

- Any new pig activity or damage that is observed. This is mapped with a GPS to allow spatial evaluation of the data in mapping programs such as Arc GIS;
- The amount of activity is subjectively estimated by a trained operator and categorised as high (activity over long period), medium (more than one pig) or low (set of prints from one pig). Remote cameras also assist with this assessment;
- The activity type is recorded – scats, tracks, diggings, wallows, actual sightings or a combination of these;
- An experienced operator records the freshness of activity as: fresh (within two days); within the last two weeks; older than two weeks but within current season; older than current



season. This allows temporal comparison of damage patterns without the confounding effects of slow recovery of vegetation following pig damage and differing levels of survey effort between seasons; and

- The size of the area affected is estimated in square metres.

This is a simple approach that allows rapid survey, spatial evaluation of trends and is able to assess the effectiveness of control in relation to damage levels. Field operators in community groups supported by SWCC and WCC are also applying a similar approach to collection of damage data in areas where community groups are undertaking feral pig control (Appendix 8, 9). The main difference between the two approaches is that the Parks and Wildlife approach has been designed with evaluation in mind and has been refined over a number of seasons such that data being input is as standardised as possible to enable rapid analysis, mapping and operational use of the data. Use of codes and pre-determined field entries at all stages in the data collection process ensures that variation in the interpretation of these fields by different operatives is minimised (Appendix 7).

However, there have been instances where the use of codes makes the recording sheets appear too difficult to complete and results in an unwillingness to use them from field operators (A. Pound *pers.com.* 2015). WCC provides field operators with digital cameras containing inbuilt GPS and requiring the operator to take a number of location photographs during their work, with accompanying field notes that link activity and damage observations to the photographs (Appendix 9). WCC officers then interpret this information and use it for mapping or analysis. This is a simple approach that is likely to be effective where administrative support is readily available and where basic data are required.

While these are simple approaches, the collection of information in the field, the use of technical equipment such as GPS and the management of the GPS data in the office are all aspects that require training and mentoring to build adequate skills, understanding and due diligence. In many cases experienced pig field operators don't have these skills and can't see the point of the data collection. Being able to see the application of the data being collected often helps to instill an understanding of the importance of adequately recording field observations. This level of information is used by groups in the south west to prioritise feral pig control activities, to identify hot spots that pigs routinely return to, and to assess the effectiveness of control efforts in reducing damage.

Current approaches also capture relative abundance indices other than damage such as scat, tracks, capture and despatch rates and sightings, which are discussed in Section 7.1.2. These activity indices help to provide context for damage observations. In many cases the relationship between the number of pigs in an area and the damage being caused is not linear. For example, a single resident pig can have a higher impact on selected values than a group of transient pigs; or a small group of pigs may revisit the same area and continue to cause damage even after several pigs have been removed from the group. It is subsequently important not to use damage measures as *pseudo* abundance estimates when planning for feral pig control programs.

In addition, the persistence of destructive impacts from feral pigs such as diggings and wallows can complicate damage measures over time, given that in many cases areas take a significant length of time to recover from the initial disturbance. It is important that estimates of relative freshness of damage are included in damage measures to allow temporal comparisons. A disadvantage of using damage measures is that these need to be area specific to generate meaningful temporal trends and the approach to measuring damage needs to be consistent. This reduces the opportunity for widespread opportunistic collection of information relating to pig damage, such as that available with broad community involvement. However, opportunistic collection of pig activity data such as observations of tracks, scats, wallows, diggings and rubs as well as actual sightings can offer significant insights into where pigs are present and active and can contribute to distribution maps and more focused surveys and controls to prevent or reduce damage.

### 7.1.2 Activity or relative abundance indices

Most monitoring of feral animal control in Australia relies on indices of abundance (Taylor 2003; Mapston 2004). Indices of abundance provide estimates of relative abundance rather than absolute abundance, and are popular because they are inexpensive to obtain and computationally simpler than most methods for estimating absolute abundance. Relative abundance and activity indices can be effective measures, provided that variation in detection probability is minimised (e.g. by encouraging standardised monitoring protocols, measuring covariates, undertaking systematic or stratified sampling) or detection probability is estimated and incorporated into estimates of abundance (MacKenzie and Kendall 2002). This approach to monitoring lends itself well to opportunistic and community based approaches to data collection. However, the use of relative abundances does not equate well to associated damage from feral pigs because the relationship between population size, activity levels and damage is rarely linear (Caughley 1977; Gibbs 2000).

The majority of feral pig monitoring occurring in the south west of WA, utilises indices of activity and relative abundance including: monitoring of bait or pre feed uptake using sand plots and camera traps; recording of sightings captures and despatches by field operators; and recording of pig activity indicators such as tracks, scats, diggings, wallows and rubs.

Feral pig tracks are identifiable by their blunt or rounded appearance at the tip of the toes and are not easily confused with other tracks unless domestic pigs are present (Stevens 1996). Diggings at and below the soil surface are frequently observed when feral pigs are present, as they use their snouts to search for and use food resources, sometimes digging to depths of over a metre (Dickson *et al.* 2001; Mapston 2004; Conover 2007). Diggings and wallows are identifiable in the field as dug out depressions in or adjacent to swamps and damp soils. Rubs are also often found in association with wallows in the warm months and are characterized by wet or dry mud-coated surfaces (Stevens 1996).

Free feeding carried out before trapping or poisoning also provides a useful technique for monitoring changes in pig activity. If the quantity of bait being consumed before and after poisoning or trapping is recorded, some idea of the effectiveness of the program can be obtained. Conducting periodic free-feeding programs over three or four days throughout the year can also provide an opportunity to identify when pig activity increases prior to the occurrence of significant damage and can also provide some insights into non-target species at risk from control activities. The seasonal availability of alternative food resources affects the tendency of feral pigs to consume free feed (McIlroy *et al.* 1993; Saunders *et al.* 1993), and the location of free feed sites is likely to influence the relationship between consumption of feed and feral pig activity/ abundance (Saunders *et al.* 1993). Indexes derived from free feed consumption should be considered as site-specific and should not be used to compare relative pig activity levels between sites.

Examples of activity measures include:

- Sighting rate from spotlighting, given as the number of sightings per km;
- Capture and despatch rates per trap, area or region;
- Trap success in relation to the number of trap nights i.e. catch per unit of trapping effort;
- Frequency of presence indicators such as tracks, scats, wallows and diggings, usually given as an index specific to an area e.g. 5 scats/ ha surveyed or 5 diggings per linear km if working on transects;
- Scat accumulation rates in plots that are routinely cleared (Hone and Martin 1998);
- Kill rates during shooting from helicopters (Choquenot *et al.* 1993); and
- The proportion of free feed or bait consumed each night (Saunders 1988).

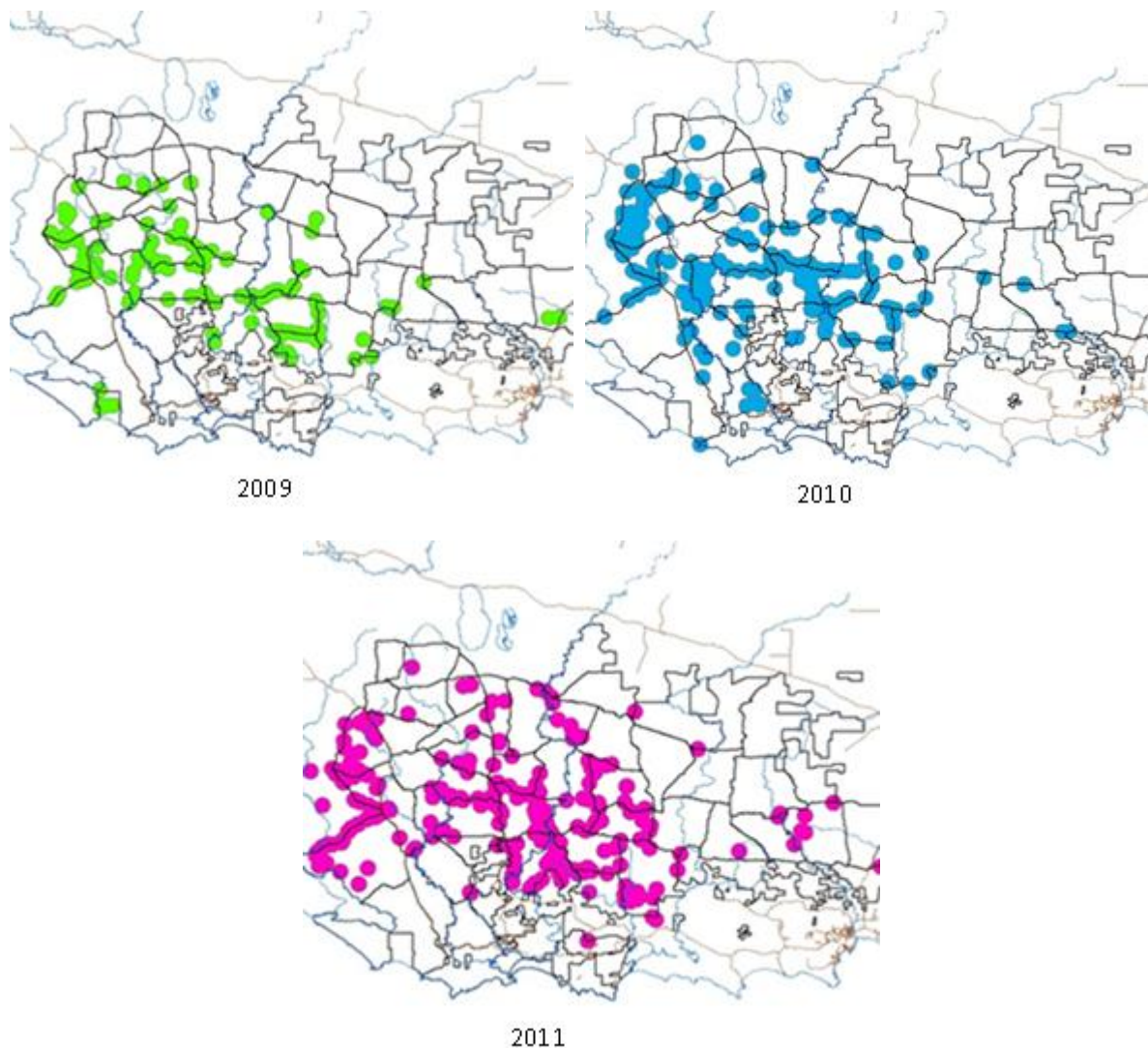


Figure 11: Feral pig activity indices can help to build an understanding of pig distribution, activity hot spots and where control efforts need to be focused in relation to assets at risk. Maps of buffered pig activity between 2009 and 2011 provided by Parks and Wildlife Frankland District show a pattern in pig activity. Survey effort needs to be factored into interpretation of data.

Simple assessments of the spatial extent and/or frequency of pig sign observed can be used to provide an index of pig abundance (Pavlov *et al.* 1992) and can also help to build an understanding of pig distribution, activity hot spots and where control efforts have been focused (Figure 11). However, there are numerous factors associated with use of activity indicators that can confound their use as a monitoring technique. For example, seasonal conditions and seasonal habitat use will influence pig activity and interactions with free-feed and changes in these indices do not necessarily equate to actual changes in activity levels or relative abundances. These natural variations need to be taken into account when evaluating observations as not all changes in activity will be attributable to control efforts (Choquenot and Lukins 1996; Mitchell and Baloch 2007). In addition, pig activity levels are often used as an indication of associated damage. This type of monitoring assumes that there is a linear relationship between population size, activity levels and damage, which is very rarely the case (e.g. Caughley 1977; Gibbs 2000).

### 7.1.3 Abundance and density estimates

Absolute abundance is the number of animals estimated to be present, and is often expressed as a density (i.e. the number of animals per unit area). Absolute abundance is usually estimated using either mark-recapture or removal sampling estimators (e.g. Parmenter 2003; Efford 2004) and more recently, the use of activity indices have been coupled with sophisticated models that can actively account for changing detection probabilities (e.g. Anderson 2001; Buckland *et al.* 2001; Bailey *et al.* 2007) to produce more accurate estimates. These methods don't perform well when the abundance of animals is low (as may occur following a control operation), or when the detection probability of a species is low. The associated sampling is usually expensive, time consuming and impractical for field application and in many cases, absolute abundance estimates are unlikely to be necessary for decision making processes associated with the management of feral pigs.

Examples of abundance/ density measures include:

- Number of animals;
- Number of animals within a defined area; and
- Number of animals per unit of area.

This approach requires a substantial investment of time and resources, a high level of field and analysis expertise, and is often impractical for monitoring over large geographical areas.

### 7.1.4 Occupancy modelling

An alternative measure when abundance cannot be estimated is occupancy ( $\Psi$ ), or the proportion of area occupied by a species (MacKenzie *et al.* 2002). By incorporating imperfect detection rates into an occupancy modelling framework, it is possible to estimate the probability that a species was present but not detected in a survey area and to subsequently differentiate between true and false absence. Furthermore, occupancy can be estimated as a function of site covariates, which can improve model performance and provide insight into factors that influence species occurrence (MacKenzie *et al.* 2002; Bailey *et al.* 2007).

Occupancy modelling can take randomly collected activity or relative abundance data and as long as it has been collected using standardised monitoring protocols, generate an occupancy rate that builds in imperfect detection probability. Occupancy modelling accounts for variation in detection probability each year or season, therefore occupancy rates can be compared temporally and spatially.

However, the following model assumptions must be met:

- No immigration or emigration occurs during the sampling period;
- Feral pigs are never falsely detected at a point when they are absent;
- Detection of feral pigs at one point is independent of detecting them at other points (e.g. by detecting them at the first point you are not scaring them to the next point); and
- Detection parameters within the vegetation and substrate groupings are constant across points at any given time.

This is a simple and rapid approach to data collection and evaluation which readily lends itself to community participation in collection of information and is statistically robust enough to allow meaningful detection of trends and patterns both temporally and spatially. The approach does rely on a relatively large sample size for occupancy rate estimation, which can be limiting if participation is minimal. In addition, generation of occupancy models requires statistical expertise, which is not always available within community based control programs. Occupancy rates provide information about the changing area occupied by feral pigs, and so will not contribute to effective program evaluation if the objectives of the program revolve around damage reduction.

## 7.2 Management and accessibility of data

There are several information management systems being used within the south west of WA for storing feral pig sighting and control data, with each group involved in pig control managing their data. Table 5 outlines some of the data management systems presently being used in WA and the following sections outline the database functionality, design and management.

Table 5: Feral pig data management systems

Data management system	Opportunities	Limitations/constraints
<b>Feral Pig Scan</b> (Invasive Animal CRC) On-line GIS mapping and data storage that allows the mapping of feral pig sightings and the problems they are causing. Sightings are recorded and maps can be produced	<ul style="list-style-type: none"> <li>Generates maps for planning and prioritisation.</li> <li>Data readily exported into other formats.</li> <li>Has a mobile phone application/interface.</li> <li>Community assistance with data collection.</li> <li>Information dissemination.</li> <li>Media releases.</li> </ul>	<ul style="list-style-type: none"> <li>Restricted data fields.</li> <li>Not responsive to changing needs.</li> <li>National register, limited localised applications.</li> <li>Mobile application requires mobile network coverage.</li> </ul>
<b>SW GRID System</b> On-line GIS mapping and data storage facility developed to record, view, manipulate and store project information.	<ul style="list-style-type: none"> <li>Database developed for WA.</li> <li>Community based.</li> <li>Measures of impact and distribution.</li> <li>Also stores photos and documents.</li> <li>Can be adapted to field requirements.</li> <li>Group based log-ins improve confidentiality of data</li> </ul>	<ul style="list-style-type: none"> <li>Mainly used by SWCC employees.</li> <li>Fine tuning of data from field required.</li> </ul>
<b>Parks and Wildlife GIS database</b> Planning and management on Parks and Wildlife managed land	<ul style="list-style-type: none"> <li>Detailed data collection.</li> <li>Standardised data fields and data collection processes.</li> <li>Readily adaptable to changing field requirements.</li> <li>Spatial applications.</li> <li>Allows for opportunistic as well as formal data collections.</li> <li>Data readily exported for analysis in non-GIS applications.</li> </ul>	<ul style="list-style-type: none"> <li>Not centralised within the agency and some Districts not using the system.</li> <li>Datasets stored in individual Districts.</li> <li>Not accessible to public.</li> </ul>
<b>DAFWA Vertebrate Pest Contact database</b> Planning and management on agricultural lands	<ul style="list-style-type: none"> <li>Private landholder reports.</li> <li>Spatial applications.</li> </ul>	<ul style="list-style-type: none"> <li>Not accessible to public.</li> <li>Confidentiality issues.</li> </ul>
<b>Squeal on pigs</b> Charles T. Barger Mobile phone Application for sightings of feral pigs in US	<ul style="list-style-type: none"> <li>Similar phone application could be used for WA</li> <li>Maps location and upload of photos of feral pigs</li> <li>Could provide useful community data and education</li> </ul>	<ul style="list-style-type: none"> <li>Requires iPhone operating system</li> <li>Requires mobile coverage.</li> <li>US Based</li> <li>Unknown cost of adapting for SW WA</li> </ul>

### *Feral Pig Scan*

Feral Pig Scan is a subsidiary website to “Feral Scan” which is a website developed by the Invasive Animals Cooperative Research Council (IACRC) to help map feral animal sightings across Australia. The nationally based program hosts sightings for rabbits, wild dogs, foxes, pigs, toads, mice, camels, goats, deers, starlings and fish. Feral Pig Scan allows the user to record and map sightings of feral pigs, damage and control areas. Users can extract data in an area for planning and management of feral pigs.

Information collected includes:

#### Sightings

- Date observed;
- Coordinates of observation;
- How many feral pigs observed;
- Sighting type; and
- Notes.

#### Damage

- Date observed;
- Coordinates of observation;
- What damage feral pigs have caused (17 fields to select from); and
- Notes.

#### Control (not publically available information, data input only)

- Start date/finish date;
- Coordinates of control action; and
- What control techniques were used (listed 10 fields to select from).

The information can be submitted by either a login or via email if not a registered user. The function of submitting via email makes the platform readily available to the general public for data upload without a cumbersome login/registration processes. Data input into the system is screened and authenticated centrally and much of the data is readily accessible to the public, which is the main reason it is not more widely adopted. The system now allows groups to set up password-secure data sets that are accessible only to members of the group with the relevant log-in details.

Data fields are standard and cannot be adapted to individual group requirements. This is of particular relevance since the data fields are simplistic and may not meet the MERI requirements of some feral pig control programs. The simple data fields do however lend themselves well to opportunistic and community assisted data collections. An Application for mobile phone and tablets is currently in the process of development to enable Feral Scan to be more widely used for this purpose and will be available by June 2015.

The website currently allows for access via mobile phone (I-Phone and Android), however many areas within the south west region are not covered by mobile phone coverage, so this application is limited by available coverage. The website also hosts a community networking email facility to assist with sharing feral pig data for planning, prioritisation, reporting and evaluation.

### *South West Geographical and Reporting Information Database*

The South West Geographic and Reporting Information Database (GRID) is an on-line Geographical Information System (GIS) mapping and data storage facility developed in partnership with GAIA Resources for SWCC staff and key partners to record, view, manipulate and store project information. A login and registration is required for the GRID system and is obtained from SWCC and logins are generally project-based such that groups can input into and view their own datasets, but have limited accessibility to data from other projects.

The GRID System collects the following information:

- Project name/activity;
- Survey area;
- Landholder details;
- Photographs and documents;
- Date and time of observations;
- GPS Coordinates of observation;
- How many feral pigs observed;
- Location of trapped pigs;
- Colour, age, size or trapped pigs;
- Damage descriptions.

The main limitation to this system is that it is reliant on continued funding from SWCC, which has an uncertain future in terms of funding and resourcing in the current political climate. Funding available for SWCC and the SW GRID database is unknown after June 2015.

A training manual is supplied for SW GRID users to assist with the complexity of utilising the data management system. This is of particular value for users with limited GIS skills and helps with data entry and map generation processes within the application. The data is readily exported as shape file data for GIS mapping in other GIS software programs such as QGIS or ArcMap. Data entry and validation is usually the responsibility of each group using the system, which can create issues with the overall quality of the data and the ability of individual groups to administer their data.

This system is versatile, readily adaptable to user needs (i.e. data fields can be modified as required), provides a spatial application that can be exported into other data formats, and adheres to data confidentiality expectations of the groups using the system. This data management system also allows storage of photographs and documents, which allows central management and communication of all project-relevant information. This is particularly useful for groups that are geographically separated.



### *Parks and Wildlife data collection*

There are currently two main approaches to feral animal data management within Parks and Wildlife. The first is an Access based data management system that stores sighting information centrally, with data entered at a District level and uploaded to the main system annually. The data stored within this system can be requested from the central custodian (Nature Conservation Branch) and extracted for analysis or import into a spatial data management system. While this data management system is widely used throughout the State, the poor accessibility of the data after it has been input and the restriction of data fields to sighting parameters have resulted in development of localised data management systems that have greater operational functionality.

Within south west WA, a GIS based data management system has evolved in Parks and Wildlife. It has been widely used in the Parks and Wildlife Warren region since 2009 and other Districts are now beginning to adopt the same approach. Data fields are standardised and have pre-determined responses to reduce individual interpretation of their intent. The data is input into attributes tables linked to geographically referenced points that can be viewed spatially. The system can deal with sightings, control data and damage data. Data can be readily viewed or exported into excel or other platforms for formal analysis. Input and validation of data is generally undertaken by a single person within each District.

Data fields include:

#### Sightings

- Date and time observed;
- GPS Coordinates of observation;
- Date observed;
- How many feral pigs observed;
- Their relative age (adult, piglet);
- Gender; and
- Colour.

#### Activity and damage

- Type of sighting (pig, wallow, digging, rub, scat, track)
- Activity level (categories provided with descriptions)
- Recency of activity (categories provided with descriptions)
- Damage level (categorised according to size or linear distance)

#### Captures

- Trap type
- Trap location
- Dates opened
- Pre-feed dates and types
- Date of captures
- Gender, age, colour and condition of captured pigs
- Observations of illegal activity

The data management systems administered by Parks and Wildlife have a high level of validation, are used actively for planning and evaluation and are adaptable and versatile. However the data are not available publically and the intent of the data management systems is the capture of data on Parks and Wildlife estate for the management of threats and protection of biodiversity values. Given this constraint, the custodianship of a central data management system that operates across tenures does not fit well within Parks and Wildlife, however there are many aspects of this system working well operationally that should be considered moving forwards.

### *Simple data collection “Squeal on pigs”*

“Squeal on pigs” is a United States based phone application which is an example of a quick and simple data collection tool. The application is quick to load/launch and information can be sent via email without a registration, which makes this a useful platform for wide community assisted data collection.

Data collected on feral pigs include:

- Photos;
- Location; and
- Notes.

This application is currently limited by the simple data fields, reliance on mobile phone coverage and the location of its base in the United States. However the concept is similar to what Feral Scan is attempting and has merit for local application if the data fields, confidentiality and accessibility issues can be addressed adequately.

### 7.3 Options for a central approach to data management

The publically available data management systems (SW GRID and Feral Scan) don’t currently have the functionality or administrative arrangements to meet the requirements of feral pig management programs in south west WA. They do however provide a solid basis for future development of a centralised platform that does meet these needs.

An effective central data management system for feral pig management in south west WA should:

- Address the monitoring, evaluation and reporting needs of the program;
- Work cross- tenure;
- Be managed by one entity and not funding reliant (i.e. government custodian);
- Operate with standardised data fields and data collection protocols;
- Be administered by trained operatives able to effectively input and validate data;
- Be operationally meaningful;
- Have versatile data entry opportunities e.g. phone applications, web input etc;
- Align with the confidentiality requirements;
- Allow for input of data from a diverse range of users e.g. agencies, community groups and public;
- Provide data in a visual format that does not compromise confidentiality (e.g. project-specific viewing of close up data and broad public views);
- Allow ready export of data in other formats (e.g. excel, shape file); and
- Is easily accessible and responsive to changing needs.

The SW GRID platform and the Feral Scan platforms somewhat meet these requirements, but neither completely meets them. SW GRID provides the best opportunities for refinement to meet the program’s needs, particularly in relation to adaptability of the data fields, standardisation of data collection requirements and versatility of data accessibility. Investigation into the development of mobile application and resolution of issues surrounding long-term custodianship of the data and maintenance of the system are needed for this to be operationally viable.

#### 7.4 Approaches to evaluation, reporting and improvement

As discussed in Section 7.1, the key to effective evaluation and reporting is in its ability to demonstrate the effectiveness of management activities and in particular progress against objectives and performance targets established for the program. Each group working on pig control in the south west of WA currently has its own set of objectives and subsequently individual approaches to evaluation and reporting (e.g. Higgs and Howe 2008). In many cases, key measures reported on are outputs such as number of pigs killed, number of kilometres or hectares surveyed, number of trap nights and captures etc. rather than program outcomes directly related to the objectives. Reporting takes both written and verbal formats, with Steering Committee and Community Control Group meetings the focus of verbal reports from each of the individual groups represented; and formal reports also completed by most of the groups receiving government funding (e.g. Higgs and Howe 2008; Burnside *et al.* 2012).

The standard of reporting varies but an example of a good reporting format is that completed annually by the Lake Muir Denbarker Community Feral Pig Eradication Group (e.g. Higgs and Howe 2008).

Higgs and Howe (2008) establish ten core objectives that guide the work of this group including:

- To minimise the effects that feral pigs have on:
  - The likelihood of spreading exotic diseases.
  - The quality of the natural environment.
  - The quality of water in catchment areas.
  - Private property adjoining forest areas.
- To share the cost and effort for feral pig control;
- To enable an immediate response to complaints from landholders who have pigs emanating from neighbouring land;
- To reduce illegal pig hunting and release of pigs into forest areas;
- To encourage a flexible trapping program that is not restricted to business hours or weekdays;
- To improve the community image of government agencies, plantation owners and farmers as responsible managers of feral animals on their lands;
- To augment current Parks and Wildlife trapping and poisoning programs;
- Collect relevant statistics on the distribution and number of feral pigs;
- Monitor the effectiveness of hunting with dogs as a means of feral pig control; and
- To advise and assist the establishment of similar working groups in other areas of the state.

These are quite broad objectives and the annual reports of this group report on both outputs of their program (pig kills) and directly address each objective in an attempt to assess progress against achieving these. In addition the report documents outcomes of new research or field trials and suggests modification of objectives according to new information or community inputs available. This is a good approach that actively assesses progress on an annual basis, assesses new information and its implications for the ongoing activities of the group and allows adaptation of objectives and control approaches accordingly.

The approach to evaluation and reporting could be improved with more measurable objectives and performance targets that provide stronger direction for field efforts and help to refine monitoring protocols. In addition, the approach to MERI needs to be standardised across all groups involved in feral pig control in the south west catchment, if overall evaluation of program effectiveness against a common set of objectives is desired.

## 7.5 Opportunities for effective MERI frameworks for feral pig control programs

In order for a monitoring, evaluation, reporting and improvement program to be effective across the feral pig control program in the south west of WA, the approach to each of these elements needs to be standardised between groups and areas where pig control is occurring. In addition, the monitoring design needs to be clearly linked to program objectives, performance indicators and measures and must contribute to evaluation of the program's progress against each of the objectives.

The design and intensity of the survey will depend on the nature of the information sought. For instance, general information on the broad distribution of pigs will entail widespread application of low-frequency sampling, probably without repeated measures. Such measures lend themselves to opportunistic and community assisted data collections. Detailed information on rate of change in feral pig activity indices or damage levels, on the other hand, will require more directed sampling that will often be area-specific.

The key elements of a monitoring program for feral pigs should include:

- Field techniques that are easy and rapid, but reliable and repeatable;
- Measures that directly relate to evaluation of performance indicators and objectives;
- Active consideration of reducing variation in detection probability, e.g. through encouraging standardised monitoring protocols, measuring covariates, undertaking systematic or stratified sampling or statistically estimating detection probability and adjusting;
- Collection of data in a standardised format that allows comparisons over time and between areas; and
- Ready availability of data in a useful format for quick evaluation and reporting, such as spatial data that can be mapped and analysed.

Evaluation and reporting should be part of the normal routine and linked to formal planning and reporting processes, such as annual updates to SFPAG and planning discussions for the subsequent 12 months. Structured and standardised approaches to reporting from each of the groups involved in feral pig control can contribute to program-level evaluation and reporting that can be communicated widely and facilitate information sharing between groups. In this way, field staff can see how the work they are doing contributes to the program, can compare their outputs, outcomes, data and approach with other groups to maintain or improve standards and can provide comment on the interpretation of results and priority setting for the program. This will foster a greater level of ownership, operational practicality and may also encourage more vigilant data management and validation processes.

## 8. Research and innovation

There are a number of research projects focusing on improving feral pig management. Current research projects in Australia focus on the following main areas:

- Development of new bait products that exhibit higher target specificity and improved humaneness profiles (e.g. PIGOUT<sup>®</sup> and HOG-GONE<sup>®</sup>);
- Development of additional feral pig management technologies and bait delivery technologies, such as the HOG-HOPPER<sup>®</sup>;
- Generation of new knowledge on feral pig ecology and impacts; and
- Generation of technologies to enable more effective monitoring and targeting of control activities (e.g. thermal imagery trials).

These areas of research will be briefly discussed and some key findings presented in Sections 8.1-8.4.

### 8.1 Advancement in bait products

Development of bait products focuses on higher target specificity, improved humaneness and field efficacy. A commercially available feral pig bait containing 1080 (PIGOUT<sup>®</sup>) was released in March 2008 as a result of collaboration between Invasive Animals CRC and Animal Control Technologies Australia (IACRC 2010). The feral pig bait, HOG-GONE<sup>®</sup> is still undergoing field trials in Australia and the United States. The active compound is sodium nitrite, a common human food additive, which is highly toxic to pigs and acts humanely by preventing oxygen binding to haemoglobin. New microencapsulated formulations of sodium nitrite that might be more stable in bait substrates are being trialled (Lapidge *et al.* 2012; Pest Smart 2013; IACRC 2013). See Section 5.9 for more details on these bait products.

### 8.2 Bait delivery technologies

Development of bait delivery technologies focuses on increasing target specificity without negatively affecting the field efficacy of baiting programs. A commercially available product HOG-HOPPER<sup>®</sup> is a low maintenance, target-specific bait delivery station for feral pig baiting programs. The HOG-HOPPER exploits the natural reach, snout strength and natural lifting behaviour of feral pigs through the use of a sliding access door that is weighted so that pigs are the only species in WA able to access baits within the bait station (Lapidge *et al.* 2012). Pigs are highly neophobic, which means that they avoid new objects and experiences. Use of the HOG-HOPPER requires only one pig from a mob to become familiar and comfortable with it for the remainder of the group to adapt their behaviour (Lapidge *et al.* 2012). The door of the HOG-HOPPER can be locked in an 'open' (free-feed) position to enable pigs to access non-toxic baits and become familiar with feeding from the station. The HOG-HOPPER can hold enough bait for several days of baiting, making it suitable for baiting more remote, environmentally sensitive areas with minimal maintenance (Lapidge *et al.* 2012).

The HOG-HOPPER was subjected to extensive pen and field testing during its development to ensure an optimum design and units have been documented to successfully prevent all non-target species, including even small rodents, from accessing toxic bait (Lapidge *et al.* 2012). In addition, field trials documented a reduction in feeding feral pigs by 90-100 percent when delivering either 1080 laced grain or PIGOUT<sup>®</sup> from the bait station (Lapidge *et al.* 2012). The only issue with the use of HOG-HOPPERS that is likely to be of relevance for use in the south west of WA is the extensive damage that some pigs have caused to the units in some areas (Lapidge *et al.* 2012), the logistics of transporting these units to less accessible areas, and carcass management considerations in areas where non-target species such as Dasyurids are present.

### 8.3 Pig ecology, impacts and controls

There are number of research projects currently underway to improve knowledge of feral pig ecology and impacts. The following examples have been extracted from IACRC (2013), most of which are student projects:

- Social aspects of feral pig management;
- Understanding and mitigating domestic pig and wildlife interactions;
- Controlling feral pigs in tropical rainforests, Qld;
- Environmental impacts of feral pigs on coastal lowland rainforests;
- Conflict in feral pig management in the wet tropics;
- Economics of feral pig damage and management in the wet tropics; and
- Long-term environmental impacts of feral pigs on tropical lowland rainforest.

In addition, a number of research outcomes have been published within the past five years that are relevant to pig control operations in WA. For example:

- Outcomes of PIGOUT, HOG-GONE and HOG-HOPPER trials (see Sections 5.9, 8.1 and 8.2; IACRC 2010; Lapidge *et al.* 2012; IACRC 2013; Pest Smart 2013);
- Use of site illumination and the vocalisations of pigs to deter non-target species from feeding on toxic pig baits (Bengsen *et al.* 2010); and
- Documentation of impacts such as oxidation and acidification of peat wetlands as a result of feral pigs, an attempt to quantify the impact of pigs on threatened species in these systems and assessment of the effectiveness of pig control at protecting these areas from further damage (Burnside *et al.* 2012).

There are also informal projects being completed by operatives in the south west, such as numerous trials of trap types and particularly improvements in door hinging mechanisms, local free feeding preferences, the use of attractants such as bladder contents of sows captured in traps, the trial of new technologies for remote monitoring of trap triggers.

### 8.4 Thermal trials

Adams (2013) aims to provide proof of concept for the use of aerially deployed infrared sensors to accurately detect feral pigs in the southwest of WA. An aerial trial was completed in 2012 using pigs sourced from a local feral pig population that had been strategically relocated into traps/ pens within Karri regeneration forest and adjacent paddock in an attempt to capture a cross section of canopy cover scenarios. A Champion Scout aircraft, fitted with a short-wave infrared (SWIR) thermal sensor, flew transects over the pig locations at heights of approximately 170m, 330m and 500m above ground level. Flights were undertaken on a single day in autumn between the hours of 0800 and 0930 and 1300 and 1500. In addition, FLIR® E40 hand held infrared cameras were used on the ground to obtain body surface temperature readings and images of feral pigs and kangaroos to assist with interpretation of images obtained during the flights.

Thermal detection of pigs beneath the various canopy covers was successful at all locations for each of the altitudes trialled, with the exception of one location which had 99.25 % canopy cover (Adams 2013). The temperature difference between the feral pigs and their surrounding environment was sufficient to make them highly detectable against their background environment. In addition, the thermal images were sensitive enough that they were able to distinguish between two different pigs present within the same pen at all three altitudes (Adams 2013). Pigs are likely to be most detectable with infrared sensors during cool weather conditions and these conditions would also minimise issues associated with heat signals from warm rocks and reflective surfaces (Adams 2013). Potential exists for the differentiation of different species from images obtained, however more work is required to develop heat signatures for interpretation of images. Further trials are planned.

## 8.5 Effective integration of research into feral pig control programs

Research is a key component of the program and is critical for program evaluation and facilitation of active adaptive management. It is important that formal research outcomes and the results of informal trials are shared with operatives involved in planning and implementation of feral pig control. This will help to reduce duplication of effort and maximise opportunities for program adaptability and improvement as a result of new information.

Processes currently in place to facilitate communication of this type of information include:

- The accessibility of up to date research on websites such as [www.feral.org.au](http://www.feral.org.au); general pig control information on the DAFWA website <https://www.agric.wa.gov.au/livestock-animals/livestock-species/pigs>; project-specific information on the SWCC projects website; <http://swccnrm.org.au/work/biodiversity/south-west-feral-pig-control>; and individual pig group web pages such as the Lake Muir Denbarker Community Feral Pig Eradication Group website <http://www.feralpig.southcoastwa.org.au/> which provides links to reports and downloaded documents of relevance.
- Biannual meetings of the Southern Feral Pig Advisory Group and individual community pig control groups.

There is a need for active consideration of the most effective means for communicating and sharing up to date research, innovations and outcomes to facilitate a genuinely adaptive program that is responsive to changing information.



## **9. Stakeholder involvement**

### **9.1 Existing structure for integration of stakeholder activities**

There are a diverse range of stakeholders involved in feral pig management in south west WA and these include government agencies, industry, community and special interest groups. A generalised diagram of stakeholders that are currently involved in feral pig management in this region is outlined in Figure 12, with a summary of their main roles. The diversity of groups shown in Figure 12 represents a range of interests and perspectives in the management of feral pigs. The broad focus of these groups includes the protection of conservation values, protection of the domestic pig industry and agricultural interests, protection of physical assets, prevention of water source contamination, human safety and visitor enjoyment of natural areas. While each of these groups may have different objectives, there is a need for their activities to be integrated into a strategic and coordinated approach to feral pig control. For this to occur, effective communication channels are required that enable the two way flow of information, sharing of skills and knowledge, realisation of opportunities for joint innovations and training, active improvement and conscious management of any program shortfalls through cooperative partnerships.

The current structure in place for feral pig control in south west WA is represented in Figure 13. Each government and natural resource management organisation has its own set of responsibilities surrounding feral pig management and they have governance relationships with their respective Minister and access to various resources to meet their obligations. The current arrangement in place for communication between these groups is an advisory group that meets biannually to share information and coordinate planning. The steering committee mentioned in the structure has been established to coordinate a federally funded pig control program in the south west, but funding for this project ceases in June 2015. In addition, vertebrate pest control groups (PCGs) and more recently Recognised Biosecurity Groups (RBGs) have been established to enable coordination of field activities. These groups are discussed further in Section 9.2.

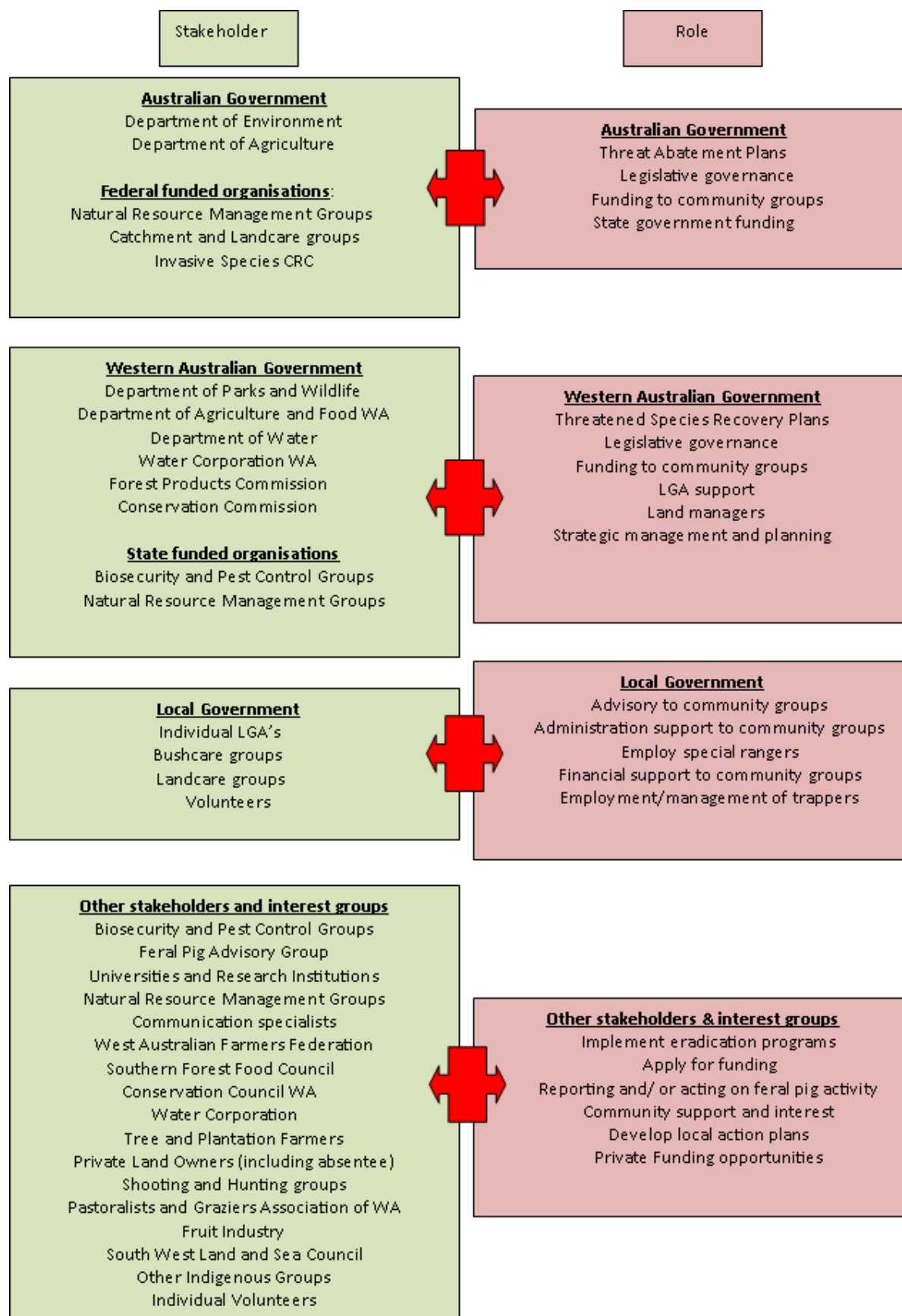


Figure 12: Known stakeholders involved in feral pig management in south west WA

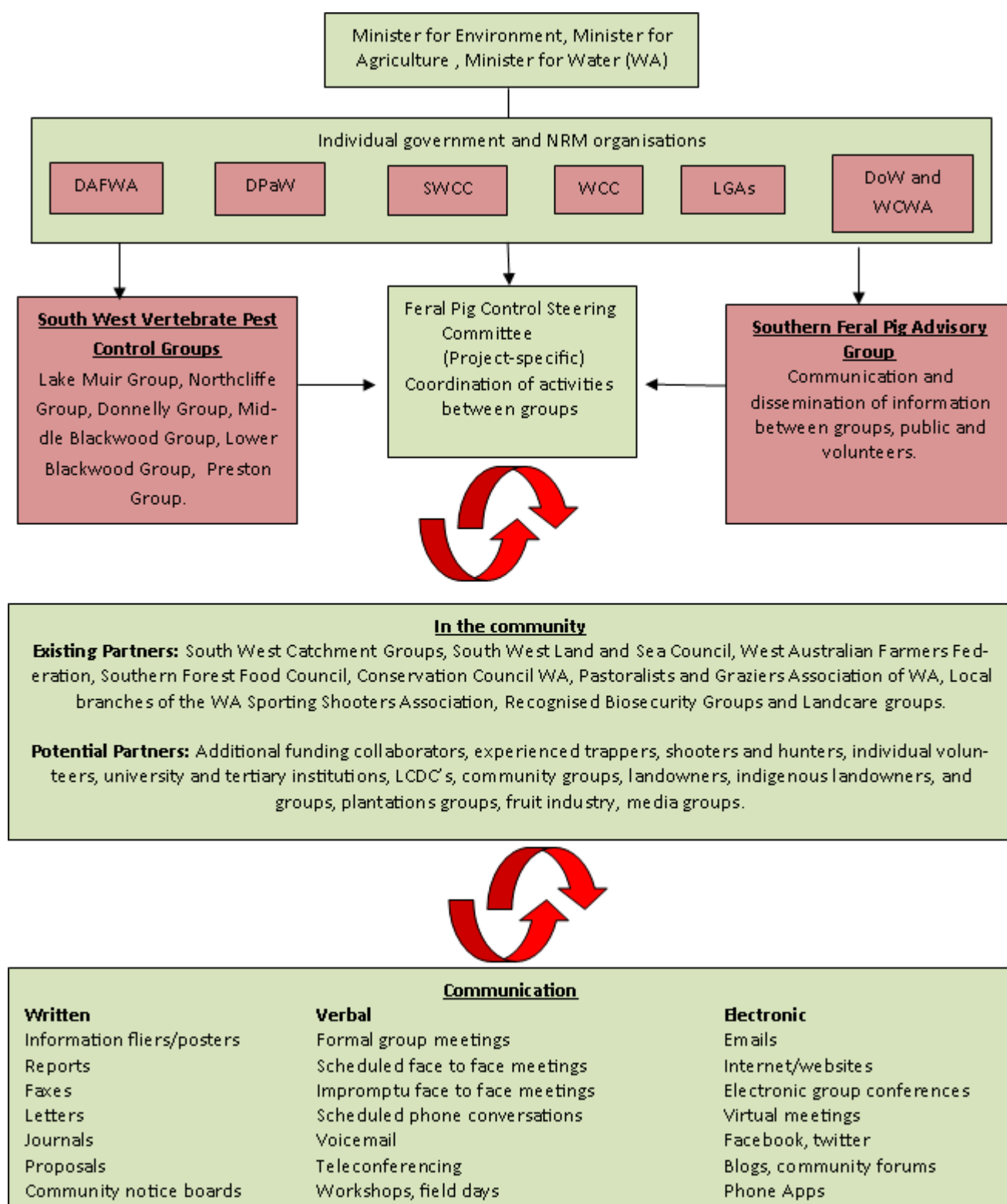


Figure 13: Existing interaction of stakeholders involved in feral pig management in south west WA

## 9.2 Liability, Insurance and community group establishment procedures

Insurance is an essential component of risk management practices for many community groups, particularly those operating on private and public lands or with field operators employed to fulfil a function. The insurance arrangements for community based feral pig control groups are currently quite complicated and differ between groups. For example, some groups have field operators employed and insured by local government; others have been employed under a Warren Catchment Council (WCC) Memorandum of Understanding (Appendix 5) and are covered under WCC insurance; others are independently incorporated with their own insurance. The latter arrangement is the preferred option, as this provides protection against any potential liability, injury or loss and places responsibility for the field operators directly with the group that is directing their work. In the first two cases, the group holding the insurance is not the group directing the work of those most at risk of injury, which potentially leaves the group vulnerable if the claims is challenged.

In order to acquire insurance a group must be incorporated with their own Australian Business Number (ABN). This has the additional benefit of enabling the group to attract independent funding without having to go through a management body (A. Pound *pers. com.* 2015).

Current requirements for the establishment of new community groups as identified by WCC (A. Pound 2015) include:

- ABN for invoicing as sole trader;
- Appropriate insurance coverage;
- Local committee of management including the appointment of a chairman and secretary;
- List of contacts of local community members;
- SFPAG member and adoption of the SFPAG Industry Code of Practice (Appendix 4);
- Code of professional conduct;
- Agreements in place to operate on relevant Parks and Wildlife and Water Corporation estates;
- Reporting process to Warren Catchments Council;
- MOU with WCC on deliverables (Appendix 5); and
- Trapper agreement (Appendix 5).

### 9.3 Pest Control Groups and Recognised Biosecurity Groups

Pest Control Groups were originally established under the *Agriculture and Related Resources Act 1976* and funded by an Agricultural Protection Rate (APR) that was applied to all pastoral lands and matched dollar-for-dollar by the State Government. The funding was managed by DAFWA (previously Agriculture Protection Board) who provided advice on pest species and recommended APRs on a regional scale. Six Pest Control Groups have been established in south west WA, including the Lake Muir Denbarker Community Feral Pig Eradication Group, the Northcliffe Declared Species Group, the Middle Blackwood Group, the Preston Group, the Lower Blackwood Group and the Donnelly Group (Figure 14).

Following implementation of the *BAM Act* in 2013, Pest Control Groups lost support and the transition to RBGs began (DAFWA 2013). Inclusion of RBGs in the *BAM Act* provides a mechanism to encourage integration, coordination and general collaboration of all stakeholders in pest management within their region. RBGs can be funded under the *BAM Act* by requesting the Minister to impose a Declared Pest Rate (DPR) in their area which is matched dollar for dollar by the State Government and deposited in a Declared Pest Account (DPA) which is administered by DAFWA. Alternatively, the groups are free to seek and obtain funds from any sources, but all expenditure must be in accordance with the priorities determined in consultation with DAFWA (DAFWA 2013).

DAFWA (2013) identifies RBGs as the preferred partnership arrangement for declared pest management in WA due to the efficiencies that can be gained through partnerships and the shared use of skills, funds and capacities. This strategic shift recognises that the role of government and the use of limited public resources should be directed away from established pests towards prevention and eradication of significant pests that are either absent or newly established (Reeves and Dodd. 2014). This approach is consistent with *BAM Act*, which places the responsibility for the management of established declared pests on landholders and land managers. This approach also aligns with an emerging, sustainable model for established pest management that is based on community commitment rather than on compliance-driven approaches (Reeves and Dodd 2014). Five RBGs have been established in the pastoral region (Figure 15). DAFWA is working towards the establishment of additional RBGs in south west WA (Tim Thompson *pers.com*. Jan 2015).

All RBGs and Pest Control Groups are operated by community volunteers, with DAFWA providing leadership, partnership arrangements, information, and undertaking compliance activities where this aligns with departmental priorities. A community coordinated biosecurity group is expected to be well equipped to provide information to landholders on the control of established pest species and to exert peer pressure on those landholders with significant pest populations, with a primary role of encouraging landholders to control pest populations before they become too large and impact on multiple neighbouring properties (Reeves and Dodd 2014).

Table 6 summarises the advantages and disadvantages of Pest Control Groups and Recognised Biosecurity Groups for feral pig management in south west WA.

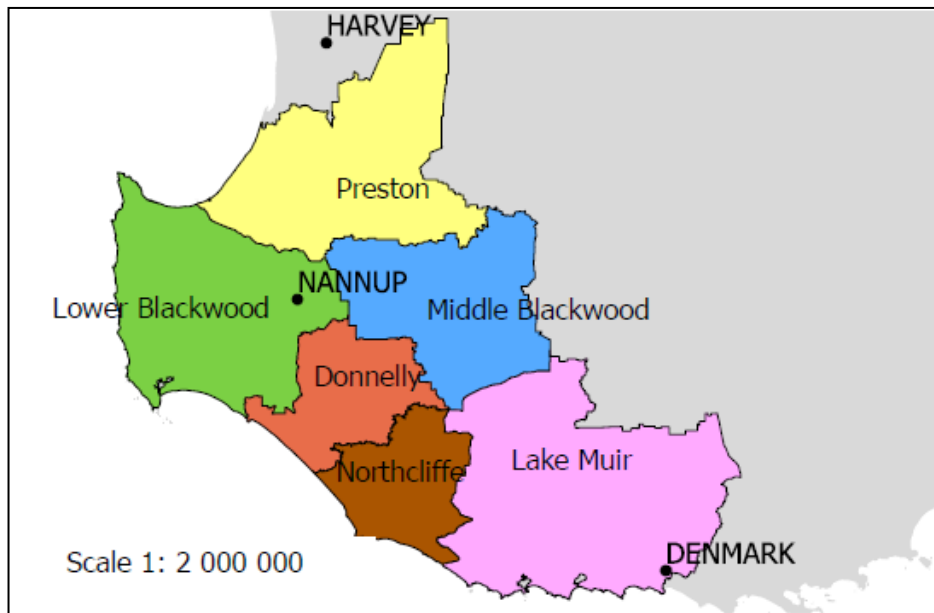


Figure 14: Current Vertebrate Pest Control Groups operating in south west WA

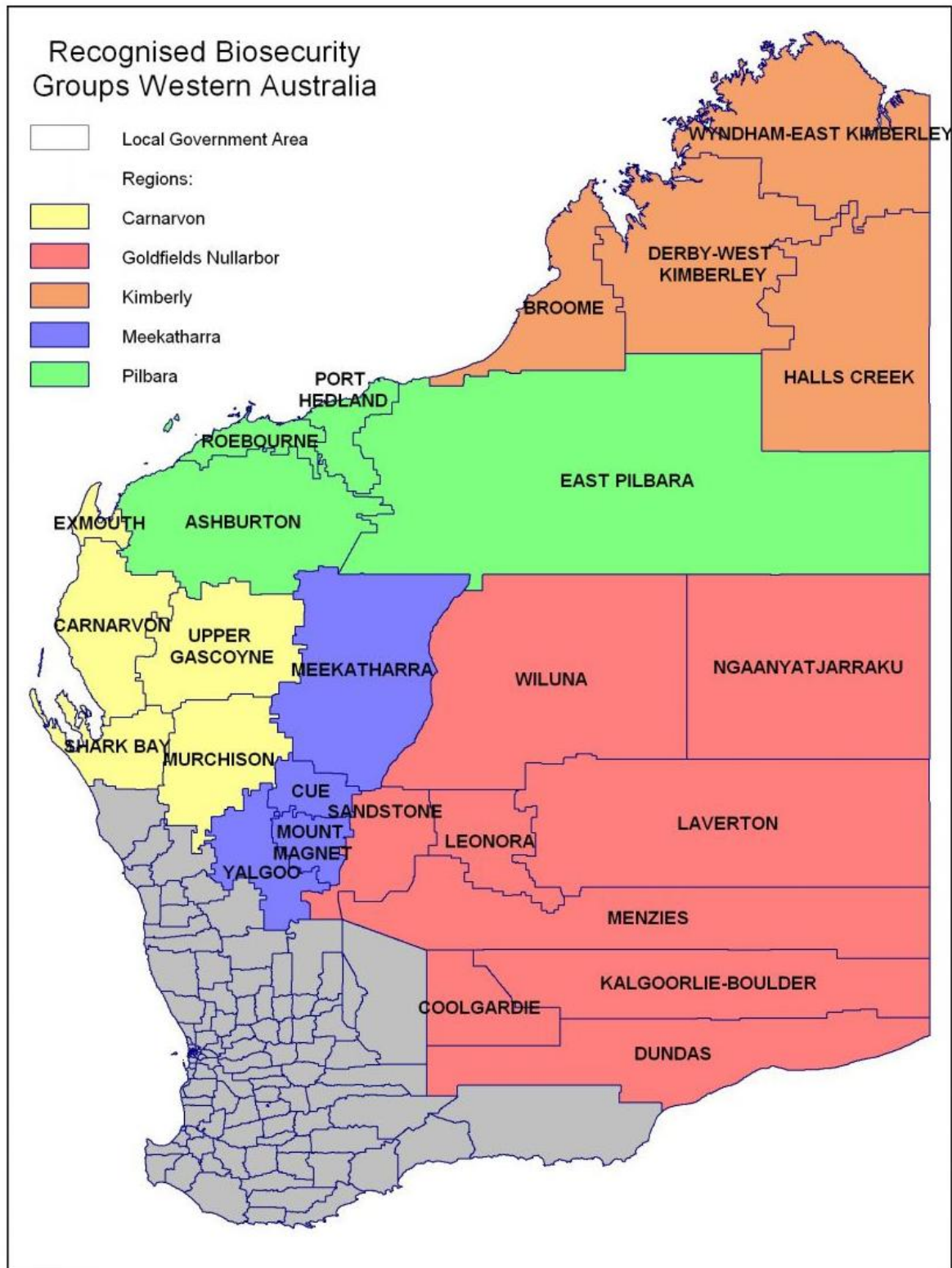


Figure 15: Recognised Biosecurity Groups established in WA in July 2010 (image extracted from [www.agric.wa.gov.au](http://www.agric.wa.gov.au)).



Table 6: Advantages and disadvantages of Pest Control Groups and Recognised Biosecurity Groups for feral pig management in south west WA

Approach	Advantages	Disadvantages
Pest Control Group	<ul style="list-style-type: none"> <li>• Allows targeted training, accreditation and authorisation of field operators.</li> <li>▪ Provides a legitimate pest control response to landholder or organisation-based complaints.</li> <li>▪ High level of local knowledge relating to pig impacts and effective control techniques.</li> <li>▪ High community ownership of the groups and outcomes.</li> <li>▪ Focused single species approach could improve skill development and retention.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Loss of geographical coverage of control if one group falls over and arrangements are not in place to cover the area.</li> <li>▪ Single species focus limits funding opportunities.</li> <li>▪ Lack of support within legislation and by State Government.</li> <li>▪ Operate at a relatively small scale which increases risk of gaps in control effort and issues with consistency of approach and data collection/ management</li> <li>▪ Each group requires insurance, and needs to be either incorporated or have a sponsor organisation. Costs add up with multiple groups.</li> </ul>
Recognised Biosecurity Group	<ul style="list-style-type: none"> <li>▪ Supported by DAFWA and State Legislation.</li> <li>▪ Reliable funding options and greater leverage for funding due to broader scope of work.</li> <li>▪ Allows for an integrated and coordinated approach to pest control, where the groups have a wide range of stakeholders and clear strategic direction.</li> <li>▪ Allows targeted training, accreditation and authorisation of field operators.</li> <li>▪ Provides a legitimate pest control response to landholder or organisation-based complaints.</li> <li>▪ High level of local knowledge relating to pig impacts and effective control techniques.</li> <li>▪ High community ownership of the groups and outcomes.</li> <li>▪ Significant opportunities to build partnerships to improve capacity for managing a range of pest species.</li> <li>▪ Reduces the <i>ad hoc</i> formation of multiple groups focusing on individual species and the potential duplication of effort and resources.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Broader scope of work and a potential loss of focus on high priority operations or loss of interest from some members of the group with specific species of interest.</li> <li>▪ Loss of geographical coverage of control if one group falls over and arrangements are not in place to cover the area.</li> </ul>

#### 9.4 Increasing opportunities for collaboration

A range of existing partners and stakeholders have been identified in Figure 13 and these groups are directly involved in feral pig management activities in south west WA. There are however a number of potential partners (stakeholders) identified in Figure 13 and listed in Appendix 10 that require active consideration in future governance and communication models. These potential partners include:

- Additional funding bodies such as industry groups with a vested interest in feral pig control or an interest in the media attention that could be gained from control outcomes;
- Experienced field operators, shooters and hunters, particularly where individuals are part of a group that can be integrated into broader control efforts;
- Community volunteers that could assist with damage surveys and data collection;
- General public and their ability to contribute to pig sighting datasets;
- University and tertiary institutions, particularly local campuses with students (or groups of students) seeking annual projects, honours, PhD and Post-doctoral projects or field experience;
- LCDC's and other special interest groups such as National Parks Associations or 'Friend's-of' groups, particularly where pigs are impacting on values that these groups are interested in or the groups are interested in partnering in communication efforts;
- Landowners with values at risk;
- Native title claimants and indigenous groups with an interest in the areas, and heritage values at risk;
- Industry groups such as plantations groups and fruit growers where values are at risk from feral pigs or where their areas of interest border feral pig control areas; and
- Media groups and political representatives that may assist in communication efforts.

Through increasing the range of stakeholders involved in feral pig control programs in south west WA, there are opportunities to improve:

- Information dissemination and communication of key messages to the general community;
- Funding opportunities through direct collaboration with private organisations and industry;
- Overall program coordination that is cross tenure; and
- Survey and control effort, resources, skills and capacity.

## 9.5 Communication tools and messages

The purpose of communication is not just to convey information, but also to influence behaviour by persuading people to support or take action toward the program's objectives, to prevent misunderstandings and to reduce barriers. Communication is effective when the message being sent is received, understood and acted upon by the intended audience. The communication techniques selected need to be achievable within the resources available, be the most effective options to reach the target audiences (including field operators, general public, partners and sponsors), contribute to the program's objectives and deliver the outcomes expected.

Technology has expanded the types of communication available and while face to face meetings, workshops and field days are still a common tool for disseminating information among field operators (Derani Sullivan *pers.com.* Dec 2014). The most common tools used to facilitate broader information sharing now include internet based approaches such as websites and mobile applications. A number of state and federal government websites provide up to date knowledge, information, links to relevant research papers and contacts relevant to feral pig management in south west WA. In addition, some of the pest control groups have websites where they upload their annual reports for broader communication. There are however, multiple media outlets (websites, magazines and newsletters) portraying pig hunting as a glorified sport and in some ways this undermines legitimate efforts to communicate key messages relevant to feral pig management.

There have been some instances in the past where media coverage to highlight coordinated pig control activities has resulted in a significant increase in illegal pig hunting activity in the area, which has interfered with legitimate efforts. However, media coverage can be a strong and effective tool to disseminate information, particularly where this is combined with the internet and focuses on clear and targeted messages. Examples include:

- '*Illegal pig hunters getting feral in WA*' published on an online news website 'WA Today' on 14 December 2014. The article tells of illegal hunters who encourage growth of wild pig populations and reached thousands of online viewers, 224 facebook users sharing the site with friends.
- Another article presented by the same news website on the 15 December 2014 '*GPS tracking of feral pigs in WA bushland*' outlines the use of thermal imagery to determine range, population and distribution of feral pigs and this story also had a readership of thousands and was shared 131 times.

There are a range of contemporary communication tools available for application to the feral pig program. Examples include:

- Traditional face to face meetings, workshops and field days;
- Website upload of information, including email;
- Links to web applications that provide effective educational resources as well as appealing to the interest of target audiences through appropriate social media. For example, u-tube footage of pigs damaging fauna habitat; twitter accounts; targeted information and pictures on Facebook; development of mobile applications that contain basic facts, key messages and the ability to actively report sightings and damage;
- Visual displays at events such as large Regional Shows. The Parks and Wildlife office in Walpole have a taxidermied pig head that they display with their taxidermied native animals which always pulls a crowd at events such as these and provides opportunities to inform people of the impact that pigs are having on threatened species; and

- Communication opportunities associated with program milestone or achievements that involve the Minister and other public figures to foster support for and knowledge of the program.

In addition to ensuring that communication is contemporary and innovative, messages need to be accurate, credible and consistent. There are multiple groups involved in communicating messages relating to the feral pig program and it is critical that there is consistency in these messages and that groups have access to relevant and up to date information.

The most appropriate communication messages for the program are likely to revolve around:

- The impact of feral pigs;
- Outcomes of management actions and research trials; and
- Issues with illegal hunting and measures for effective behavioural change.

In communicating these key messages, it is important to recognise and overcome barriers to effective communication such as:

- Language. It is important to avoid emotional, neutral, vague, negative statements, interpretations and connotations and to consider ethnic backgrounds in the community.
- Pre-existing perceptions, prejudice and stereotyping. People have a tendency to hear and see what they expect and to hold on to preconceptions and pre-existing thoughts. An understanding of pre-existing attitudes and beliefs that key groups hold will help to more effectively target messages that encourage change.
- Environmental barriers. When communication is not face to face misunderstanding can occur. Environmental barriers for information dissemination can make it more challenging to enable feedback loops and assess the effectiveness of your message.
- Time and timing. Rushing the dissemination of information can give incomplete, unclear or poorly targeted messages. Poor timing can also cause communication to fail.
- Message complexity. Excessive volume of information can result in the audience being unable to adequately process the intended messages and can cause misinterpretation and misinformation.

While government agencies play a major role in developing community understanding and awareness of key issues, non-government groups such as biosecurity groups can also play an important role (DoE 2005). The role of government is often to influence messages and provide credibility to information disseminated to the community. However, if non-government groups and the broader community support and share the information, messages are often much more meaningful in generating broad changes in community perception and knowledge (Figure 16).

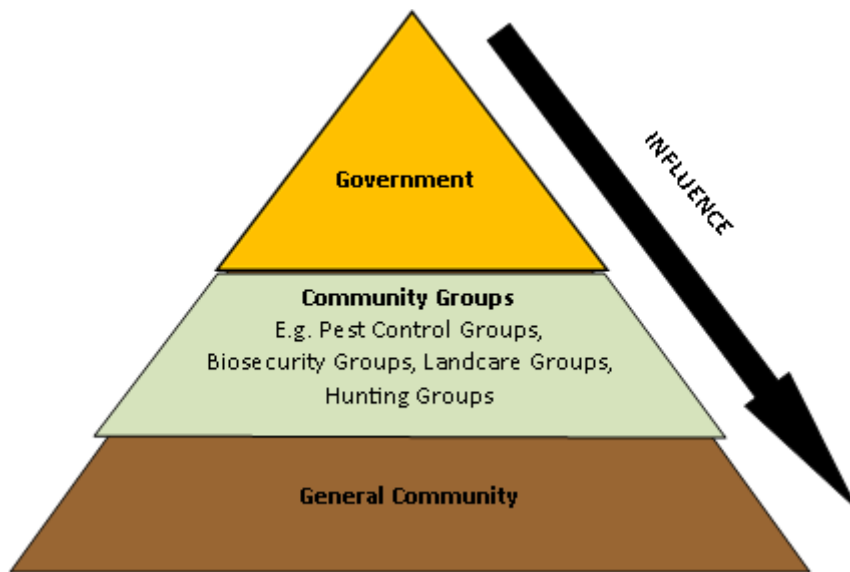


Figure 16: The relative level of influence of government and community on information dissemination and impact of messages. The influence of information is often driven by government, but becomes much broader and more meaningful with community involvement and endorsement.

In order to improve communication outcomes, there is a need for clear communication objectives, messages and performance targets, an approach that actively considers the most effective communication tools and encourages active communication with internal and external stakeholders and community, facilitates the transfer of knowledge, increases community involvement, partnerships and sponsorships and proactively addresses risks associated with public perceptions of the program.

## 9.6 Opportunities for an improved approach to coordination of stakeholders

Feral pig management in south west WA operates across multiple organisations and stakeholder groups. At a decision making level, each of the government and natural resource management organisations has its own set of responsibilities and objectives surrounding feral pig management. These link to the National Threat Abatement Plan, but are specific to the region and the obligations of the organisation. Operational delivery of feral pig control work is achieved by community pest control groups and RBGs that sit under DAFWA, field operators employed by Parks and Wildlife and field operators employed by local government. Formal arrangements exist between these groups such as 'working arrangement' documents that establish communication requirements, areas of work, approaches to control and environmental requirements (Parks and Wildlife 2011). Informal communication occurs between operatives in the field to ensure their activities are not interfering with another group's activities.

Overall coordination of activities between these operational groups currently occurs through an advisory group that meets biannually to share information, coordinate planning and evaluate performance. Membership on this group includes representatives from each of the organisations responsible for pig management activities (DAFWA, Parks and Wildlife, local government, NRM), each of the pig control groups, RBGs and other stakeholder groups as invited. Information from this meeting is passed on to field operators by their representative(s) on the group such that operational areas, control techniques and opportunities for integration of activities are communicated.

This approach allows for wide coordination of activities, but the relatively small nature of some of the groups, their single species focus and the large number of groups results in a risk that reduced funding or issues with skills, resources and capacity could result in cessation of effort in these areas and a subsequent gap in control that affects all other areas through reinvasion potential. This is particularly significant given budget cuts to government organisations that affect field resources, and for community groups reliant on State NRM funding that is due to run out in June 2015.

There are five critical elements of an effective management structure that should be considered going forwards:

- Clear strategic direction in terms of priority setting, program objectives, performance measures and evaluation requirements. This level of information ensures that all stakeholder groups involved in active implementation of pig control are working towards a common and widely accepted outcome.
- Clear reporting relationships/ communication pathways and custodianship of the feral pig strategy in south west WA.
- Robust multi-stakeholder groups such as RBGs that have a strong ability to attract and seek funding and have good support from the government and NRM organisations required to deliver feral pig management outcomes.
- Clear processes for coordination of planning and operational delivery of feral pig management. These processes need to be robust to changing community values, resources and group activity levels to ensure the maintenance of broad coverage and integration of control efforts across the geographical area of interest.
- Clear processes for communication between groups and broader stakeholders that allow effective information dissemination, active focus on building partnerships, increasing funding opportunities, and integration of monitoring and research outcomes into operations.

## 10. Costs of feral pig control

Land managers invest resources in control when they believe the benefits of control (e.g. reduced impact on threatened species or reduced losses in crop yield) outweigh the costs. The overall economic viability and efficiency of any control strategy is largely dependent upon the objective of the program, the density of pigs in an area, environmental factors such as terrain and accessibility, and the efficiency of the operators (Saunders 1988; Choquenot *et al.* 1996; CRC 2003). As discussed in Section 6.1, approaches to prioritisation of investment should consider a range of factors, of which cost is one. Factors such as values at risk, feasibility, community support, longevity of funding and availability of control options also play a significant role in analysis of expected benefit-cost outcomes.

Budget and resourcing costs of feral pig control are not easily identified, particularly when integrated with other activities. In addition, available control techniques are usually incapable of removing all individuals in a single event and require integration with other techniques or repeated applications of the technique or a sequence of techniques to maximise effectiveness. This further complicates estimates of costs and measures of cost-effectiveness that often relate to a single control technique. The use of multiple control techniques often reduces the overall cost of control due to an increase in efficiency.

There are few recent published estimates of the magnitude of spending relating to controlling the feral pig problem in Australia. Bomford and Hart (2002) estimated that landholders and the Australian government spend \$5 million per annum on pig control and \$1.5 million on pig control research. Other estimates of spending on feral pig control present different control options in terms of the cost per pig killed. These figures are largely meaningless when considered outside the context of the geographical area where they were reported, due to inherent differences in pig densities, habitats, operator skill and options available, which significantly affect costs of control.

In the south west of WA approximately \$170,000 was spent between December 2013 and May 2014 on conservation estate to protect threatened species and sensitive ecosystems from feral pigs (*pers.com.* Alison McGilvray, Mark Virgo and Claire Forward Jan 2015). Activities funded include survey for pig activity and damage, trapping, ground shooting, tracking with dogs, fence maintenance and baiting trials. It is difficult to separate expenditure into specific pig control activities due to the integration of activities during operations and broader administrative, vehicle running and material costs that are spread between activities. However, approximately 25% of the funds were spent on survey and ground shooting activities, 36% of the funds on trapping activities, 32% on ground shooting with the assistance of tracking dogs, 5% on baiting trials and 2% on fence maintenance. Some of the funding was obtained through State NRM grants and the ongoing likelihood of this funding being available is uncertain. In addition, approximately \$120,000 is spent annually to fund community pig control groups operating on private property and on the interface between conservation estate and agricultural lands to reduce damage to agricultural values. Expenditure by private landholders and groups outside of the formal control network in the south west is largely unknown.

As the density of pigs decreases, the costs of control increase due to the higher level of effort required to locate remaining pigs, which often retreat to inaccessible refuge areas and learn to avoid repeated controls. The benefit of removing these lingering pigs is still likely to exceed the cost where sensitive values are at risk from feral pigs and available control options remain feasible.

A coordinated community approach can help to offset costs of controlling feral pigs by reducing duplication of effort, reducing refuge areas which harbour pigs that then reproduce and re-colonise controlled areas, and by increasing skill and expertise of operators through collaborations, partnerships and mentoring (DAFWA 2014). Where collaborations occur, it is important that these are structured in such a way that if one group was to cease control activities this would not



undermine the efforts of the groups continuing their efforts. In addition, control activities that rely on long-term funding need to have some plan in place for meeting funding requirements.

Opportunities for funding feral pig control efforts could include:

- In a 2004 survey Australian households expressed a 'willingness to pay' \$11–118 per household per year to protect endangered species from vertebrate pests, which equates to \$79–850 million per year (McLeod 2004).
- Royalties for Regions funding can be sought through the *Biosecurity Defence* initiative to provide a sustained structure to community coordinated approaches to vertebrate pest management (DAFWA 2014).
- Where community collaborations are structured under Regional Biosecurity Groups with an approved Operational Plan, funding may be available under the *BAM Act*. This involves the imposition of a Declared Pest Rate (DPR) by the Minister for Agriculture, which is then matched dollar for dollar by the State Government (DAFWA 2014).
- Industry Funding Schemes (IFS) are also a mechanism under the *BAM Act* for the control of declared pests which enable producers to raise their own funds for managing pests directly threatening the profitability of their industry.
- Active engagement with industry partners that may have an interest in providing financial support to promote their industry in the media or to protect values they may have at risk from pigs.

## **PART 2 – A FERAL PIG MANAGEMENT STRATEGY FOR SOUTH WEST WA**

### **11. Purpose and Scope**

This plan has 9 key objectives:

1. To ensure a collaborative, coordinated and integrated approach to feral pig management activities across tenures, organisations and groups in south west WA
2. To build and maintain stakeholder knowledge, community awareness, involvement and support for key messages, initiatives and outcomes of feral pig management in south west WA
3. To ensure cumulative outcomes are not lost through operational reductions arising from reduced budget, resources or shortfalls in skills and training.
4. To prevent the establishment of new populations of feral pigs in areas of high priority.
5. To reduce the damage from feral pigs to high priority biodiversity, agricultural and water assets in south west WA
6. To minimise the risk of feral pigs and control activities spreading pathogens.
7. To ensure all feral pig management activities are humane and target specific
8. To ensure an adaptive and contemporary program that actively evaluates the effectiveness of activities and is responsive to changing knowledge and field conditions.
9. To resolve knowledge gaps significant to feral pig management in south west WA and integrate new knowledge into operations and future research.
10. To reduce the negative impacts from non-approved pig hunters.

This plan represents a framework for feral pig management in the south west of Western Australia and is consistent with the requirements of the National Feral Pig Threat Abatement Plan (DoE 2005). Objectives and strategies outlined in Section 12 are relevant to the geographical area represented in Figure 3 however the strategies are broad enough that they can be applied more widely should groups in areas outside of this region be interested in adopting a similar approach.

Groups involved in feral pig control in the south west of Western Australia include government and non-government agencies, private landholders and community groups with a diverse range of values, perspectives and responsibilities relevant to the threat of feral pigs in this landscape. Section 12 attempts to facilitate a more integrated, cooperative and targeted approach by these multiple stakeholders to achieve the outcomes desired for feral pig management in this region.

## **12. Objectives, Strategies and Performance Indicators**

### **12.1 Ensuring a collaborative and integrated approach**

Feral pig management in south west WA requires a wide coordination of activities between multiple stakeholders with varying responsibilities. In order for this to occur, management frameworks are required that facilitate effective communication, cooperative partnerships, increased opportunities for funding and effective coordination and integration of training, control, monitoring and research activities. Management frameworks also need to be consistent with the broader requirements of government and community.

#### *Objective 1*

*A collaborative, coordinated and integrated approach to feral pig management activities across tenures, organisations and groups in south west WA.*

#### *Strategies*

- Establish and implement a governance structure that clearly identifies the intended reporting, communication/ integration framework and the roles and responsibilities of all stakeholders.
- The governance framework for pig control in the south west is consistent with the broader biosecurity requirements.
- Implement clear guidelines for establishing new community groups.
- Increase and/ or maintain engagement of partners and collaborators outside of government to improve capacity or funding opportunities.

#### *Performance Indicators*

- A functional governance structure is implemented for feral pig management in the south west by December 2020\*.
- The implemented governance structure is consistent with Recognised Biosecurity Group Frameworks.
- Guidelines for establishing new community groups are formalized by December 2020.
- Groups have formalized partnerships with relevant RBGs by December 2020.

*\*Time constraints applied to the Performance Indicators are based on the 5 year tenure of this plan and the associated review process in 2010. Early achievement of PI's is highly desirable where possible, particularly where non completion of PI's affects the progress of strategies to meet the objectives identified in this strategy.*

#### *Proposed management framework*

In order to ensure effective integration and coordination of pig control activities in south west WA, clear reporting relationships, responsibilities and communication pathways are critical. Robust multi-stakeholder groups such as RBGs that can become incorporated, acquire insurance policies to protect their field operators and have a strong ability to attract and seek funding, are the preferred partnership arrangement for declared pest management in WA (DAFWA 2013). The management framework proposed in Figure 17 is based on this premise and attempts to maximise the efficiencies that can be gained through partnerships and the shared use of skills, funds and capacities.

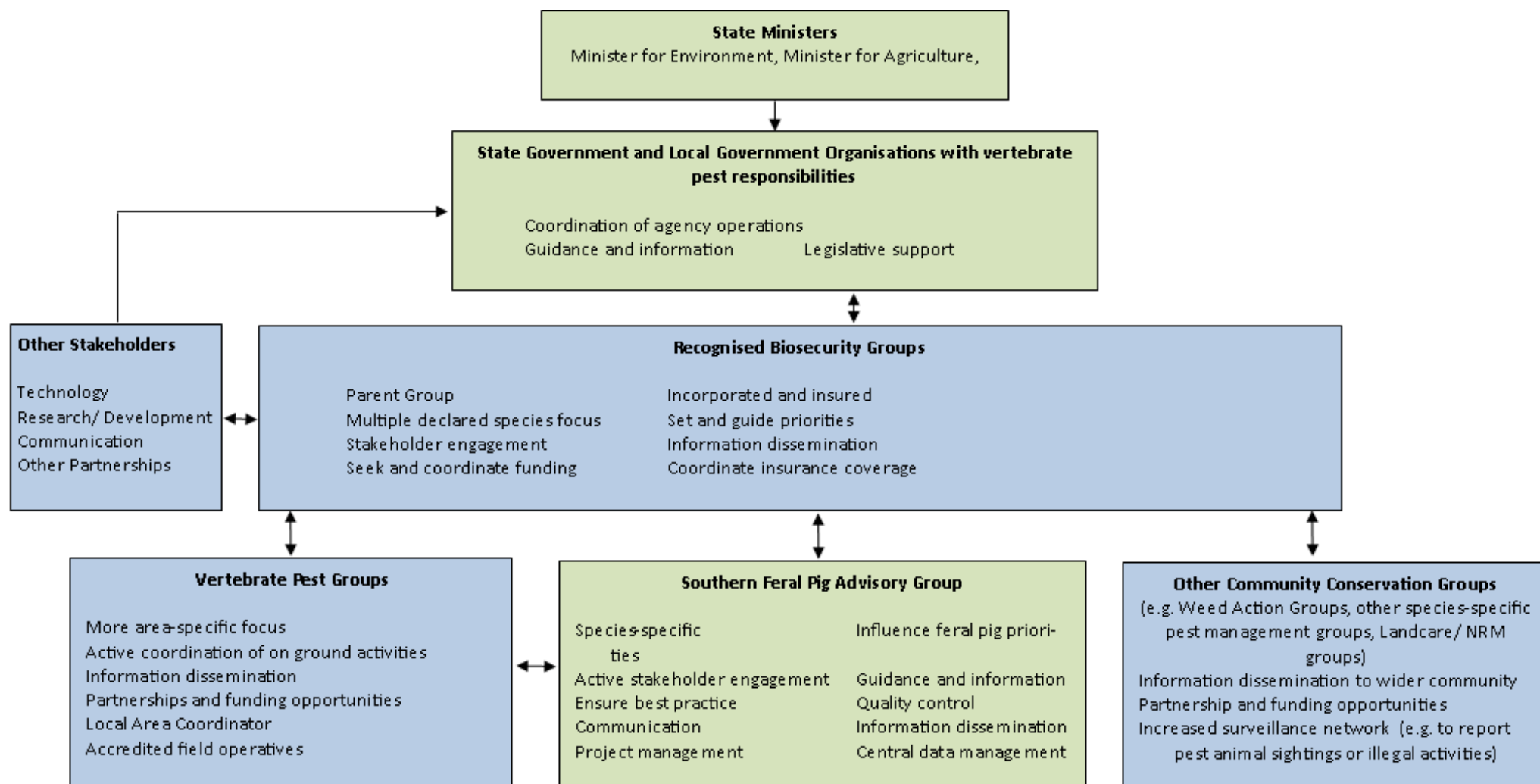


Figure 17: Proposed framework for feral pig management in south west WA.

### Guidelines for establishing new groups

As discussed in previous sections, RBGs are the preferred partnership arrangement for pest management in WA. RBGs are based on community commitment and DAFWA anticipate that the geographical formation of these groups will be based on local government boundaries for ease of information dissemination and establishment of declared pest rates, where applicable. It is important to note that administration of multiple small, species or area-specific groups is not desirable and that the formation of RBGs is intended to reduce this need. There is however still likely to be a role for smaller groups operating under the RBGs for feral pig control and Figure 18 provides guidance for the establishment of such groups.

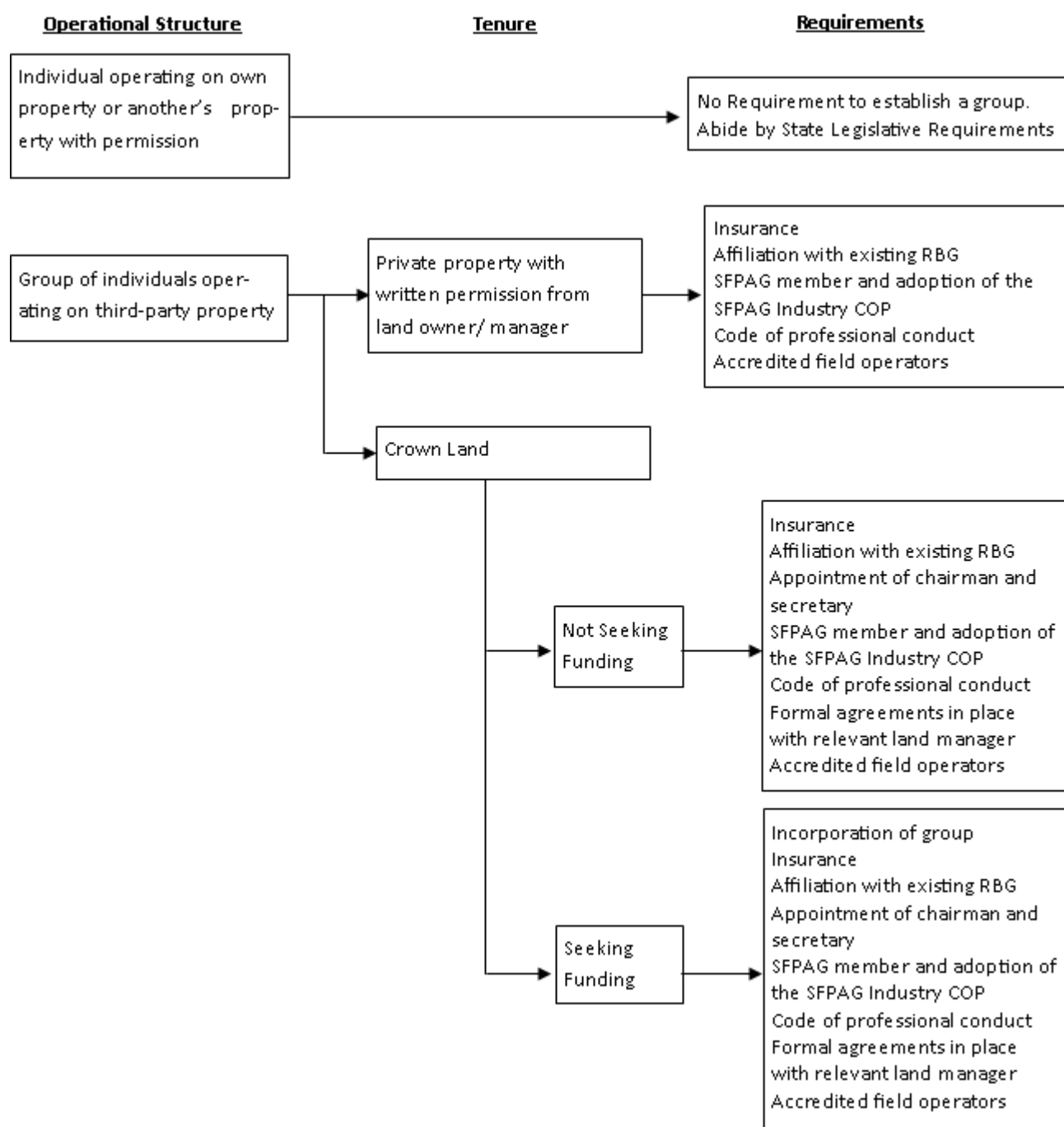


Figure 18: Guidance for establishment of vertebrate pest control groups in south west WA

## 12.2 Increasing community engagement, awareness and education

In order to achieve effective communication outcomes, there is a need for clear communication objectives, messages and performance targets, an approach that actively considers the most effective communication tools and encourages active communication with internal and external stakeholders and community, facilitates the transfer of knowledge, increases community involvement, partnerships and sponsorships and proactively addresses risks associated with public perceptions of the program.

### *Objective 2*

*Build and maintain stakeholder knowledge, community awareness, involvement and support for key messages, initiatives and outcomes of feral pig management in south west WA.*

### *Strategies*

- Develop and implement a communication plan that establishes clear communication objectives, messages and performance targets, identifies effective communication tools for internal and external stakeholders and community, facilitates the transfer of knowledge, increases community involvement, partnerships and sponsorships and proactively addresses risks associated with public perceptions of the program.

In the absence of a plan:

- Refine key messages such as the impact of feral pigs, management actions, research outcomes, issues with illegal hunting and measures for effective behavioural change.
- Build community awareness and support for key messages.
- Develop appropriately packaged and targeted information for communication with stakeholders and the broader community.
- Build and maintain partnerships to increase capacity for communication.
- Establish clear communication pathways to enable an immediate response to complaints from landholders (Higgs and Howe 2008).
- Improve the community image of government agencies, plantation owners and farmers as responsible managers of feral animals on their lands (Higgs and Howe 2008).

### *Performance Indicators:*

- Communication plan developed and implemented by December 2020.
- Clear messages documented for the program by December 2015.
- Establishment of partnerships that increase capacity for communication by December 2020.
- A clear communication pathway developed to enable an immediate response to complaints from landholders; disseminated to landholders by December 2020.
- Baseline data on community attitudes relevant to awareness of and support for key messages, and support for work occurring on government land by December 2016; improvement in community attitudes and awareness such that >50% of community members are aware of and support the program's messages by December 2020.

### 12.3 Maximising cost-effectiveness and long-term operational support

Effective feral pig control outcomes are dependent on a secure, long term funding base, consistent support from operational groups, skilled and experienced operators and functional partnerships and collaborations. In order to ensure that cumulative outcomes are not lost through reduced budget or operational capacity, there is a need for a prioritised investment planning process that is objective and robust to changing budgets. In addition, a model for delivery of training and a process for tracking the availability and competency of field operators will help to maintain program credibility. A changing budget is inevitable and collaborations and partnerships may help to increase operational and financial capacity and contribute to long-term outcomes.

#### *Objective 3*

*Ensure cumulative outcomes are not lost through operational reductions arising from reduced budget, resources or shortfalls in skills and training.*

#### Strategies

- Establish clear approaches for prioritization of investment that are robust to changing budgets and resources.
- Establish procedures for delivering training, assessing competencies and maintaining a record of the skills, experience and competency levels of field operators available to support the strategic plan and MERI framework.
- Build strong collaborations and partnerships to increase capacity, including proactive engagement with funding bodies and sponsors.

#### *Performance Indicators*

- The Southern Feral Pig Advisory Group has developed and implemented a prioritization framework by December 2020.
- Procedures have been established for delivering training, assessing competencies and maintaining a record of the skills, experience and competency levels of field operators available to support the strategic plan and MERI framework by December 2020.
- Partnerships have been developed that increase capacity in terms of geographical scope, training, and integration of activities or communication.

### *Recommended Prioritisation Framework*

The Investment Framework for Environmental Resources (INFFER; Pannell *et al.* 2012) provides a comprehensive and integrated approach to prioritisation and offers the ability to objectively compare the feasibility and cost-effectiveness of competing projects and targets in a framework that can be adapted as knowledge improves or parameters change. INFFER allows full consideration of the range of assets, land areas and targets for the program in relation to feasibilities, risks, costs and benefits and provides comparable benefit-cost ratio that can be used to rank values, targets or projects. The process is adaptable to changing knowledge and budgets and is transparent and defensible. This approach could be readily adapted for use in objective prioritisation of feral pig control targets. The benefit-cost ratio is calculated as:  $BCR = V * W * A * F * P * G * DF$  where:

*V = the value of the asset;* Pannell *et al.* 2012 identify a scoring system that allows assets to be ranked according to their significance at an international, national, state, regional and local level, allows a comparative monetary value to be assigned and enables a threshold level of 1 to be applied to the BCRs to indicate which projects will generate benefits in excess of costs. This scale could be reinterpreted for the feral pig program and the range of assets being considered.

*W = multiplier for impact of works on asset value, as a proportion of V.* What proportion of the asset's value would be protected or improved as a result of the project? *W* represents the future reduction in damage to the values of the area that would result if the program was fully adopted and implemented, compared to if it wasn't.

*A = the proportion of required adoption of actions that is expected to be achieved.* The probability that all of the works and actions required by the program will be completed; this could be influenced by many factors, including: costs, financial benefits, riskiness, complexity, compatibility with existing practices and systems, social pressures for or against the practice, the strength of community networks, community knowledge/awareness, community attitudes, and so on also play a role.

*F = multiplier for technical feasibility.* The probability that the project will *not* fail due to problems with technical feasibility, such as an inability to maintain feral pigs below the levels needed to protect ecological values due to reinvasion, reserve size, shape or an inability to manage fire or other interactive threats that may undermine feral pig control efforts.

*P = probability that socio-political factors will not derail the project.* The probability that the project will *not* fail due to socio political risks such as capacity, conflicting priorities, social, administrative or political factors, including support or opposition by local community groups and networks, likely resistance to the project at the political level, bureaucratic approvals that would be needed, support or opposition by local government, industry pressures etc.

*G = probability that essential funding subsequent to this project will be forthcoming* (e.g. longer term funding that is needed to retain the benefits generated by this project).

*DF = the discount factor for the time lag on benefits.* Consistent with standard economic theory, the discount factor is calculated as  $DF = 1/(1 + r)^L$ , where *L* = time lag until the majority of anticipated benefits from the project occur (years) and *r* is the real discount rate, assumed to be 5%. This assumes that the benefits of the project begin after a certain time lag and are then sustained. The lag time for all areas was arbitrarily set at ten years.



#### 12.4 Preventing the establishment of feral pigs in new areas

Permanent removal of the entire feral pig population in the south west of Western Australia is unlikely to be an achievable strategy with current available control techniques. However, in areas where pigs have not yet established, local eradication within a defined area is a viable option. This approach should be considered where complete local eradication is achievable, feral pigs are known to pose a significant risk to identified high priority assets, the cost of achieving eradication is acceptable and there is no risk that pigs will naturally reinvade the eradication site. An example of where this approach would be most valuable is where a small number of domestic pigs have been recently released into a pig-free area. This objective is dependent on the identification and surveillance of areas of high priority, rapid response to the detection of pigs within and adjacent to these areas and management of the illegal movement of pigs to reduce the likelihood of reinvasion.

##### *Objective 4*

*Prevent the establishment of new populations of feral pigs in areas of high priority.*

##### *Strategies*

- Identify and monitor areas of high priority that are at risk from feral pigs.
- Undertake local eradication programs within or adjacent to high priority areas where low numbers of pigs have been recently detected (e.g. as a result of release), and there is no potential for recolonisation from nearby areas.
- Encourage behavioural change through education and increased public awareness of feral pig impacts, the detrimental role of non-approved amateur hunters and the need for this behaviour to cease.
- Increase engagement of government and community in documenting feral pig sightings and illegal pig hunting activity.

##### *Performance Indicators*

- Areas of high priority identified and monitoring process established by 2020.
- Establish consistent baseline data and then aim for no new established populations of feral pigs outside of the known area of occupancy.
- Changing attitudes towards recreational hunting > 50% decrease in the level of public support for independent recreational pig hunting by December 2020.
- Public data capture process developed and implemented by December 2020.

## 12.5 Reducing damage from established groups of feral pigs

In areas where feral pigs are already established, strategic management of pig populations is necessary to reduce their impact on identified high priority assets and areas. The reduction and maintenance of pig numbers below a level where they are causing significant damage at a landscape scale is an ideal objective. However, this is often not achievable due to the intelligence, adaptability and rapid reproductive strategies of feral pigs, which make them difficult to control at this scale. A strategic management focus on areas of high priority is critical where budgets and resources are finite. Reducing damage often requires sustained surveillance and management to ensure pigs causing damage are targeted or directed away from high priority areas. In addition, the interaction of other disturbances needs to be taken into account where these increase the potential vulnerability of high priority assets. Effective control in the south west will require a coordinated and cooperative approach between stakeholders across all tenures upon which the feral pigs occur. Integrated management using a range of control techniques is likely to be most effective in reducing the impacts caused by feral pigs, given their wide distribution and their ability to learn to evade capture or removal.

### *Objective 5*

*Reduce the damage from feral pigs to high priority biodiversity, agricultural and water assets in south west WA.*

### *Strategies*

- Identify and monitor areas of high priority that are known to be at risk from feral pigs.
- Undertake sustained surveillance and control of feral pigs within and adjacent to high priority areas where pigs are present.
- Ensure control approaches are adaptive to changing pig behaviour, group structure and levels of cognisance (e.g. pre-feed effectiveness; influence of 'trap shy or bait shy animals', influence of dominant pigs).
- Use an integrated and complementary range of control techniques that are suited to the local situation and group of pigs.
- Increase feral pig control efforts in high priority areas affected by fire.
- Integrate feral pig management activities across tenures and geographical areas to ensure the most effective coverage and use of control techniques.

### *Performance Indicators*

- Areas of high priority identified and monitoring process established by 2020.
- Establish consistent baseline data on pig damage within high priority agricultural and biodiversity areas and establish measures that equate to acceptable damage thresholds in these systems.
- Monitoring techniques and thresholds that encourage review of field techniques to improve efficacy.
- Informal and formal communication occurring between groups; formal working arrangements that identify responsibilities and areas of control for each pig season; no significant temporal or spatial gaps in control where high priority areas have been identified.

## 12.6 Reducing the risk of disease

Feral pigs are known hosts or vectors of several endemic and exotic diseases and parasites that affect humans, such as Q fever (*Coxiella burnetii*), leptospirosis (Weil's disease), brucellosis, melioidosis, tuberculosis and sparganosis. Personnel involved in managing feral pigs are potentially at a higher risk of exposure to these diseases and parasites due to their proximity to the animals, fluids and faecal material. Hygiene protocols have already been developed by the SFPAG to protect field operators from the risks of disease and these are contained in the SFPAG code of conduct.

Feral pigs can also vector environmental pathogens such as *Phytophthora cinnamomi* (dieback) and *Batrachochytrium dendrobatidis* (frog Chytrid fungus). Field operators moving around in the same environments as feral pigs can also unwittingly become vectors of these diseases, particularly when moving between wetland areas or from low to high profile across topographical gradients. It has been recognised that standard environmental hygiene protocols are required to reduce the risk of human vectoring of *P. cinnamomi* and *B. dendrobatidis* during feral pig control activities. This is of particular importance given the intent to focus pig control activities in and surrounding areas of high ecological value, which are often those most vulnerable to the introduction of new diseases.

### Objective 6

*Minimise the risk of feral pig control activities spreading pathogens.*

### Strategies

- Implement standardized hygiene protocols for pig control activities that minimize the risk of field operators contracting Q fever (*Coxiella burnetii*), leptospirosis (Weil's disease), brucellosis, melioidosis, tuberculosis and sparganosis.
- Develop and implement standardized hygiene protocols for pig control activities that minimize the risk of spread of environmental pathogens including *Phytophthora cinnamomi* (dieback) and *Batrachochytrium dendrobatidis* (frog Chytrid fungus).
- Adhere to Department of Water restrictions within public drinking water source areas.

### Performance Indicators:

- Protocols in the SFPAG code of conduct relating to hygiene protocols for field operators implemented by December 2015.
- Protocols developed for environmental hygiene protocols and included in the SFPAG Code of Conduct; implemented by December 2016.
- Department of Water restrictions relevant to public drinking water source areas adhered to.

### *Recommended environmental hygiene protocols*

- Vehicle movement is to be confined to the surface of roads and tracks unless otherwise approved.
- Where areas are sign-posted as Disease Risk Areas (DRA), a permit must be obtained from the Department of Parks and Wildlife prior to entry and conditions specified in the permit adhered to.
- Vehicles must be cleaned of mud, soil and plant material, prior to entering any sign-posted DRA and in most cases these areas can only be accessed when soils are dry, unless otherwise specified in the DRA permit.
- For all foot based operations, footwear and equipment must be cleaned of soil and plant debris and sprayed with a methylated spirits solution prior to leaving the road surface.
- If areas low in the profile are wet and soil is picked up in footwear, this must be removed prior to moving upslope (landform based clean downs) or between wet areas. Ideally footwear should be sprayed with methylated spirits following removal of soil, or the soles placed in 1 % bleach solution for at least one minute.
- Cleaning of footwear should be carried out at a safe distance from surface water and under no circumstance should bleach be disposed of where it can run into a drain or surface water area. All cleaning of footwear, equipment and disposal of bleach should occur outside of PDWSAs.

#### Recommended field hygiene kit:

- Disinfectant spray bottle and/or wash bottle
- Disinfecting solution - Methylated Spirits
- Scraper or scrubbing brush
- Small bucket to stand in
- Diluted Bleach solution (1 %)

## 12.7 Minimising non-target risks

The potential impact of feral pig control efforts on non-target species requires active management during pig control programs. The choice of control techniques for feral pigs needs to actively minimise impacts on non-target species and should be based on an understanding of the non-target species present onsite that are likely to be at risk. In addition, non-target impacts should be monitored throughout implementation of control measures and modifications made to remove unacceptable impacts immediately upon detection.

### *Objective7*

*Ensure all feral pig management activities are humane and target specific.*

### *Strategies*

- Ensure that techniques selected are as humane as possible and comply with the *Animal Welfare Act 2002*, the 'Feral Animals - Code of practice for the capture and marketing of feral animals in WA', and the SFPAG Code of Conduct.
- Select control techniques that actively minimise impacts on non-target species present in the area of control.
- Consider and manage secondary poisoning risks (carcass and vomit).
- Ensure control approaches adhere to best practice and incorporate new knowledge and techniques.

### *Performance Indicators*

- All control activities comply with the *Animal Welfare Act 2002*, the 'Feral Animals - Code of practice for the capture and marketing of feral animals in WA', and the SFPAG Code of Conduct
- No significantly detrimental non-target impacts arise from control activities; or modification of activities in response to potential non-target impacts.
- No secondary poisoning incidents of non-target species from carcasses or vomit.
- Communication and review processes that encourage the active adjustment of techniques as information improves.

## 12.8 Monitoring, evaluation, reporting and improvement (MERI)

MERI frameworks are essential for the demonstration of management effectiveness, justification of financial investment and provision of support for decision making processes. Monitoring and evaluation provide the basis for assessing whether objectives and strategies specified for the program are being achieved; reporting processes allow communication of successes and areas requiring improvement; and an improvement component allows the program to adapt to changing knowledge, field and political conditions to remain relevant and effective. Since implementation of a MERI plan requires significant commitment of resources, it is important that the plan is practical and can be resourced sustainably. The monitoring design for feral pig control needs to be clearly linked to program objectives, performance indicators and measures and must contribute to evaluation of the program's progress against each of the target objectives.

### *Objective 8*

*An adaptive and contemporary program that actively evaluates the effectiveness of activities and is responsive to changing knowledge and field conditions*

### *Strategies*

- Develop a MERI plan that supports the strategic plan, allows active evaluation of success, identifies thresholds and triggers at which management action must be taken, and provides a process for transfer of information and program improvement.
- A consistent and standardized approach to MERI across south west WA.

### *Performance Indicators*

- MERI plan developed by December 2018.
- The MERI plan is adopted and implemented by all groups involved in pig control in the south west WA by December 2020.

*Recommended MERI framework*

Key Steps	Outputs
Planning through program logic	<ul style="list-style-type: none"> <li>• Clear identification of high value and high priority areas that are the focus for the program</li> <li>• Clear program objectives and strategies</li> <li>• Clear performance indicators, to enable evaluation of progress against each of the program objectives</li> <li>• Key assumptions about how change will occur</li> <li>• Key evaluation questions and methods to enable demonstration of progress through time</li> <li>• Identification of thresholds and triggers at which action must be taken to address negative trends</li> <li>• Outline any necessary training or financial inputs required</li> </ul>
Monitoring Design	<ul style="list-style-type: none"> <li>• A monitoring design that is clearly linked to the program objectives, strategies and performance indicators</li> <li>• A clear understanding of how data collected will be used for analysis or evaluation and the required data sensitivity to achieve this</li> <li>• A clear process for management of data, maintenance of data collection standards and quality control for data entry</li> <li>• Identification of training and support requirements</li> <li>• Establishment of standard methods, timelines and responsibilities for monitoring and data management</li> </ul>
Evaluation and reporting	<ul style="list-style-type: none"> <li>• Identification of the evaluation and reporting needs of the program, e.g. output, financial, outcome and program level evaluation and reports.</li> <li>• Establishment of standard processes, timelines and responsibilities for evaluation and reporting, including reporting</li> <li>• Communication of evaluation results to internal stakeholders, external stakeholders and the broader community</li> </ul>
Improvement and adaptive management	<ul style="list-style-type: none"> <li>• Specify standard processes, timelines and responsibilities for reflection on results of monitoring in relation to pre-determined thresholds and triggers</li> <li>• Strategies for integration of monitoring and research findings into operations, active adaptive management and program improvement</li> <li>• Changes to program direction or operational protocols</li> </ul>

## 12.9 Innovation and research

Innovation and research are key components of the program that are particularly important for active adaptive management and program improvement. In order to maximise opportunities for program adaptability and improvement, partnerships will be necessary to facilitate research that addresses significant knowledge gaps. There is also a need to identify and regularly review research priorities for the program to ensure that research efforts remain contemporary and relevant.

### *Objective 9*

*Resolve knowledge gaps significant to feral pig management in south west WA and integrate new knowledge into operations and future research.*

### *Strategies*

- Encourage partnerships to facilitate research that meets the needs of the program.

### *Performance Indicators*

- Research is being undertaken to address identified knowledge gaps as per the priorities listed below.

### *Research priorities for the program as at 2015 include:*

- Improvement of methods for determining feral pig distribution, including the development of ground and aerial based thermal imagery.
- Development of simple on-ground feral pig conservation/impact indicators to assist land managers to: monitor populations of feral pigs; define a threshold at which ecosystem functioning is being significantly affected by feral pigs and/or where there is demonstrable biodiversity benefit to feral pig control; and the point at which control programs should begin.
- Assessment of satellite imagery and geographic information systems that could be effectively used to measure feral pig damage.
- Quantification of the impact of feral pigs on native species including threatened species and ecological communities and assessing the effectiveness of ongoing control programs.
- Quantification of the relationship between feral pig population densities and their level of impact for different ecosystems.
- Investigation into ecosystem recovery after feral pig removal or eradication, such as the densities of soil invertebrates, vertebrates, and the rates of reestablishment of plant cover.
- Investigation into the role that feral pigs may have in the spread of plant pathogens including *Phytophthora cinnamomi*.
- Quantification of the drivers of feral pig movements in relation to seasons and refuge area characteristics in an effort to refine control targets.
- Investigations into how to effectively undertake wide-scale feral pig management programs.
- Quantification of the impacts of illegal pig hunters and investigation into the psyche of pig hunters to inform behavioural change strategies.



#### 12.10 Non-approved pig hunters

Hunters that operate outside of the approved governance structures, codes of practice and collaborative approach to pig control, have the potential to significantly undermine the credibility and effectiveness of feral pig management in this region. Illegal hunting brings with it risks of damage to private property assets, destruction of baits; destruction of or tampering with traps and monitoring equipment; risk of injury or death to hunters, hunting dogs and other recreational users; behavioural modification of pigs, which interferes with the effectiveness of other control efforts being undertaken in the area; and the movement and release of pigs to facilitate continued hunting opportunities. Non-approved pig hunting activities are a significant threat to the success of this strategy and are not supported in this region.

##### *Objective 10*

*To reduce the negative impacts from non-approved pig hunters.*

##### *Strategies*

- Encourage behavioural change through education and increased public awareness of the detrimental role of non-approved hunters and the need for this behaviour to be ceased.
- Increase engagement of government and community in documenting illegal pig hunting activity.
- Continue to engage officials in remote surveillance and policing the hunting, transport and release of pigs.

##### *Performance Indicators*

- Changing attitudes towards recreational hunting > 50% decrease in the level of public support for independent recreational pig hunting by December 2020.
- Public data capture process developed and implemented by December 2020.
- Multi-agency relationship maintained.

## 12.11 Summary of objectives strategies and performance indicators

No.	Objectives	Strategies	Performance Indicators
1.	A collaborative, coordinated and integrated approach to feral pig management activities across tenures, organisations and groups in south west WA.	<p>Establish and implement a governance structure that clearly identifies the intended reporting, communication/ integration framework and the roles and responsibilities of all stakeholders.</p> <p>The governance framework for pig control in the south west is consistent with the broader biosecurity requirements.</p> <p>Implement clear guidelines for establishing new community groups.</p> <p>Increase and/ or maintain engagement of partners and collaborators outside of government to improve capacity or funding opportunities.</p>	<p>A functional governance structure is implemented for feral pig management in the south west by December 2020.</p> <p>The implemented governance structure is consistent with Recognised Biosecurity Group Frameworks.</p> <p>Guidelines for establishing new community groups are formalized by December 2020.</p> <p>Groups have formalized partnerships with relevant RBGs by December 2020.</p>
2.	Build and maintain stakeholder knowledge, community awareness, involvement and support for key messages, initiatives and outcomes of feral pig management in south west WA.	<p>Develop and implement a communication plan that establishes clear communication objectives, messages and performance targets, identifies effective communication tools for internal and external stakeholders and community, facilitates the transfer of knowledge, increases community involvement, partnerships and sponsorships and proactively addresses risks associated with public perceptions of the program.</p> <p>Refine key messages such as the impact of feral pigs, management actions, research outcomes, issues with illegal hunting and measures for effective behavioural change.</p> <p>Build community awareness and support for key messages.</p> <p>Develop appropriately packaged and targeted information for communication with stakeholders and the broader community.</p> <p>Build and maintain partnerships to increase capacity for communication.</p> <p>Establish clear communication pathways to enable an immediate response to complaints from landholders.</p> <p>Improve the community image of government agencies, plantation owners and farmers as responsible managers of feral animals on their lands.</p>	<p>Communication plan developed and implemented by December 2020.</p> <p>Clear messages documented for the program by December 2015.</p> <p>Establishment of partnerships that increase capacity for communication by December 2020.</p> <p>A clear communication pathway developed to enable an immediate response to complaints from landholders; disseminated to landholders by December 2020.</p> <p>Baseline data on community attitudes relevant to awareness of and support for key messages, and support for work occurring on government land by December 2016.</p> <p>Improvement in community attitudes and awareness such that &gt;50% of community members are aware of and support the program's messages by December 2020.</p>

No.	Objectives	Strategies	Performance Indicators
3.	Ensure cumulative outcomes are not lost through operational reductions arising from reduced budget, resources or shortfalls in skills and training.	<p>Establish clear approaches for prioritization of investment that are robust to changing budgets and resources.</p> <p>Establish procedures for delivering training, assessing competencies and maintaining a record of the skills, experience and competency levels of field operators available to support the strategic plan and MERI framework.</p> <p>Build strong collaborations and partnerships to increase capacity, including proactive engagement with funding bodies and sponsors.</p>	<p>The Southern Feral Pig Advisory Group has developed and implemented a prioritization framework by December 2020.</p> <p>Procedures have been established for delivering training, assessing competencies and maintaining a record of the skills, experience and competency levels of field operators available to support the strategic plan and MERI framework by December 2020.</p> <p>Partnerships have been developed that increase capacity in terms of geographical scope, training, integration of activities or communication.</p>
4.	Prevent the establishment of new populations of feral pigs in areas of high priority.	<p>Identify and monitor areas of high priority that are at risk from feral pigs.</p> <p>Undertake local eradication programs within or adjacent to high priority areas where low numbers of pigs have been recently detected (e.g. as a result of release), and there is no potential for recolonisation from nearby areas.</p> <p>Encourage behavioural change through education and increased public awareness of feral pig impacts, the detrimental role of non-approved amateur hunters and the need for this behaviour to cease.</p> <p>Increase engagement of government and community in documenting feral pig sightings and illegal pig hunting activity.</p>	<p>Areas of high priority identified and monitoring process established by 2020.</p> <p>Establish consistent baseline data and then aim for no new established populations of feral pigs outside of the known area of occupancy.</p> <p>Changing attitudes towards recreational hunting &gt; 50% decrease in the level of public support for independent recreational pig hunting by December 2020.</p> <p>Public data capture process developed and implemented by December 2020.</p>

No.	Objectives	Strategies	Performance Indicators
5.	Reduce the damage from feral pigs to high priority biodiversity, agricultural and water assets in south west WA.	<p>Identify and monitor areas of high priority that are known to be at risk from feral pigs.</p> <p>Undertake sustained surveillance and control of feral pigs within and adjacent to high priority areas where pigs are present.</p> <p>Ensure control approaches are adaptive to changing pig behaviour, group structure and levels of cognisance (e.g. pre-feed effectiveness; influence of 'trap shy or bait shy animals', influence of dominant pigs).</p> <p>Use an integrated and complementary range of control techniques that are suited to the local situation and group of pigs.</p> <p>Increase feral pig control efforts in high priority areas affected by fire.</p> <p>Integrate feral pig management activities across tenures and geographical areas to ensure the most effective coverage and use of control techniques.</p>	<p>Areas of high priority identified and monitoring process established by 2020.</p> <p>Establish consistent baseline data on pig damage within high priority agricultural and biodiversity areas and establish measures that equate to acceptable damage thresholds in these systems.</p> <p>Monitoring techniques and thresholds that encourage review of field techniques to improve efficacy.</p> <p>Informal and formal communication occurring between groups; formal working arrangements that identify responsibilities and areas of control for each pig season; no significant temporal or spatial gaps in control where high priority areas have been identified.</p>
6.	Minimise the risk of feral pigs and control activities spreading pathogens.	<p>Implement standardized hygiene protocols for pig control activities that minimize the risk of field operators contracting Q fever (<i>Coxiella burnetii</i>), leptospirosis (Weil's disease), brucellosis, melioidosis, tuberculosis and sparganosis.</p> <p>Develop and implement standardized hygiene protocols for pig control activities that minimize the risk of spread of environmental pathogens including <i>Phytophthora cinnamomi</i> (dieback) and <i>Batrachochytrium dendrobatidis</i> (frog Chytrid fungus).</p> <p>Adhere to Department of Water restrictions within public drinking water source areas.</p>	<p>Protocols in the SFPAG code of conduct relating to hygiene protocols for field operators implemented by December 2015.</p> <p>Protocols developed for environmental hygiene protocols and included in the SFPAG Code of Conduct; implemented by December 2016.</p> <p>Department of Water restrictions relevant to public drinking water source areas adhered to.</p>

No.	Objectives	Strategies	Performance Indicators
7.	Ensure all feral pig management activities are humane and target specific.	<p>Ensure that techniques selected are as humane as possible and comply with the <i>Animal Welfare Act 2002</i>, the 'Feral Animals - Code of Practice for the capture and marketing of feral animals in WA', and the SFPAG Code of Conduct.</p> <p>Select control techniques that actively minimise impacts on non-target species present in the area of control.</p> <p>Consider and manage secondary poisoning risks (carcass and vomit).</p> <p>Ensure control approaches adhere to best practice and incorporate new knowledge and techniques.</p>	<p>All control activities comply with the <i>Animal Welfare Act 2002</i>, the 'Feral Animals - Code of Practice for the capture and marketing of feral animals in WA', and the SFPAG Code of Conduct</p> <p>No significantly detrimental non-target impacts arise from control activities; or modification of activities in response to potential non-target impacts.</p> <p>No secondary poisoning incidents of non-target species from carcasses or vomit.</p> <p>Communication and review processes that encourage the active adjustment of techniques as information improves.</p>
8.	An adaptive and contemporary program that actively evaluates the effectiveness of activities and is responsive to changing knowledge and field conditions.	<p>Develop a MERI plan that supports the strategic plan, allows active evaluation of success, identifies thresholds and triggers at which management action must be taken, and provides a process for transfer of information and program improvement.</p> <p>A consistent and standardized approach to MERI across south west WA.</p>	<p>MERI plan developed by December 2018.</p> <p>The MERI plan is adopted and implemented by all groups involved in pig control in the south west by December 2020.</p>

No.	Objectives	Strategies	Performance Indicators
9.	Resolve knowledge gaps significant to feral pig management in south west WA and integrate new knowledge into operations and future research.	Encourage partnerships to facilitate research that meets the needs of the program (key research priorities identified in section 12.9).	Research is being undertaken to address identified knowledge gaps as per the priorities listed.
10.	To reduce the negative impacts arising from non-approved pig hunters.	<p>Encourage behavioural change through education and increased public awareness of the detrimental role of non-approved hunters and the need for this behaviour to be ceased.</p> <p>Increase engagement of government and community in documenting illegal pig hunting activity.</p> <p>Continue to engage officials in remote surveillance and policing the hunting, transport and release of pigs</p>	<p>Changing attitudes towards recreational hunting &gt; 50% decrease in the level of public support for independent recreational pig hunting by December 2020.</p> <p>Public data capture process developed and implemented by December 2020.</p> <p>Multi-agency relationship maintained.</p>

### **13. Strategic plan implementation, evaluation and review**

The Southern Feral Pig Advisory Group will facilitate implementation of the plan, encourage involvement of key stakeholders and undertake effective evaluation and review of the plan to ensure it and the feral pig management program remain contemporary and adaptive to changing knowledge and field circumstances. The SFPAG will need the full support of its composite members and groups and the stakeholders identified in this plan to achieve the collaborative action required for effective implementation, evaluation and review.

The duration of this plan is initially for a five year period, but the duration of the feral pig management program is likely to be ongoing as there are currently no feasible techniques for eradicating feral pigs at this scale. In addition, the costs of many actions will be determined by the level of resources that stakeholders commit to control of feral pigs. This plan is based on an ideal scenario and does not necessarily indicate the commitment of individual stakeholders to undertaking specific actions, as these may be subject to budgetary and other constraints, such as competing priorities for investment.

It is recommended that this plan be reviewed at intervals of no longer than five years. Objectives, strategies and performance indicators should be updated as new information or techniques become available and in response to program-level evaluation, review and recommendations for improvement arising from the MERI framework.

## 14. References

- Adams, P. J. (2014) 'Quantifying feral pig abundance and efficacy of control strategies in southwest WA.' Invasive Animals Cooperative Research Centre, Canberra.
- Allen, L. R. (1984) 'Feral Pig Control Handbook'. Rural Lands Protection Board, Queensland.
- Anderson, D. R., Burnham, K. P., White, K. P., and Otis, D. L. (1983). Density estimation of small mammal populations using a trapping web and distance sampling methods. *Ecology* 64, 674–680.
- Animal Control Technologies Australia (2014) 'HOGGONE® project continues apace.' Accessed online 12 December 2014 at <http://www.animalcontrol.com.au/news/2014/20140606-1.htm>
- Bailey, L. L., Hines, J. E., Nichols, J. D., and MacKenzie, D. I. (2007). Sampling design trade-offs in occupancy studies with imperfect detection: examples and software. *Ecological Applications* 17, 281–290.
- Bain, K., Wayne, A., and Bencini, R. (2015). Subtle differences between north and south have profound implications for extrapolation in the management of the Quokka (*Setonix brachyurus*) in the southern forests of WA. *Wildlife Research* (in press).
- Bain, K., Burnside, R., and Sawyer, M. (2011) 'Use of Judas Pigs to locate key groups of feral pigs for eradication in the Walpole Wilderness Area'. Department of Environment and Conservation, Walpole, December 2011.
- Barrett, R. H., Goatcher, B. L., Gogan, P. J., and Fitzhugh, E. L. (1988). Removing feral pigs from Annadel State Park. *Transactions of the Western Section of the Wildlife Society* 24, 47–52.
- Barrett, R.H., Pine, D.S., 1980. History and status of wild pigs, *Sus scrofa*, in San Benito County, California. *California Fish and Game* 67, 105-117.
- Bengsen, A. J., Leung, L. K-P., Lapidge, S. J., Gordon, I. J. (2010) Artificial illumination reduces bait-take by small rainforest mammals. *Applied Animal Behaviour Science* 127, 66–72.
- Bomford, M. (1990) 'A Role for Fertility Control in Wildlife Management?' Bureau of Rural Resources Bulletin 7. Australian Government Publishing Service, Canberra.
- Bomford, M. and Hart, Q. (2002) Non-indigenous vertebrates in Australia, in Pimentel, D. (ed.) 'Biological Invasions – Economic and Environmental Costs of Alien Plant Animal and Microbe Species'. CRC Press.
- Bowman, D.M.J.S. and McDonough, L. (1991) Feral pig (*Sus scrofa*) rooting in a monsoon forest–wetland transition, northern Australia. *Wildlife Research* 18, 761–765.
- Brown, B.N. (1976) *Phytophthora cinnamomi* associated with patch death in tropical rainforests in Queensland. *Australian Plant Pathology Society Newsletter* 5, 1–4.
- Brown, M., and Munckton, C. (2010). 'Scoping Study: Training and Capacity Building in Vertebrate Pest Management.' Invasive Animals Cooperative Research Centre, Canberra.
- Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borchers, D. L., and Thomas, L. (2001). 'Introduction to Distance Sampling – Estimating Abundance of Biological Populations.' (Oxford University Press: Oxford, UK.)
- Burkhart, K. K. (2001). Anticoagulant rodenticides. In 'Clinical Toxicology.' (Ed M.D. Ford) (WB Saunders Company: Philadelphia). Pp. 848-853.
- Burnside, R., Bain, K. and Sawyer, M. (2012) 'Quantification of the impact of feral pigs (*Sus scrofa*) on the Sunset Frog (*Spicospina flammacaerulea*), Reedia (*Reedia spathacea*), Walpole Burrowing Crayfish (*Engaewa walpolea*) and Quokka (*Setonix brachyurus*).' Report to South Coast NRM, Albany.



- Calenge, C., Maillard, D., Fournier, P., and Fouque, C. (2004). Efficiency of spreading maize in the garrigues to reduce wild boar (*Sus scrofa*) damage to Mediterranean vineyards. *European Journal of Wildlife Research* 50, 112–120.
- Calenge, C., Maillard, D., Vassant, J., and Brandt, S. (2002). Summer and hunting season home ranges of wild boar (*Sus scrofa*) in two habitats in France. *Game Wildlife Science* 19, 281–301.
- Caley, P. (1993). 'The ecology and management of feral pigs in the wet–dry tropics of the Northern Territory.' Thesis, University of Canberra.
- Caley, P. (1994). Factors affecting the success rate of traps for catching feral pigs in a tropical habitat. *Wildlife Research* 21, 287–292.
- Caley, P. (1997). Movements, activity patterns and habitat use of feral pigs (*Sus scrofa*) in a tropical habitat. *Wildlife Research* 24, 77–87.
- Caley, P., and Ottley, B. (1995). The effectiveness of hunting dogs for removing feral pigs (*Sus scrofa*). *Wildlife Research* 22, 147–154.
- Campbell, S., Everett, M., Wishart, J., Smith, M., Adams, P., and Lapidge, S. (2009) 'Baiting Feral Pigs in the Kimberley.' Pastoral Memo – Northern Pastoral Region .
- Campbell, T. A., and Long, D. B. (2009). Feral swine damage and damage management in forested ecosystems. *Forest Ecology and Management* 257, 2319–2326.
- Caughley, G. (1977). 'Analysis of Vertebrate Populations.' (John Wiley: London).
- Choquenot, D., and Ruscoe, W. A. (2003). Landscape complementation and food limitation of large herbivores: habitat-related constraints on the foraging efficiency of wild pigs. *Journal of Animal Ecology* 72, 14–26.
- Choquenot, D., Kilgour, R. J., and Lukins, B. S. (1993). An evaluation of feral pig trapping. *Wildlife Research* 20, 15–22.
- Choquenot, D., Lukins, B., and Curran, G. (1997). Assessing lamb predation by feral pigs in Australia's semi-arid rangelands. *Journal of Applied Ecology* 34, 1445–1454.
- Choquenot, D., McIlroy, J. and Korn, T. (1996) 'Managing Vertebrate Pests: Feral Pigs.' (Bureau of Resource Sciences, Australian Government Publishing Service: Canberra).
- Conover, M.R. (2002). 'Resolving Human–wildlife Conflicts the Science of Wildlife Damage Management'. (Lewis Publishers: Boca Raton, Florida).
- Conover, M.R., (2007). 'Predator–prey Dynamics the Role of Olfaction.' (CRC Press: Boca Raton, Florida).
- Conservation Commission (2014). 'Forest Management Plan 2014 -2023'. (Conservation Commission: WA).
- Cowled, B. D. and Lapidge S. J. (2004). 'A project that investigates current options for managing feral pigs in Australia and assesses the need for the development of more effective and humane techniques and strategies-Stage 2 Report.' (Pest Animal Control Cooperative Research Centre: Canberra).
- Cowled, B. D., Elsworth, P., and Lapidge, S. J. (2008). Additional toxins for feral pig (*Sus scrofa*) control: identifying and testing Achilles' heels. *Wildlife Research* 35, 651–662.
- Cowled, B. D., Giannini, F., Beckett, S. D., Woolnough, A., Barry, S., Randall, L., and Garner, G. (2009). Feral pigs: predicting future distributions. *Wildlife Research* 36, 242–251.

- Cowled, B. D., Lapidge, S. J., Smith, M., and Staples, L. (2006). Attractiveness of a novel omnivore bait, PIGOUT<sup>®</sup>, to feral pigs (*Sus scrofa*) and assessment of risks of bait uptake by non-target species. *Wildlife Research* 33, 651–660.
- Cowled, B., and Garner, G. (2008). A review of geospatial and ecological factors affecting disease spread in wild pigs: Considerations for models of foot-and-mouth disease spread. *Preventive Veterinary Medicine* 87, 197–212.
- Cowled, B., and O'Connor, C. (2004). A project that investigates current options for managing feral pigs in Australia and assesses the need for the development of more effective and humane techniques and strategies -Stage 3 Report. Pest Animal Control Cooperative Research Centre, Canberra, Australia.
- CRC (2003). Feral Pig Impacts and Control Issues in Tropical Forest Landscapes. *Rainforest CRC Research* ISSUE 1 JUNE 2003.
- Department of Agriculture and Food WA (2013). 'Recognised Biosecurity Groups – FAQs Issue No. 01: Formation of Recognised Biosecurity Groups (RBGs) in Agricultural Areas' (DAFWA: WA).
- Department of Agriculture and Food WA (DAFWA) (2014). 'A Community Coordinated Approach to control of Established Weeds and Pest Animals.' (DAFWA: WA).
- Department of Local Government and Regional Development (2003). 'Code of Practice for the Capture and Marketing of Feral Animals in WA.' (Department of Local Government and Regional Development: WA).
- Department of the Environment (2005). 'Threat abatement plan for the predation, habitat degradation, competition and disease transmission by feral pigs.' (Commonwealth of Australia: Canberra).
- Department of the Environment (2013). 'Threat abatement advice for predation, habitat degradation, competition and disease transmission by feral pigs.' (Commonwealth of Australia: Canberra).
- Department of Water (2009). 'Water quality protection note 96 November 2009: Pest animal management in public drinking water source areas.' (Government of WA).
- Dexter, N. (1995) 'The behaviour of feral pigs in north-west New South Wales and its implications for the epidemiology of foot and- mouth disease'. Thesis. University of New England, Armidale.
- Dickson, J.G., Mayer, J.J., Dickson, J.D., (2001). Wild hogs. In: 'Wildlife of Southern Forests: Habitat and Management.' (Ed: J. G. Dickson). (Hancock House Publishers: Blaine USA). Pp. 191–208.
- Dorrington, B., McIlroy, J., Mitchell, J., and Roberts, C. (2001). Community based feral pig trapping in the wet tropics. IN 'Feral Pigs: pest status and prospects for control.' Proceedings of a feral pig workshop'. (James Cook University: Cairns).
- Efford, M. (2004). Density estimation in live-trapping studies. *Oikos* 106, 598–610
- Elsworth, P. G., Mitchell, J. L., and Parker, R. W. (2004). 'Evaluation of attractants and toxins for improved target specificity in the control of feral pigs'. (Queensland Government, Natural Resources and Mines, Robert Wicks Pest Animal Research Centre: Queensland).
- Engeman, R. M., Smith, H. T., Severson, R., Severson, M. A., Shwiff, S. A., Constantin, B., and Griffin, D. (2004). The amount and economic cost of feral swine damage to the last remnant of a basin marsh system in Florida. *Journal for Nature Conservation* 12, 143–147.
- Fleming, P. J. S., Choquenot, D. and Mason, R. J. (2000). Aerial baiting of feral pigs (*Sus scrofa*) for the control of exotic disease in the semi-arid rangelands of New South Wales. *Wildlife Research* 27, 531–537.

- Fordham, D., Georges, A., Corey, B., and Brook, B. (2006). Feral pig predation threatens the indigenous harvest and local persistence of snake-necked turtles in northern Australia. *Biological Conservation* 133, 379–388.
- Geisser, H. and Reyer, H. (2004). Efficacy of hunting, feeding, and fencing to reduce crop damage by wild boars. *Journal of Wildlife Management* 68, 939–946.
- Gibbs, J.P. (2000). Monitoring populations. In 'Research techniques in animal ecology'. (Eds L. Boitani and T. K. Fuller). (Columbia University Press: New York). Pp 213–252.
- Giles, J. R. (1980). 'The ecology of the feral pig in western New South Wales'. Thesis, University of Sydney.
- Gong, W., Sinden, J., Braysher, M., and Jones, R. (2009). 'The Economic Impacts of Vertebrate Pests in Australia.' (Invasive Animals Cooperative Research Centre: Canberra.)
- Gregory G. (1996). Perception of pain associated with 1080 poisoning. In 'Humaneness and vertebrate pest control: Proceedings of the seminar held on March 27th 1996.' (Eds. P. Fisher and C.A. Marks). (Department of Agriculture: Victoria). Pp 62-65.
- Heymann, D. (2008). *Control of Communicable Diseases Manual*, 19th edition. Washington, DC: American Public Health Association.
- Higgs, T., and Howe, M. (2008). 'The Lake Muir and Denbarker Community Feral Pig Eradication Group: a Cooperative Project on Feral Pig Control on the South Coast of WA.' Bi -Annual Report 2007 and 2008. Accessed online 3 January 2015.
- Hone, J. (1983). A short-term evaluation of feral pig eradication at Willandria in western New South Wales. *Australian Wildlife Research* 10, 269–275.
- Hone, J. (1990). Note on seasonal changes in population density of feral pigs in three tropical habitats. *Australian Wildlife Research* 17, 131–134.
- Hone, J. (2002) Feral pigs in Namadgi National Park, Australia: dynamics, impacts and management. *Biological Conservation* 105, 231–242.
- Hone, J. and Atkinson, B. (1983). Evaluation of fencing to control feral pig movement. *Australian Wildlife Research* 10, 499–505.
- Invasive Animals CRC (2010). 'Research Portfolio Summary 2010'. (Invasive Animals Cooperative Research Centre: Canberra).
- Kagi, J. (2015). Recreational hunting on Crown land may go ahead if WA committee's recommendations adopted. ABC News Online 10 March 2015. Accessed at <http://www.abc.net.au/news/2015-03-10/recreational-hunting-on-crown-land-may-go-ahead-on-trial/6296184>.
- Katahira, L., Finnegan, P., and Stone, C. (1993). Eradicating feral pigs in montane mesic habitat at Hawaii Volcanoes National Park. *Wildlife Society Bulletin* 21, 269-274.
- Keuling, O., Stier, N., Roth, M. (2008). How does hunting influence activity and spatial usage in wild boar *Sus scrofa* L? *European Journal of Wildlife Research* 54, 729-737.
- Legendijk, D., and Gusset, M. (2008). Human–carnivore coexistence on communal land bordering the Greater Kruger Area, South Africa. *Environmental Management* 42, 971– 976.
- Lapidge, S., Wishart, J., Staples, L., Fagerstone, K., Campbell, T., and Eiseemann, J. (2012) Development of a Feral Swine Toxic Bait (Hog-Gone®) and Bait Hopper (Hog-Hopper™) in Australia and the USA. IN Proceedings of the 14th WDM Conference (Ed: S. N. Frey)
- Laurance, W. F., and Harrington, G. N. (1997). Ecological associations of feeding sites of feral pigs in the Queensland wet tropics. *Australian Wildlife Research* 24, 579-590.

- Leask, A. (2010). New Zealand Herald Article. Downloaded 31/12/2014 from <http://www.nzherald.co.nz/nz/news/article>
- Li, A. Y., Williams, N., Fenwick, S. G., Hardy, G. E. St. J., and Adams, P. J. (2014). Potential for dissemination of *Phytophthora cinnamomi* by feral pigs via ingestion of infected plant material. *Biological Invasions* 16, 765–774.
- Lipscomb, D.J., (1989). Impacts of feral hogs on longleaf pine regeneration. *Southern Journal of Applied Forestry* 13, 177–181.
- Littauer, G. A. (1993). Control techniques for feral hogs. In 'Feral Swine: A Compendium for Resource Managers.' (Eds: C. W. Hanselka and J. F. Cadenhead). (Texas Agricultural Extension Service, Kerrville: Texas). Pp 139–148.
- Long, J. L. (2003). 'Introduced Mammals of the World: Their History, Distribution and Influence.' (CSIRO Publishing: Melbourne).
- MacKenzie, D. I., and Kendall, W. L. (2002). How should detection probability be incorporated into estimates of relative abundance? *Ecology* 83, 2387–2393
- MacKenzie, D. I., Nichols, J. D., Lachman, G. B., Droege, S., Royle, J. A., and Langtimm, C. A. (2002). Estimating site occupancy rates when detection probabilities are less than one. *Ecology* 83, 2248–2255.
- Mapston, M.E. (2004). Feral hogs in Texas. (Texas Cooperative Extension: College Station, Texas).
- Marks, C. A., Hackman, C., Busana, F., and Gigliotti, F. (2000). Assuring that 1080 toxicosis in the fox is humane: fluoroacetic acid (180) and drug combinations. *Wildlife Research* 27, 483–494.
- Masters, K. (1979) 'Feral pigs in the south-west of WA. Final Report to Feral Pig Committee.' (Agriculture Protection Board and Department of Conservation and Land Management: WA).
- Masters, K. (1981). The private life of the wild pig. *Journal of Agriculture* 22, 103–105.
- McIlroy, J. C. (1983). The sensitivity of Australian animals to 1080 poison V: the sensitivity of feral pigs, *Sus scrofa*, to 1080 and its implications for poisoning campaigns. *Australian Wildlife Research* 10, 139–148.
- McIlroy, J. C. (1995). New techniques for an old problem—recent advances in feral pig control in Australia. *IBEX Journal of Mountain Ecology* 3, 241–244.
- McIlroy, J. C. (1996). Rationale for the use of 1080 to control vertebrate pests. In: 'Humaneness of Vertebrate Pest Control .' (Eds P.M. Fisher and C.A. Marks). (Ropet Printing: Tynong North, Australia). Pp 27–33.
- McIlroy, J. C., and Gifford, E. J. (1997). The 'Judas' pig technique: a method that could enhance control programmes against feral pigs, *Sus scrofa*. *Wildlife Research* 24, 483–491.
- McIlroy, J. C., and Gifford, E. J. (2005). Are oestrous feral pigs, *Sus scrofa*, useful as trapping lures? *Wildlife Research* 32, 605–608.
- McIlroy, J. C., Gifford, E. J., and Forrester, R. I. (1993). Seasonal patterns in bait consumption by feral pigs (*Sus scrofa*) in the hill country of South-eastern Australia. *Wildlife Research* 20, 637–651.
- McIlroy, J.C. (1989). Aspects of the ecology of feral pigs, *Sus scrofa*, in the Murchison area, New Zealand. *New Zealand Journal of Ecology* 12, 11–22.
- McIlroy, J.C. (1990). Feral pig. In: 'The Handbook of New Zealand Mammals.' (Ed: C.M. King). (Oxford University Press: New Zealand). Pp 358–371.

- McIlroy, J.C. (1993). 'Feral pig management problems in the wet tropics of Queensland World Heritage Area. Final consultancy report on control of feral pigs (*Sus scrofa*) associated with the wet tropics of Queensland World Heritage Area.' (Wet Tropics Management Agency: Cairns).
- McIlroy, J.C. and Saillard, R.J. (1989). The effect of hunting with dogs on the numbers and movements of feral pigs, *Sus scrofa*, and the subsequent success of poisoning exercises in Namadgi National Park, Australian Capital Territory. *Australian Wildlife Research* 16, 353–363.
- McIlroy, J.C., Braysher, M. and Saunders, G.R. (1989). Effectiveness of a warfarin - poisoning campaign against feral pigs, *Sus scrofa*, in Namadgi National Park, Australian Capital Territory. *Australian Wildlife Research* 16, 195 - 202.
- McLeod, R. (2004). 'Counting the Cost: Impact of Invasive Animals in Australia 2004.' (Cooperative Research Centre for Pest Animal Control: Canberra.)
- Mitchell, B., and Balogh, S. (2007). 'Monitoring techniques for vertebrate pests: Feral pigs.' (NSW Department of Primary Industries: Sydney).
- Mitchell, J. (2010). 'Experimental research to quantify the environmental impact of feral pigs within tropical freshwater ecosystems.' (Department of the Environment, Water, Heritage and the Arts: Canberra).
- Morrison, S.A., Macdonald, N., Walker, K., Lozier, L., Shaw, M.R. (2007). Facing the dilemma at eradication's end: uncertainty of absence and the Lazarus effect. *Frontiers in Ecology and the Environment* 5, 271–276.
- Noble, K. (1996). 'Sustainable Best Practice Feral Pig Management in the Queensland Wet Tropics. Final Report to the Vertebrate Pest Program.' (Department of Natural Resources and Mines: Townsville).
- O'Brien, P. H. (1988). The toxicity of sodium monofluoroacetate (compound 1080) to captive feral pigs. *Australian Wildlife Research* 15, 163-170.
- Pannell, D.J., Roberts, A.M., Park, G., Alexander, J., Curatolo, A. and Marsh, S. (2012). Integrated assessment of public investment in land-use change to protect environmental assets in Australia. *Land Use Policy*, 29, 377-387.
- Parmenter, R. R., Yates, T. L., Anderson, D. R., Burnham, K. P., Dunnum, J. L., Franklin, A.B., Friggens, M. T., Lubow, B. C., Miller, M., Olson, G.S., Parmenter, C. A., Pollard, J., Rexstad, E., Shenk, T. M. Stanley, T. R., and White, G. C. (2003). Small-mammal density estimation: a field comparison of grid-based vs. web-based density estimators. *Ecological Monographs* 73, 1–26.
- Pavlov, P. M., Kilgour R. J., and Pederson, H. (1981). Predation by feral pigs on merino lambs at Nyngan, New South Wales. *Australian Journal of Experimental Agriculture and Animal Husbandry* 21, 570–574.
- Pavlov, P.M. (1980). 'The diet and general ecology of the feral pig in the Girilambone district of New South Wales.' M.Sc. Thesis, Monash University, Melbourne.
- Pavlov, P.M. (1983). Feral pigs. In: 'The Australian Museum Complete Book of Australian Mammals.' (Ed: R. Strahan). (Angus and Robertson: Sydney). Pp 494–495.
- Pavlov, P.M., Hone, J. and Moore, L.A. (1992). Feral pigs, rainforest conservation and exotic disease in north Queensland. *Wildlife Research* 19, 179–193
- Peacock T. (2003). Virally vectored immunocontraception is not a viable option for feral pig control. In: 'Proceedings of the Feral Pig Action Agenda.' (Ed: S. J. Lapidge). (Pest Animal Control Cooperative Research Centre: Canberra).

- Pest Smart (2013). 'CASE STUDY: Feral pig HOGGONE® baiting trials in Goondiwindi, Qld.' Accessed online 5 January 2015 at [http://www.feral.org.au/wp-content/uploads/2013/02/FPCS1\\_goondiwindi.pdf](http://www.feral.org.au/wp-content/uploads/2013/02/FPCS1_goondiwindi.pdf)
- Pullar, E.M. (1950). The wild (feral) pigs of Australia and their role in the spread of exotic diseases in Australia. *Australian Veterinary Journal* 26, 99–109.
- Pullar, E.M. (1953). The wild (feral) pigs of Australia: their origin, distribution and economic importance. *Memoirs of the National Museum*, Melbourne 18, 7–23.
- Ramsay, B. J. (1994). 'Commercial Use of Wild Animals in Australia.' (Bureau of Resource Sciences, Australian Government Publishing Service: Canberra).
- Reeves, A., and Dodd, J. (2014). Cotton bush response plan. Department of Agriculture and Food Western Australia.
- Reidy, M. M., Campbell, T. A., and Hewitt, D. G. (2008). Evaluation of Electric Fencing to Inhibit Feral Pig Movements. *The Journal of Wildlife Management* 72, 1012–1018.
- Rolls, E. C. (1969). 'They All Ran Wild.' (Angus and Robertson, Sydney).
- Saunders, G. (1988). 'The ecology and management of feral pigs in New South Wales.' Thesis, Macquarie University, Sydney.
- Saunders, G. (1993). Observations on the effectiveness of shooting feral pigs from helicopters in western New South Wales. *Wildlife Research* 20, 771–776
- Saunders, G. (1993) The demography of feral pigs (*Sus scrofa*) in Kosciusko National Park, New South Wales. *Wildlife Research* 20, 559–570.
- Saunders, G. and Kay, B. (1991). Movements of feral pigs (*Sus scrofa*) at Sunny Corner, New South Wales. *Wildlife Research* 18, 49–61.
- Saunders, G., Kay, B., and Nicol, H. (1993). Factors affecting bait uptake and trapping success for feral pigs (*Sus scrofa*) in Kosciusko National Park. *Wildlife Research* 20, 653–665.
- Sharp, T., and Saunders, G. (2004). 'Model code of practice for the humane control of feral pigs.' NSW Department of Primary Industries, Orange.
- Sherley, M. (2007). Is sodium fluoroacetate (1080). a humane poison? *Animal Welfare* 16, 449–458.
- State Law Publisher, WA (2013a). *Biosecurity and Agriculture Management Act 2007*. Information accessed online 15/12/2014 from: [www.slp.wa.gov.au](http://www.slp.wa.gov.au).
- State Law Publisher, WA (2002). *Animal Welfare Act 2002*. Information accessed online 15/12/2014 from: [www.slp.wa.gov.au](http://www.slp.wa.gov.au).
- State Law Publisher, WA (2010). *Wildlife Conservation Act 1950*. Information accessed online 15/12/2014 from: [www.slp.wa.gov.au](http://www.slp.wa.gov.au).
- State Law Publisher, WA (2014). *Country Areas Water Supply Act 1947*. Information accessed online 15/12/2014 from: [www.slp.wa.gov.au](http://www.slp.wa.gov.au).
- State Law Publisher, WA (2006) *Veterinary Chemical Control and Animal Feeding Stuffs Act 1976*. Information accessed online 15/12/2014 from: [www.slp.wa.gov.au](http://www.slp.wa.gov.au).
- State Law Publisher, WA (2013b). *Exotic Diseases of Animals Act 1993*. Information accessed online 15/12/2014 from: [www.slp.wa.gov.au](http://www.slp.wa.gov.au).
- Smith, M.J. (1990). 'The role of bounties in pest management with specific reference to state dingo control programs.' (Charles Sturt University: Canberra).

- Sodeikat, G., and Pohlmeier, K. (2003). Escape movements of family groups of wild boar *Sus scrofa* influenced by drive hunts in Lower Saxony, Germany. *Wildlife Biology* 9, 43–49.
- Spencer, P. B. S., and Hampton, J. O. (2005) Illegal Translocation and Genetic Structure of Feral Pigs in WA. *The Journal of Wildlife Management* 69, 377–384
- Stevens, R.L. (1996). 'The Feral Hog in Oklahoma.' (Samuel Roberts Noble Foundation: Oklahoma USA).
- Stewart, C., Burnside, R., Bain, K., and Sawyer, M. (2011). Feral Animal Data Collection Form and Protocols for Frankland District, Department of Environment and Conservation, Walpole.
- Taylor, R., (2003). 'The Feral Hog in Texas.' (Texas Parks and Wildlife: Texas).
- Tierney, T. A., and Cushman, J. H. (2006). Temporal changes in native and exotic vegetation and soil characteristics following disturbances by feral pigs in a California grassland. *Biological Invasions* 8, 1073–1089
- Tisdell, C.A. (1982) 'Wild Pigs: Environmental Pest or Economic Resource?' (Pergamon Press: Sydney).
- Twigg, L. E., Lowe, T., and Martin, G. (2007). Bait consumption by, and 1080-based control of, feral pigs in the Mediterranean climatic region of south-WA. *Wildlife Research* 34, 125–139.
- Twigg, L. E., Lowe, T., Everett, M., and Martin, G. (2006). Feral pigs in north-WA: population recovery after 1080 baiting and further control. *Wildlife Research* 33, 417–425
- Twigg, L. E., Lowe, T., Martin, G., and Everett, M. (2005). Feral pigs in north-WA: basic biology, bait consumption, and the efficacy of 1080 baits. *Wildlife Research* 32, 281–296
- Twigg, L.E., and Parker, R.W. (2010). Is sodium fluoroacetate (1080) a humane poison? The influence of mode of action, physiological effects, and target specificity, *Animal Welfare* 19, 249–263.
- Updike, D., and Waithman, J. (1996). Dealing with wild pig depredation in California: the strategic plan. In: Proceedings of the Vertebrate Pest Conference, 17. pp. 40–43.
- West, P., and Saunders, G. (2003). 'Pest animal survey 2002. An analysis of pest animal distribution and abundance across NSW and the ACT'. (NSW Agriculture: Orange).
- West, P. (2008). Assessing Invasive Animals in Australia 2008. National Land and Water Resources Audit and Invasive Animals CRC, Canberra.
- Wilcox, J. T., Aschehoug, E. T., Scott, C. A., and Van Vuren, D. H. (2004). A test of the Judas technique as a method for eradicating feral pigs. *Transactions of the Western Section of the Wildlife Society* 40, 120–126.
- Williams A.T. (1948). 'Sodium fluoracetate poisoning.' In: Hospital Corps Quarterly. (United States Government Printing Office, Navy Department: Washington). Pp 16–17.
- Williams, B. L., Holtfreter, R. W., Ditchkoff, S. S., and Grand, J. B. (2011). Trap style influences wild pig behaviour and trapping success. *Journal of Wildlife Management* 75, 432–436
- Wilson, G., Dexter, N., O'Brien, P. and Bomford, M. (1992). 'Pest animals in Australia – a Survey of Introduced Wild Mammals.' (Kangaroo Press and Bureau of Rural Resources: Canberra).
- Wirth, H. J. (1995). 'Vertebrate pest control and animal welfare – the National Consultative Committee on Animal Welfare view.' In: Proceedings of the 10th Australian Vertebrate Pest Control Conference. (Dept. of Primary Industry and Fisheries: Hobart).
- Woolnough, A. P., Gray, G. S., Lowe, T. J., Kirkpatrick, W. E., Rose, K., and Martin, G. R. (2005). 'Distribution and Abundance of Pest Animals in WA: a Survey of Institutional Knowledge.' (Vertebrate Pest Research Section, Department of Agriculture: WA).

Woolnough, A. P., West, P. B., and Saunders, G. R. (2004). Institutional knowledge as a tool for pest animal management. *Ecological Management and Restoration* 5, 226–228.

Wyckoff, A. C., Henke, S. E., Campbell, T. A., and VerCauteren, K.C. (2006). 'Is trapping success of feral hogs dependent upon weather conditions?' In: Proceedings of the 10th Australian Vertebrate Pest Control Conference. (Dept. of Primary Industry and Fisheries: Hobart). Pp 370–372.



## ACRONYMS

APR	Agricultural Protection Rate
BAM Act	Biosecurity and Agriculture Management Act 2007
CAWS Act	Country Areas Water Supply Act 1947
DAFWA	Department of Agriculture and Food, Western Australia
DoE	Department of the Environment, Australian Government
DoW	Department of Water, Western Australia
DPA	Declared Pest Account
DPR	Declared Pest Rate
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
GRID	Geographic and Reporting Information Database
MERI	Monitoring, Evaluation, Reporting and Improvement
Parks and Wildlife	Department of Parks and Wildlife, Western Australia
PCG	Pest Control Group
PDWSA	Public Drinking Water Supply Area
RBG	Recognised Biosecurity Group
SFPAG	Southern Feral Pig Advisory Group
SWCC	South West catchments Council
TAA	Threat Abatement Advice
VCCAFS Act	Veterinary Chemical Control and Animal Feeding Stuffs Act 1976
WC Act	Wildlife Conservation Act 1950
WCWA	Water Corporation, Western Australia

## APPENDICES

## Appendix 1: Legislation applicable to feral pigs in Western Australia

Statutory Document	Sections of the Acts that apply
<b><i>Biosecurity and Agriculture Management Act 2007 (SLP 2014).</i></b>	<p><b>Part 2</b></p> <ul style="list-style-type: none"> <li>• <b>Division 3, Section 22 Declared Pests</b> - Prohibited organisms are declared a pest for the whole of the state.</li> <li>• <b>Division 3, Section 23 (a), (b), (c) and (d) Dealing with Declared Pests</b> – persons must not keep, breed, cultivate the declared pest, or release into the environment the declared pest. Penalty (a) fine of \$50,000; or (b) if a high impact organism a fine of \$100, 000 and imprisonment for 12months.</li> <li>• <b>Division 3, Section 24 Subsection (1), (2), (3) and (4) Introducing or supplying a declared pest</b> – persons must not bring a declared pest into an area of the state from another area of the State. If they do so they commit an offence. Penalty (a) \$20,000; or (b) if it's a high impact organism a fine of \$100,000 and imprisonment of 12 months. Persons must not supply to a person in an area of the State a declared pest, if they do so commit an offence of the Act. Penalty (a) fine of \$20,000; or (b) a fine of \$100, 000 and imprisonment for 12months.</li> <li>• <b>Division 3, Section 30 Subsection (1), (2), (3) Duty to control declared pest</b> – Outlines prescribed control measures to control a declared pest under regulations or a management plan and the requirement of persons, or persons conducting an activity on the land to control the declared pest. Penalty fine of \$20,000.</li> <li>• <b>Division 5, Section 45 and 46, Management Plans</b> – The minister may issue a plan for the management of an area to provide for the control of a declared pest in the area which may be whole or part of the State. Outlines what a management plan must contain. A Management Plan may create offences punishable by a fine not exceeding \$20,000. Also requires that there should be consultation with affected persons (appropriate and reasonably practicable).</li> <li>• <b>Division 6, Section 48, 49, 50 and 51 Biosecurity Councils</b> – outlines the establishment of a Biosecurity Council, membership and annual reporting of Biosecurity Councils.</li> </ul> <p><b>Part 6</b></p> <ul style="list-style-type: none"> <li>• <b>Division 1, Subdivision 3, Section 137 &amp; 138 Declared Pest Account</b> – Outlines the establishment of an operating account and the purposes money can be debited to a Declared Pest Account.</li> </ul>

Statutory Document	Sections of the Acts that apply
<b><i>Biosecurity and Agriculture Management Act 2007 (SLP 2014) continued.</i></b>	<p><b><u>Part 7</u></b></p> <ul style="list-style-type: none"> <li>• <b>Division 5, Section 168 Advisory groups</b> – The minister may appoint persons to constitute an advisory group</li> <li>• <b>Division 5, Section 169 Recognised Biosecurity Groups</b> - The minister may recognise a body as a Biosecurity Group</li> <li>• <b>Division 5, Section 170 Funds available for Biosecurity Groups</b> – The Minister, with the consent of a body recognised under Section 169, transfer money to the Declared Pest Account as recognised under Section 138. Section outlines the direction and period of the funds allocation.</li> </ul> <p><b><u>Part 8</u></b></p> <p><b>Section 191 Subsection (1) Codes of Practice</b> – The Minister may issue a code of practise for controlling, keeping, carrying out agricultural activities, use of chemical products in relation to a declared pest.</p>
<b><i>Biosecurity and Agriculture Management Regulations 2013 (WACR 2013)</i></b>	<p><b><u>Part 3</u></b></p> <ul style="list-style-type: none"> <li>• <b>Division 2 Animal Feed Standards:</b> Defines material acceptable for animal feed as per Schedules 1, 2, and 3 of the regulations.</li> <li>• <b>Division 6 Pig Feed, Section 35 &amp; 36 Approved Pig Feed:</b> lists the material which is approved for pig feed and outlines that the Director General may by notice approve feed which contains flesh, bones , blood or offal of a mammal that has been treated by a process for baiting of feral pigs, research relating to feral pig and therapeutic treatment of a pig.</li> </ul>
<b><i>Animal Welfare Act 2002 (SLP 2013)</i></b>	<p><b><u>Part 3</u></b></p> <ul style="list-style-type: none"> <li>• <b>Section 19 Subsection (1), (2) &amp; (3)Cruelty to Animals</b> – A person must not be cruel to an animal. Penalty Minimum \$2000, Maximum \$50,000 and imprisonment for 5 years. Outlines the definitions of being cruel to an animal, including transportation, confined, restricted or caught.</li> <li>• <b>Section 24 Defence Killing Pests</b> – Using the defence of allegedly killing a pest.</li> <li>• <b>Section 27 Subsection 27 Defence releasing animals into the wild</b> – using the defence of releasing the animal into the wild.</li> <li>• <b>Section 31 Possession of things intended to inflict cruelty</b> – A person must not be in possession of anything with the intention of using the thing to inflict cruelty.</li> </ul>

Statutory Document	Sections of the Acts that apply
<b>Wildlife Conservation Act 1950 (Wildlife Act)</b>	<ul style="list-style-type: none"> <li>• <b>Section 23f Subsection (4) &amp; (6) rare or endangered species of flora</b> – A person is not to take rare flora, a person who takes rare flora contrary to the provisions of this Section is liable to a penalty not exceeding \$10,000.</li> </ul>
<b>Country Areas Water Supply Act 1947 (CAWS Act) (SLP, 2014)</b>	<p>Sections of the <i>CAWS Bylaws</i> that apply to feral pigs include:</p> <ul style="list-style-type: none"> <li>• <b>Division 2, Section 22 Carcasses to be removed from near water</b> – animal carcasses to be placed a safe distance to high water mark of any well, bore, or any feeder.</li> <li>• <b>Division 2, Section 35 Hunting, shooting and fishing</b> - The CEO may from time to time prescribe restrictions on hunting, shooting and fishing in the catchment area.</li> <li>• <b>Division 3, Section 26, 28 30</b> – refuse, rubbish, filth, blood, offal, urine, polluting materials not to be deposited in any part of the catchment area.</li> </ul>
<b>Veterinary Chemical Control and Animal Feeding Stuffs Act 1976 (VCCAFA Act) (SLP, 2006)</b>	<p><b>Part 1 Section 5 –Interpretation:</b> definitions which may relate to feral pigs include:</p> <ul style="list-style-type: none"> <li>• <b>“additive”</b> means a substance or combination of substances added to the basic feed mix for continuous long term administration to stock for a specific purpose;</li> <li>• <b>“basic feed”</b> means any grain, seeds, hay, meat, or fish used as, or in the preparation of, an animal feeding stuff;</li> <li>• <b>“animal feeding stuff”</b> means any substance, including any mixture or compound, or any biological product, and whether in package form or in bulk, used or intended for consumption, or offered for sale for consumption, by any animal other than — <ul style="list-style-type: none"> <li>(a) a dog or cat;</li> <li>(b) a fish kept as a domestic pet and not for the purpose of human consumption; or</li> <li>(c) a bird kept as a domestic pet and not for the purpose of human consumption or the laying of eggs for human consumption, and includes basic feed, processed food, manufactured stock foods, additives, supplements, nutrients, and by-products, and any substance classified as an animal feeding stuff for the purposes of this Act;</li> </ul> </li> </ul>

Statutory Document	Sections of the Acts that apply
<b><i>Exotic Diseases of Animals Act 1993</i></b>	<p>Sections of the <i>Exotic Diseases of Animals Act 1993</i> that apply to feral pigs include:</p> <ul style="list-style-type: none"> <li>• <b>Part 2, Division 2, Section 8:</b> A person or land occupied by that person who is in charge of an animal or has in their possession, control, an animal or animal product which the person suspects is infected commits an offence against the Act. Penalty \$5,000</li> <li>• <b>Part 2, Division 2, Section 10:</b> A person who is in possession , threatens or administers exotic disease agents directly or indirectly into an animal commits an offence. Penalty \$10,000</li> </ul>

**Appendix 2: Species of nationally listed threatened flora and fauna identified in the National Threat Abatement Advice (2013) as being adversely affected by feral pigs. Those that are shaded occur in south west WA**

Scientific Name	Common Name	Threat Status	Certainty
<b>FAUNA</b>			
<i>Amytornis barbatus barbatus</i>	Grey Grasswren (Bulloo)	Vulnerable	Perceived
<i>Bettongia penicillata ogilbyi</i>	Woylie	Endangered	Known
<i>Bettongia tropica</i>	Northern Bettong	Endangered	Perceived
<i>Caretta caretta</i>	Loggerhead Turtle	Endangered	
<i>Casuarus casuarus johnsonii</i>	Southern Cassowary (Australian), Southern Cassowary	Endangered	Known
<i>Chelonia mydas</i>	Green Turtle	Vulnerable	
<i>Chlamydogobius micropterus</i>	Elizabeth Springs Goby	Endangered	Known
<i>Chlamydogobius squamigenus</i>	Edgbaston Goby	Vulnerable	Known
<i>Christinus guentheri</i>	Lord Howe Island Gecko	Vulnerable	Perceived
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	Endangered	Known
<i>Dermochelys coriacea</i>	Leatherback Turtle, Leathery Turtle, Luth	Endangered	Potential
<i>Elseya lavarackorum</i>	Gulf Snapping Turtle	Endangered	Known
<i>Engaeus martigener</i>	Furneaux Burrowing Crayfish	Endangered	Perceived
<i>Engaewa pseudoreducta</i>	Margaret River Burrowing Crayfish	Critically Endangered	Perceived
<i>Engaewa reducta</i>	Dunsborough Burrowing Crayfish	Critically Endangered	Perceived
<i>Engaewa walpolea</i>	Walpole Burrowing Crayfish	Endangered	
<i>Epthianura crocea macgregori</i>	Yellow Chat (Dawson)	Critically Endangered	Perceived
<i>Epthianura crocea tunneyi</i>	Yellow Chat (Alligator Rivers)	Endangered	Known
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	Vulnerable	Known
<i>Erythrura gouldiae</i>	Gouldian Finch	Endangered	Known
<i>Esacus magnirostris</i>	Beach Stone-curlew		

Scientific Name	Common Name	Threat Status	Certainty
<i>Euploea alcathoe enastri</i>	Gove Crow Butterfly	Endangered	Perceived
<i>Geocrinia alba</i>	White-bellied Frog, Creek Frog	Endangered	Known
<i>Geocrinia vitellina</i>	Orange-bellied Frog	Vulnerable	Known
<i>Geophaps smithii blaaui</i>	Partridge Pigeon (western)	Vulnerable	Perceived
<i>Gudeoconcha sophiae magnifica</i>	Magnificent Helicarionid Land Snail	Critically Endangered	Potential
<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot (Eastern)	Endangered	
<i>Lasiorninus krefftii</i>	Northern Hairy-nosed Wombat, Yaminon	Endangered	Perceived
<i>Liopholis guthega</i>	Guthega Skink	Endangered	Potential
<i>Litoria lorica</i>	Armoured Mistfrog	Critically Endangered	Perceived
<i>Litoria nannotis</i>	Waterfall Frog, Torrent Tree Frog	Endangered	Perceived
<i>Litoria nyakalensis</i>	Mountain Mistfrog	Critically Endangered	Perceived
<i>Litoria olongburensis</i>	Wallum Sedge Frog	Vulnerable	Perceived
<i>Litoria rheocola</i>	Common Mistfrog	Endangered	Perceived
<i>Malurus coronatus coronatus</i>	Purple-crowned Fairy-wren (western)	Vulnerable	Known
<i>Mathewsoconcha grayi ms</i>	Gray's Helicarionid Land Snail	Critically Endangered	Potential
<i>Mathewsoconcha phillipii</i>	Phillip Island Helicarionid Land Snail	Critically Endangered	Potential
<i>Mixophyes fleayi</i>	Fleay's Frog	Endangered	Known
<i>Mixophyes iteratus</i>	Giant Barred Frog, Southern Barred Frog	Endangered	Known
<i>Mystivagor mastersi</i>	Masters' Charopid Land Snail	Critically Endangered	Potential
<i>Nangura spinosa</i>	Nangur Spiny Skink	Critically Endangered	
<i>Natator depressus</i>	Flatback Turtle	Vulnerable	Known
<i>Neochmia phaeton evangelinae</i>	Crimson Finch (white-bellied)	Vulnerable	Known
<i>Nyctimystes dayi</i>	Lace-eyed Tree Frog, Australian Lacelid	Endangered	Perceived
<i>Oligosoma lichenigera</i>	Lord Howe Island Skink	Vulnerable	Perceived
<i>Paralucia spinifera</i>	Bathurst Copper Butterfly	Vulnerable	Known



Scientific Name	Common Name	Threat Status	Certainty
<i>Potorous longipes</i>	Long-footed Potoroo	Endangered	Perceived
<i>Psephotus chrysopterygius</i>	Golden-shouldered Parrot	Endangered	Perceived
<i>Pseudocharopa ledgibirdi</i>	Mount Lidgbird Charopid Land Snail	Critically Endangered	Potential
<i>Pseudocharopa whiteleggei</i>	Whitelegge's Land Snail	Critically Endangered	Potential
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	Vulnerable	Known
<i>Pseudophryne corroboree</i>	Southern Corroboree Frog	Endangered	Perceived
<i>Pseudophryne pengilleyi</i>	Northern Corroboree Frog	Vulnerable	Perceived
<i>Quintalia stoddartii</i>	Stoddart's Helicarionid Land Snail	Critically Endangered	Potential
<i>Rheobatrachus silus</i>	Southern Gastric-brooding Frog	Extinct	Known
<i>Rheodytes leukops</i>	Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle	Vulnerable	Perceived
<i>Scaturiginichthys vermeilipinnis</i>	Redfin Blue Eye, Redfin Blue-eye	Endangered	Known
<i>Spicospina flammocaerulea</i>	Sunset Frog	Endangered	Perceived
<i>Taudactylus acutirostris</i>	Sharp-snouted Day Frog, Sharp-snouted Torrent Frog	Extinct	Perceived
<i>Taudactylus pleione</i>	Kroombit Tinker Frog, Pleione's Torrent Frog	Critically Endangered	Known
<i>Taudactylus rheophilus</i>	Tinkling Frog	Endangered	Perceived
<i>Turnix melanogaster</i>	Black-breasted Button-quail	Vulnerable	Known
<i>Xeromys myoides</i>	Water Mouse, False Water Rat	Vulnerable	Known
<i>Zyzomys maini</i>	Arnhem Rock-rat, Arnhem Land Rock-rat	Vulnerable	Known
<i>Zyzomys palatalis</i>	Carpentarian Rock-rat	Endangered	Known
<b>FLORA</b>			
<i>Acacia ammophila</i>		Vulnerable	Known
<i>Acacia phasmoides</i>	Phantom Wattle	Vulnerable	Perceived
<i>Almaleea cambagei</i>	Torrington Pea	Vulnerable	Known
<i>Archontophoenix myolensis</i>	The Myola Archontophoenix	Endangered	Perceived

Scientific Name	Common Name	Threat Status	Certainty
<i>Arenga australasica</i>	Australian Arenga Palm	Vulnerable	Perceived
<i>Asplenium wildii</i>		Vulnerable	Perceived
<i>Astrotricha roddii</i>		Endangered	Perceived
<i>Ballantinia antipoda</i>	Southern Shepherd's Purse	Endangered	Known
<i>Baloskion longipes</i>		Vulnerable	Known
<i>Beyeria lepidopetala</i>	Small-petalled Beyeria, Short-petalled Beyeria	Endangered	Known
<i>Boronia deanei</i>	Deane's Boronia	Vulnerable	Known
<i>Burmannia</i> sp. Bathurst Island (R.Fensham 1021)		Endangered	Known
<i>Cadellia pentastylis</i>	Ooline	Vulnerable	Known
<i>Caladenia arenaria</i>	Sand-hill Spider-orchid	Endangered	Perceived
<i>Caladenia atroclavia</i>	Black-clubbed Spider-orchid	Endangered	Known
<i>Caladenia elegans</i>	Elegant Spider-orchid	Endangered	Known
<i>Caladenia harringtoniae</i>	Harrington's Spider-orchid, Pink Spider-orchid	Vulnerable	Known
<i>Caladenia hoffmanii</i>	Hoffman's Spider-orchid	Endangered	Perceived
<i>Caladenia tessellata</i>	Thick-lipped Spider-orchid, Daddy Long-legs	Vulnerable	Potential
<i>Caladenia winfieldii</i>	Majestic Spider-orchid	Endangered	Known
<i>Callistemon forresterae</i>	Forrester's Bottlebrush	Vulnerable	Potential
<i>Callitriche cyclocarpa</i>	Western Water-starwort	Vulnerable	Known
<i>Calonema dorrienii</i>	Cossack Spider-orchid	Endangered	Perceived
<i>Calonema wanosa</i>		Vulnerable	Known
<i>Calotis glandulosa</i>	Mauve Burr-daisy	Vulnerable	Known
<i>Chingia australis</i>		Endangered	Known
<i>Crepidium lawleri</i>		Endangered	
<i>Cynanchum elegans</i>	White-flowered Wax Plant	Endangered	Known

Scientific Name	Common Name	Threat Status	Certainty
<i>Denhamia parvifolia</i>	Small-leaved Denhamia	Vulnerable	Perceived
<i>Diplazium cordifolium</i>		Vulnerable	Known
<i>Diplazium pallidum</i>		Endangered	Known
<i>Diuris pedunculata</i>	Small Snake Orchid, Two-leaved Golden Moths, Golden Moths, Cowslip Orchid, Snake Orchid	Endangered	
<i>Diuris venosa</i>	Veined Doubletail, Goat Orchid, Veined Donkey- orchid	Vulnerable	Known
<i>Drakaea concolor</i>	Kneeling Hammer-orchid	Vulnerable	Perceived
<i>Eleocharis obicis</i>	Spike rush	Vulnerable	Known
<i>Eriocaulon carsonii</i>	Salt Pipewort, Button Grass	Endangered	Known
<i>Eryngium fontanum</i>	Blue Devil	Endangered	Known
<i>Gardenia psidioides</i>	Hann Gardenia	Vulnerable	Perceived
<i>Gentiana baeuerlenii</i>		Endangered	Perceived
<i>Gentiana bredboensis</i>		Vulnerable	Known
<i>Gentiana wissmannii</i>	New England Gentian	Vulnerable	Perceived
<i>Grevillea molyneuxii</i>		Endangered	Known
<i>Grevillea scortechinii</i> subsp. <i>sarmentosa</i>	Toothbrush Grevillea, Backwater Grevillea	Vulnerable	Known
<i>Habenaria macraithii</i>		Endangered	Perceived
<i>Homoranthus prolixus</i>		Vulnerable	Known
<i>Hoya australis</i> subsp. <i>oramicola</i>		Vulnerable	Perceived
<i>Hydriastele costata</i>		Vulnerable	Perceived
<i>Hypocalymma longifolium</i>	Long-leaved Myrtle	Endangered	Known
<i>Kennedia glabrata</i>	Northcliffe Kennedia	Vulnerable	Known
<i>Lawrencia buchananensis</i>		Vulnerable	Known
<i>Lechenaultia chlorantha</i>	Kalbarri Leschenaultia	Vulnerable	Known
<i>Lepidium aschersonii</i>	Spiny Pepper-cress	Vulnerable	Known

Scientific Name	Common Name	Threat Status	Certainty
<i>Lepidium monoplacoides</i>	Winged Pepper-cress	Endangered	
<i>Leucopogon confertus</i>	Torrington Beard-heath	Endangered	Perceived
<i>Microtis globula</i>	South-Coast Mignonette Orchid	Vulnerable	Perceived
<i>Mitrella tiwiensis</i>		Vulnerable	Perceived
<i>Myriophyllum coronatum</i>		Vulnerable	Perceived
<i>Phaius australis</i>	Lesser Swamp-orchid	Endangered	Known
<i>Phaius bernaysii</i>		Endangered	Known
<i>Phaius pictus</i>		Vulnerable	Perceived
<i>Phaius tancarvilleae</i>	Swamp Lily, Greater Swamp-orchid	Endangered	Known
<i>Pimelea curviflora</i> var. <i>curviflora</i>		Vulnerable	Known
<i>Planchonella eerwah</i>	Shiny-leaved Condoo, Black Plum, Wild Apple	Endangered	Known
<i>Plectranthus torrenticola</i>		Endangered	Perceived
<i>Plesioneuron tuberculatum</i>		Endangered	Perceived
<i>Prasophyllum morganii</i>	Mignonette Leek-orchid, Cobungra Leek-orchid, Dense Leek-orchid	Vulnerable	
<i>Pterostylis cucullata</i>	Leafy Greenhood	Vulnerable	
<i>Pterostylis saxicola</i>	Sydney Plains Greenhood	Endangered	
<i>Pterostylis sinuata</i>	Northampton Midget Greenhood	Endangered	Known
<i>Ptychosperma bleeseri</i>	Darwin Palm	Endangered	Known
<i>Pultenaea parrisiae</i>		Vulnerable	Known
<i>Reedia spathacea</i>	Reedia	Critically Endangered	Known
<i>Rutidosia leiolepis</i>	Monaro Golden Daisy	Vulnerable	Perceived
<i>Sankowskya stipularis</i>		Endangered	Perceived
<i>Sarcochilus roseus</i>		Vulnerable	Perceived
<i>Solanum dunalianum</i>		Vulnerable	Known

Scientific Name	Common Name	Threat Status	Certainty
<i>Spathoglottis plicata</i>		Vulnerable	Perceived
<i>Stachystemon nematophorus</i>	Three-flowered Stachystemon	Vulnerable	Known
<i>Styphelia perileuca</i>		Vulnerable	Perceived
<i>Swainsona murrayana</i>	Slender Darling-pea, Slender Swainson, Murray Swainson-pea	Vulnerable	Perceived
<i>Tasmannia glaucifolia</i>	Fragrant Pepperbush	Vulnerable	Known
<i>Tasmannia purpurascens</i>	Broad-leaved Pepperbush	Vulnerable	Known
<i>Tetradlea juncea</i>	Black-eyed Susan	Vulnerable	Known
<i>Thelymitra dedmaniarum</i>	Cinnamon Sun Orchid	Endangered	Known
<i>Trachymene scapigera</i>	Mountain Trachymene	Endangered	Perceived
<i>Tylophora williamsii</i>		Vulnerable	Perceived
<i>Typhonium jonesii</i>		Endangered	Perceived
<i>Typhonium mirabile</i>		Endangered	Perceived
<i>Vappodes lithocola</i>		Endangered	Perceived
<i>Verticordia fimbrialepis subsp. fimbrialepis</i>	Shy Featherflower	Endangered	
<i>Vrydagzynea grayi</i>		Endangered	Perceived
<i>Wodyetia bifurcata</i>	Foxtail Palm	Vulnerable	Perceived
<i>Xerothamnella parvifolia</i>		Vulnerable	Known
<i>Xylopiopsis monosperma</i>		Endangered	Potential
<i>Zeuxine polygonoides</i>	Velvet Jewel Orchid	Vulnerable	Perceived

**Appendix 3: State listed threatened and priority fauna species likely to be affected by feral pigs.**

<b>Species name</b>	<b>WA Rank</b>	<b>EPBC Rank</b>	<b>Common name</b>
<i>Cherax tenuimanus</i>	CR	CR	Margaret River Marron
<i>Engaewa pseudoreducta</i>	CR	CR	Margaret River Burrowing Crayfish
<i>Geocrinia alba</i>	CR	EN	White-bellied Frog
<i>Pezoporus flaviventris</i>	CR	CR	Western Ground Parrot
<i>Potorous gilbertii</i>	CR	CR	Gilbert's Potoroo
<i>Pseudemydura umbrina</i>	CR	CR	Western Swamp Tortoise
<i>Atrichornis clamosus</i>	EN	VU	Noisy Scrub-bird
<i>Bettongia picillata ogilbyi</i>	EN	EN	Woylie
<i>Caretta caretta</i>	EN	EN	Loggerhead Turtle
<i>Engaewa reducta</i>	EN	EN	Dunsborough Burrowing Crayfish
<i>Galaxias truttaceus hesperius</i>	EN	EN	Western Trout Minnow
<i>Lepidochelys olivacea</i>	EN	EN	Olive Ridley Turtle
<i>Parantechinus apicalis</i>	EN	EN	Dibbler
<i>Psophodes nigrogularis nigrogularis</i>	EN	EN	Western Whipbird (heath subsp)
<i>Austroassiminea letha</i>	VU	VU	Cape Leeuwin Freshwater Snail
<i>Botaurus poiciloptilus</i>	VU	EN	Australasian Bittern
<i>Chelonia mydas</i>	VU	VU	Green Turtle
<i>Dasyornis longirostris</i>	VU	VU	Western Bristlebird
<i>Dasyurus geoffroii</i>	VU	VU	Chuditch
<i>Engaewa walpolea</i>	VU	VU	Walpole Burrowing Crayfish
<i>Galaxiella munda</i>	VU	VU	Western Mud Minnow
<i>Geocrinia vitellina</i>	VU	VU	Orange-bellied Frog
<i>Leipoa ocellata</i>	VU	VU	Malleefowl
<i>Myrmecobius fasciatus</i>	VU	VU	Numbat, Walpurti
<i>Nannatherina balstoni</i>	VU	VU	Balston's Pygmy Perch
<i>Petrogale lateralis ssp lateralis</i>	VU	VU	Black-flanked Rock-wallaby
<i>Setonix brachyurus</i>	VU	VU	Quokka
<i>Spicospina flammocaerulea</i>	VU	VU	Sunset Frog
<i>Westralunio carteri</i>	VU	VU	Bi-valve
<i>Arbanitis inornatus</i>	P1	NL	Trapdoor Spider
<i>Austromerope poultoni</i>	P1	NL	Scorpionfly
<i>Calamoecia elongata</i>	P1	NL	
<i>Daphnia occidentalis</i>	P1	NL	
<i>Geotria australis</i>	P1	NL	Pouched Lamprey
<i>Kawaniphila pachomai</i>	P1	NL	Cricket
<i>Pachysaga strobila</i>	P1	NL	Cricket
<i>Trichosternus relictus</i>	P1	NL	Beetle
<i>Acercella poorginup</i>	P2	NL	Poorginup Swamp Watermite
<i>Bothriembryon glauerti</i>	P2	NL	
<i>Bothriembryon irvineanus</i>	P2	NL	
<i>Elapognathus minor</i>	P2	NL	Short-nosed Snake

<b>Species name</b>	<b>WA Rank</b>	<b>EPBC Rank</b>	<b>Common name</b>
<i>Fibulacamptus bisetosus</i>	P2	NL	
<i>Nannoperca pygmaea</i>	P2	NL	Little pygmy perch
<i>Pseudohydraphantes doegi</i>	P2	NL	Doeg's Watermite
<i>Galaxiella nigrostriata</i>	P3	NL	Black-stripe Minnow
<i>Ixobrychus flavicollis australis</i>	P3	NL	Black Bittern
<i>Pachysaga munggai</i>	P3	NL	Cricket
<i>Charadrius rubricollis</i>	P4	NL	Hooded Plover
<i>Geocrinia lutea</i>	P4	NL	Nornalup Frog
<i>Hydromys chrysogaster</i>	P4	NL	Water-rat, Rakali
<i>Ixobrychus minutus</i>	P4	NL	Little Bittern
<i>Macropus irma</i>	P4	NL	Western Brush Wallaby
<i>Morelia spilota imbricata</i>	P4	NL	Carpet Python
<i>Psophodes nigrogularis oregon</i>	P4	NL	Western Whipbird (sthn WA subsp)
<i>Isodon obesulus fusciventer</i>	P5	NL	Quenda

**INDUSTRY CODE OF PRACTICE  
FOR  
FERAL PIG CONTROL (TRAPPING AND ERADICATION)**

Southern Feral Pig Advisory Group  
Western Australia 2010

*VERSION 2.5*

This manual is to compliment the “Code of Practice for Feral Pigs” for Humane Vertebrate Pest Control developed by the Invasive Animals Cooperative Research Centre.

[www.invasiveanimals.com/downloads/COP\\_for\\_feral\\_pigs.pdf](http://www.invasiveanimals.com/downloads/COP_for_feral_pigs.pdf)

## **1. Introduction**

Feral pigs in Western Australia can cause a significant impact on all aspects of the community.

These impacts can be through the destruction of crops, or the transference of disease. Economical loss associated with feral pig damage in the agriculture sector is substantial. The damage can be direct as in the damage to infrastructure (fences, pasture, or crops) or indirect as in the loss of income in the processing stages of the crop; or the effect of ill health from disease transference through the community; or the loss of natural habitat and iconic species that may be threatened by feral pig activity; or the transference of organisms such as *Phytophthora dieback* which impacts 40% of native plant species in the WA environment.

Feral pigs cause considerable damage to natural ecosystems inside and outside of National Parks and State Forests. They can enter residential areas and destroy lawns, gardens and areas of small fruit orchards and other farm enterprises.

To maximise the effectiveness of feral pig control in Western Australia, appropriately accredited pig trappers must operate under this “Code of Practice” and assist Federal, State and Local Governments and agencies; landholders or stakeholders; and the general community in all aspects of feral pig control.



## 2. Objectives

The objectives of the “Feral Pig Code of Practice” are:

1. Trappers employed must be accredited. Accreditation is obtained after successful completion of Certificate III Rural Operations Feral Pig Training Course offered by Durack Institute of Technology. Accredited trappers and apprentice trappers (who only work under guidance of an accredited trapper) must operate under the guidelines of this Code of Practice;
2. Apprentice trappers need to undertake the Certificate II Rural Operations offered by Durack Institute of Technology.
3. To use accredited trappers in areas throughout the Local Committee’s area of operation, or, as and when requested, to trap in other areas with complaints regarding feral pig activity, or when a designated trapping season begins;
4. To assist landholders adjacent to or near National Park and State Forest Boundaries in the control of feral pigs;
5. To control or eradicate feral pigs and thus reduce the environmental, social and economical impacts feral pigs can cause within the Local Committee’s area; and
6. To tabulate feral pig capture data for analysis and reference.

## 3. Trapper Requirements

The basic requirements for a trapper are:

1. a signed work agreement (refer to local committee requirements)
2. a current senior first aid certificate
3. a medical fitness certificate and a reasonable degree of fitness
4. prepared to provide a police clearance certificate when required
5. agree to “on the spot” drug and alcohol testing when required
6. a sound knowledge of map reading
7. be able to operate a GPS
8. be able to operate a 2 way radio
9. be able to record the required data (refer Section 4.1.13)
10. be willing to work in isolated areas with other trappers and follow set guidelines
11. be willing to complete any accredited educational or certified course as may be required

## 4. General Procedures

### 4.1. Trapping Procedures

The following procedures form the “Code of Conduct” and must be adhered to:

1. the person using a firearm must be licensed by the Police for that firearm and have completed and passed an accredited Department of Environment and Conservation (DEC) firearms course;
2. always ensure that firearm use is in the safest possible manner;
3. that you have a “duty of care” to the welfare of all animals within your control;
4. that you have a “duty of care” to the welfare of all persons within your work environment
5. destruction of all feral pigs must be done humanely, as set out in the section below;
6. trappers must work with a “buddy” to ensure each others safety;
7. wear/use the required personal protective clothing/equipment as set out by the Local Committee. This may mean wearing HI-VIS clothing as and when required by certain landholders/stakeholders;
8. trappers or any of their associates must not sell or give away feral pigs, dead or alive;
9. where possible remove carcasses 100metres away from a water course and 50metres from any roadside;
10. When operating in a Public Drinking Water Source Area (PDWSA) all activities must be in accordance with Water Quality Protection Note 96, June 2009, Pest animal management in public drinking water source areas.
11. at all times carry a first aid kit and 2-way radio;
12. vehicles used must be well maintained in a sound and roadworthy state;
13. record all the data that is required by the Local Committee such as:
  - Number of pigs caught
  - Sex and age. (E.g. sucker, adult male, young sow etc.).
  - Weight
  - Bait/lure used
  - Pre-feeding time frames
  - General condition and health of pigs. (I.e. parasites, abnormalities etc).
  - GPS Readings
  - Date of capture
  - Pregnancy Status
  - DNA and body samples (if applicable)
  - Photograph every pig caught and destroyed
14. adhere to landholders requests and contact landholder/stakeholder prior to entry to their land and sign relevant forms (refer to local committee requirements);
15. obtain written permission to enter private property for feral animal control (refer to local committee requirements);
16. carry a letter of introduction at all times (refer to local committee requirements);
17. adhere to landholder/stakeholders request for risk area management such as the appropriate protocols as set out by DEC for operating in dieback risk areas;
18. Maintain traps in good working order;
19. Trappers are to check traps **daily** and dispose of pigs expeditiously. If pigs are kept in a trap for media or other reasons the landholder is to be advised and a note left on the trap. All humane considerations such as a supply of food and water must be considered;

20. Under no circumstances is any person to enter a trap when live feral pigs are enclosed within the trap;
21. Dogs are **only** to be used to seek out, contain and/or bail pigs. Dogs mauling or attacking feral pigs is **strictly** forbidden. Dogs may not be muzzled in order that the dog may be able to defend itself and/or the dog handler if attacked. Permission must be granted by relevant landholders before using dogs on their property;

That as soon as the feral pig is safely bailed up with no direct physical contact by authorised personnel and/or the dog(s) then the feral pig shall be immediately euthanized by using appropriate calibre and /or type of firearm.

At all times, the trapper needs to ensure that his/her actions are appropriate to the situation including, but not limited to, safety to themselves: safety and wellbeing of the dog(s) and ensuring that the feral pig is treated humanely which strictly adheres to the "Code of Practice for capture and Marketing of Feral Animals in Western Australia 2003" and with no breaches to the Animal Welfare Act 2002.

22. Horses can only be used in designated areas; for a designated timeframe and with the approval of DEC;
23. Trappers using manufactured Poison Baits must have the relevant certification and/or licenses, and all correct details and contacts are made before laying said poison baits, and then only under the Local Committee and landholder/stakeholders' approval;
24. All 1080 use must be in accordance with the "Code of Practice for the Safe Use and Management of 1080 in Western Australia, April 2009".
25. Always use a bait/lure of a standard that will not spread weeds or disease. Any left over residue must be removed after pre-feeding and trapping has been completed;
26. Do not confront suspect users of state forest and private property. To write down vehicle registration number, make of vehicle, number of occupants, information about dogs and firearms and report soon as practical to relevant people or authorities;
27. If completing an autopsy and/or retrieving DNA and/or body samples and/or finding pregnancy and unborn litter status, the correct protective clothing/equipment must be used. (See 6 Health and Safety for disease's transmittable to humans)
28. Adhere to Local Committee directives when given;
29. Report any issues of concern to the Local Committee.
30. Any photos or any other electronic media taken to verify a kill shall remain the property of SFPAG and/or the local pig group or funding body and is not to be used in any other forum.

#### **4.2. Committee Requirements**

The Local Committee must ensure that the correct and proper details and needs are supplied to trappers and relevant authorities and/or may request/supply.

1. That a letter be sent to local police stations annually advising that trapping activities is being undertaken in the area and that that trappers hold a permit to carry and discharge a firearm on DEC land;
2. Ensure trappers have correct firearms license;
3. The registration number of trapper's vehicles are recorded with the DEC District Officer;
4. The Secretary of Local Committee is responsible for coordination of a process which ensures that a current DEC permit to carry and discharge a firearm on DEC estate is held by each Trapper;

5. The committee may, at any time, request that a random drug and/or alcohol test be taken by Trappers employed on the feral pig trapping project;
6. To supply trappers with any required items of Personal Protective Equipment (PPE) needed to complete their job and tasks in a safe manner. Equipment required to gain the correct data such as GPS units, scales and digital cameras is also to be supplied;
7. To ensure trappers are employed with correct work agreements and insurance cover;
8. To supply timesheets and data sheets and ensure wages, travel and associated expenses are paid;
9. To set the minimum standards for traps in accordance with DAFWA Farmnote No 36/2003 or with standards as set by the local committee within DAFWA guidelines;



#### *4.3. Traps*

1. All equipment to which pigs have access should be designed and maintained so as to avoid both injury and pain.
2. The release of any pig after capture is not permitted.
3. Any native wildlife captured is to be released immediately unless injured. Advice must be sought from the Department of Environment and Conservation as soon as possible on actions to take in cases of injured native wildlife.
4. Traps are to be placed in areas where ample shade is available throughout the day.
5. Set traps are to be checked daily.
6. When traps are not in use for free feeding or trapping, either the trap door must be maintained in the open position or the trap must be removed from the trap site.

#### *4.4. Key Steps to Improve Trapping Success*

The key elements to catching whole family groups of pigs at once and reducing non-target species in traps are: proper and appropriate trap design, free feeding, suitable locations for traps, regular maintenance of the door mechanism and regular inspection once the trap is set.

Additional recommendations for a successful trapping campaign are:

1. Stop all activities that may disturb the pigs normal feeding and behavioral habits, e.g. do not undertake any shooting or dogging.
2. Set the trap in a shady area with as much natural vegetation as possible. Traps should also be set close to areas where pigs have been feeding. Vehicle access is recommended as carrying large amounts of bait to a trap will soon become a chore.
3. It is best to lay a number of traps in a circuit to make daily checking easier. Checking of traps could also be integrated into other daily routines.
4. Pre-feeding should be carried out at several sites prior to placement of a trap. Once the trap is set, place fresh bait both inside and outside the trap to keep the pigs feeding at the site. Once the pigs settle down and become used to feeding at the site regularly put fresh bait inside the trap only. Continue feeding inside the trap for a few nights before setting the trap. It is important to ensure all pigs in the group are feeding inside the trap before it is set.
5. The bait used in the initial stages should be whatever the pigs are naturally eating. Pigs feeding on a single food source are more than likely not going to be persuaded to take an alternative food source. However experimenting with different baits can produce results. Bait should be a readily available source at low or no cost as large quantities may be required.
6. Use bait with a strong attractive smell.
7. Lay large amounts of bait in the trap.
8. Lay additional bait material on top of previous bait.
9. Set the trap every night and check each day. If the trap cannot be checked daily, the trap shall be set in the shade. Water must be supplied in all circumstances.
10. Do not be deterred if pigs are hesitant to enter traps, as time and patience should overcome this.

Some ideas for enticing shy pigs are:

- a) Disturb the ground inside the trap with a hoe.
- b) Use aromatic attractants such as molasses, vanilla essence, aniseed, creosote or fish oil
- c) Lay a fresh bait trail from the pad or fresh diggings to the trap.

## 5. Humane Destruction

The following has been obtained from the Australian Model Codes of Practice for the Welfare of Animals prepared for the Standing Committee on Agriculture and Resource Management (SCRAM). Both the Pigs 1998 and Feral Livestock animals – Destruction or Capture, Handling and Marketing Codes (1996) have been endorsed as the national codes by the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). The code of practice for the welfare of animals emphasises that, whatever the form of husbandry, managers and others responsible for the day to day needs of pigs have a responsibility to care for animals under their control.

### 5.1. *Welfare Problems Associated With Culling*

Culling of animals in management programs should be carried out with due regard for the welfare of the animals involved. Personnel responsible for the control of feral animals should be aware of their responsibilities to limit the amount of suffering of target animals and avoid suffering of non target animals. The methods used should involve the lowest level of suffering consistent with effective control. The method of slaughter should be effective and cause a sudden and painless death for the animal. It is important that the animal be “handled” quietly beforehand to ensure it is not unnecessarily distressed or alarmed. In practice, a variety of methods may be used with shooting as a humane endpoint, e.g. trapping using feed and water as bait.

The following methods are unacceptable on animal welfare grounds:

1. Poisoning using unregistered poisons which cause severe and prolonged pain;
2. Denial of water without provision of alternative sources as a means of killing animals;
3. Wounding of animals so that they will die away from the shooting area; and
4. Trapping without prompt destruction or removal of captured animals.

Shooting within traps or out in the field, if carried out properly is the most effective for humanely destroying pigs. Shooting of feral animals should only be carried out by:

1. By experienced and conscientious shooters;
2. By persons who have a current firearms license and comply in every respect with the provisions of the relevant weapons act;
3. By using a firearm capable of killing the target animal with a single round; and
4. When the animal is cleanly sighted.

### 5.2. *Safety*

The following aspects of firearm safety should be kept in mind:

1. For smaller pigs (less than 40kg) and ground shooting, .243 calibre rifles with 80 or 100 grain soft nose projectiles are suitable. In competent hands smaller calibre rifles such as .222, .223 may be acceptable;
2. Contained or constrained pigs can be humanely destroyed with a .22 calibre rifle;
3. Persons other than the marksman and an animal handler should be cleared from the area and stand well behind the marksman;
4. Never fire while the animal is moving its head. Wait patiently for a quiet interval before firing.
5. To provide maximum impact and the least possibility of misdirection the range should be as close as circumstances permit; and
6. While the humane killer pistol and the captive-bolt pistol are designed to be pressed firmly on the head prior to being discharged, it is not safe to do this with a standard rifle or pistol (Australian Agriculture Council, Sub-Committee on Animal Welfare 1996).

### 5.3. *Methods*

1. Temporal Method: The pig is shot from the side of the head so that the bullet enters the skull at a point midway between the eyes and the base of the ear on the same side. This method is preferred for adult pigs because of the heavier bone structure of the front of the skull.
2. Frontal Method: The firearm should be aimed horizontally into the skull at a point midway across the forehead and for adult pigs about 2cms above the level of the eye (Australian Agriculture Council, Sub-Committee on Animal Welfare 1996).
3. Poll Method: Aim behind the head at a point midway along a line drawn from the base of each ear.

## 6. Health and Safety

Feral pigs are known to carry many diseases that can affect other livestock (not just pigs) and be transmitted to humans. Those most likely to affect humans are:

1. Sparganosis: A parasite that affects the muscles of humans.
2. Leptospirosis: A serious illness that causes very high temperatures, kidney problems and jaundice.
3. Q Fever: This disease occurs in all animals. It can cause very high temperatures and result in severe heart problems.

Q fever and Leptospirosis cause symptoms similar to Ross River Fever and can be contracted through contact with blood, meat and urine, through broken skin, intake of urine contaminated food or water and inhalation of infection air-borne organisms. Both can be fatal. Owing to these possibilities it is advisable to avoid excess handling of feral pigs.

## 7. Risk and Indemnity

1. The accredited trapper will be liable for loss or damage (including injury whether or not resulting in death) arising from the unlawful or negligent acts or omissions of the accredited trapper, in the course of conducting (or attempted or purported conducting) of trapping and shooting activities.
2. The accredited trapper releases and indemnifies all landholders and/or stakeholders and their associated officers, servants, agents relatives, employees and visitors from and against all actions whatsoever and howsoever arising which may be brought or made against any of them by any person including the accredited trapper, arising from:
  - Any willful or negligent act or omission of the accredited trapper or any person for whose conduct the accredited trapper is liable.
  - Any unlawful or negligent act or omission of the visitors or invitees of the accredited trapper.
  - Death, injury, loss or damage suffered by the accredited trapper, or any visitors or invitees of the accredited trapper except where the death, injury or loss is caused the negligence or other wrongful act or omission of the landholders or stakeholders, or their relevant officers, servants, agents, relatives, employees and visitors.
3. Accredited trappers or any other person are under no circumstances to enter a trap when live feral pigs are enclosed within the trap.
4. **Employment or representing the involved Stakeholders**  
The accredited trapper does not become an employee or agent of any of the landholder and/or stakeholders by virtue of the accreditation.  
The accredited trapper shall not in the exercise of activities under this accreditation represent themselves or allow themselves to be represented as an employee or agent of the landholder and/ or stakeholders involved.



# **MEMORANDUM OF UNDERSTANDING**

This **Memorandum of Understanding** (MOU) outlines the codes of practice, standards, principles, practices, processes and protocols which all parties agree to uphold and strictly maintain while participating in and so representing the **South West Feral Pig Control project 2013 – 15**.

The signatory parties to this MOU are four community feral pig control groups, namely:

- Preston Communities Vertebrate Pest Management Group
  - Lower Blackwood Vertebrate Pest Management Group
  - Middle Blackwood Vertebrate Pest Management Group
  - Donnelly Vertebrate Pest Management Group
- and the:

- Warren Catchments Council Inc.

This MOU is recognised by the:

- State NRM Office (the project funding body), and
  - South West Catchments Council Inc (SWCC, the project proponent),
- and by the project delivery partners:
- Department of Agriculture & Food WA (DAFWA)
  - Department of Parks & Wildlife (Parks and Wildlife)

## ABBREVIATIONS

<b>the Project</b>	this component part of the overarching South West Feral Pig Control project which is coordinated and implemented by the WCC and which involves the four listed community feral pig control groups.
<b>Group</b>	any one of the four community feral pig control groups participating in the Project.
<b>Group Committee</b>	the governing committee of any Group.
<b>PCVPMG</b>	Preston Communities Vertebrate Pest Management Group
<b>LBVPMG</b>	Lower Blackwood Vertebrate Pest Management Group
<b>MBVPMG</b>	Middle Blackwood Vertebrate Pest Management Group
<b>DVPMG</b>	Donnelly Vertebrate Pest Management Group
<b>Operator</b>	any one of the people trained, accredited, authorised by their respective Group and permitted by the appropriate landholder to operate in the field to control feral pigs.
<b>WCC</b>	Warren Catchments Council Inc (sub-regional NRM group)
<b>SWCC</b>	South West Catchments Council Inc (regional NRM group)
<b>DAFWA</b>	Department of Agriculture and Food WA
<b>Parks and Wildlife</b>	Department of Parks and Wildlife

For the duration of the Project, each party agrees to the following:

## **1. WARREN CATCHMENTS COUNCIL INC (WCC)**

### **1.1. INSURANCE:**

- 1.1.1. arrange and pay the premium for public liability insurance to cover the authorised feral pig control work of each Operator working under the instruction of a Group Committee;
- 1.1.2. arrange and pay the premium for Work Cover insurance to cover the authorised feral pig control work of each Operator working under the instruction of a Group Committee.

### **1.1 COMMUNICATION:**

- 1.1.1 form and maintain appropriate channels of good communication with each Group;
- 1.1.2 liaise with the other sub-regional groups whose catchments are impacted by the Project;
- 1.1.3 initiate on behalf of each group good communication with SWCC, DAFWA & Parks and Wildlife;
- 1.1.4 support each Group in their ongoing communication with SWCC, DAFWA & Parks and Wildlife.

### **1.2 TRAINING & WORKSHOPS:**

- 1.2.1 arrange for all required training on at least one occasion common to all Groups;
- 1.2.2 pay the basic course fees of all required training on one occasion for each Operator;
- 1.2.3 arrange and pay for the running of various community workshops.

### **1.4 PAYMENT FOR OPERATIONS:**

- 1.4.1 pay Operators for their authorised feral pig control work under the following conditions:
  - the Operator is appropriately accredited and is current for all licences;
  - the Operator is working to the current version of the Code of Practice;
  - the Operator is working under the explicit authorisation of the Group Committee;
  - the work is within the agreed activities and budget of the Project;
  - the work is carried out only under all necessary permits including land access permits.
- 1.4.2 the maximum number of hours able to be paid for shall be in accordance with arrangements agreed between WCC and each Group from time-to-time through the Project;

- 1.4.3 the hourly base rate of pay shall be within a range determined by the Project proponent and shall have a 'casual load' of 30% added to the base rate to arrive at a gross hourly rate of pay;
- 1.4.4 the actual hourly base rate of pay for individual Operators shall be selected from the range determined by the Project proponent and shall be dependent upon the qualification or rank of the Operator as agreed first between WCC and the Group Committee, and then between the Group Committee and the Operator;
- 1.4.5 pay Operators a per kilometre rate of reimbursement for travel costs at a rate determined by the Project proponent and for an actual travelled distance, the maximum of which is determined and agreed by WCC and the Group Committee and communicated to the Operator;
- 1.4.6 pay Operators only on receipt of a valid tax invoice endorsed by an authorised office bearer of the Group Committee and by the WCC Project Officer;
- 1.4.7 pay any GST charged by the Operator if the Operator is registered for GST and if the amounts to be paid are clearly labelled as including GST.
- 1.4.8 pay as soon as is practical and within not more than 28 days of receipt of properly endorsed tax invoice, by either electronic funds transfer (EFT) or by cheque whichever is preferred and arranged for by the Operator by note with their tax invoice.

## **1.5 FUTURE FUNDING:**

- 1.5.1 seek, and advise Groups on, possible future funding opportunities.

# **2. THE GROUPS, THEIR COMMITTEES & THEIR OPERATORS**

## **2.1 EACH GROUP COMMITTEE WILL:**

- 2.1.1 be aware of and authorise all operations;
- 2.1.2 prevent unauthorised operations from occurring;
- 2.1.3 maintain strict Occupational Health & Safety standards among their Operators;
- 2.1.4 liaise with local Police and local Shire(s) regarding the Group's formation and operations on a seasonal basis;
- 2.1.5 provide in a timely fashion to WCC copies of all relevant documentation, certificates and etc;
- 2.1.6 provide to WCC a Group Register listing the name, street addresses / location numbers and contact details of each member and indicating which members are committee members or office bearers;
- 2.1.7 endorse and adopt the Feral Pig Control Industry Code of Practice version 2.5;
- 2.1.8 seek membership of the Southern Feral Pig Advisory Group Inc (SFPAG) and be represented at SFPAG meetings (twice annually);
- 2.1.9 liaise with sub-regional catchment and LCDC groups overlaying the Group operational area;
- 2.1.10 provide in a timely fashion to WCC copies of Group meeting minutes.

## **2.2 EACH GROUP WILL PROVIDE OPERATORS WHO HAVE:**

- 2.2.1 completed and passed Certificate III Vertebrate Pest Management;

- 2.2.2 successfully completed a Parks and Wildlife firearms safety course including possession of a current Police Clearance (unless the Operator is ranked as a Trainee, in which case the Trainee only accompanies a fully-licensed operator and does not use a firearm);
- 2.2.3 a current Senior First Aid certificate;
- 2.2.4 a current valid driver's licence;
- 2.2.5 their own valid and currently registered ABN;
- 2.2.6 provided their bank account details for EFT (BSB & account number) or have requested cheque payments and have provided a postal address;
- 2.2.7 signed an agreement with their Group Committee to adhere strictly to the Feral Pig Control Industry Code of Practice version 2.5;
- 2.2.8 a road-worthy vehicle and equipment maintained in good operational condition;
- 2.2.9 all the required tools of the trade;
- 2.2.10 a current endorsed shoot plan as per PARKS AND WILDLIFE regional/district requirements.

### **2.3 EACH OPERATOR WILL:**

- 2.3.1 comply with Project monitoring & reporting requirements (using GPS, camera & log book);
- 2.3.2 liaise with PARKS AND WILDLIFE (Lead Trappers only);
- 2.3.3 attend training and development at request of their Group Committee wherever possible;
- 2.3.4 sign a work agreement with their committee as per 2.1.7 above (copies are to be held by the Operator, their Group Committee and WCC).

### **2.4 EACH OPERATOR MAY:**

- 2.3.1 be, but does not have to be, registered for GST and the tax invoices they present must clearly state whether or not the amounts to be paid include GST.

# NOTES

## KEY POINTS:

1. Safety comes first: safety for operators, others and the public.
2. There must be absolutely humane treatment of all animals at all times: pigs and dogs equally.
3. There must be strict and complete adherence to the Feral Pig Control Industry Code of Practice version 2.5, all permit requirements and all rules of operation at all times.
4. By participating in the Project, all individuals involved, whether committee members or Operators, are representing their Group, the Project and the entire community-based feral pig control sector at all times, even when not working.

## DOGS:

**It is recognised that, with proper training and under proper direction, detector dogs can be a very useful tool for the control of feral pigs. However, it is also clear that the improper use of dogs may present one of the greatest risks to the future of the entire community-based feral pig control sector.**

1. For the term of this Project, our best advice is: don't use dogs.
2. If dogs are deployed, then dogs shall be deployed only as detector dogs.
3. The Operator shall ensure that there is never any contact between dog and pig.
4. Any dog use at any time and any place, whether private or public land, must always strictly and completely adhere to the Feral Pig Control Industry Code of Practice version 2.5
5. There must be absolutely humane treatment of all animals at all times: pigs and dogs equally.
6. For any land, public or private, the land manager must provide explicit written approval for use of dogs on that land at that time.

**To deploy dogs on public land, the Operator must have in their possession the explicit written permission of the land manager, which is the WA Department of Parks & Wildlife, including clear reference to the dates the permission is valid for, the name of the Operator and their Group and the boundaries of the permitted land. Copies of this permission must be provided to the Group Committee and to the WCC before deployment.**

## INVOICING & PAYMENTS:

1. The Operator must complete their log book daily.
2. The original white (tear out) sheet will be provided to WCC in batches with the relevant tax invoice to match (monthly).
3. Operator tax invoices must be properly endorsed by their committee (no endorsement, no payment).
4. Payment by EFT is preferred; Operators must provide bank details.
5. Payments will be made as soon as practical (bear in mind that WCC has its own committee, the Treasurer of which signs off on all payments).
6. Payments will only be made for work done within the conditions of the Project.

### DONNELLY VERTEBRATE PEST MANAGEMENT GROUP

.....  
(signature of Chair or President)

.....  
(signature of a second office bearer)

.....  
(print name of Chair or President)

.....  
(print name of second office bearer)

..... / ..... / .....  
(date)

..... / ..... / .....  
(date)

### MIDDLE BLACKWOOD VERTEBRATE PEST MANAGEMENT GROUP

.....  
(signature of Chair or President)

.....  
(signature of a second office bearer)

.....  
(print name of Chair or President)

.....  
(print name of second office bearer)

..... / ..... / .....  
(date)

..... / ..... / .....  
(date)

### LOWER BLACKWOOD VERTEBRATE PEST MANAGEMENT GROUP

.....  
(signature of Chair or President)

.....  
(signature of a second office bearer)

.....  
(print name of Chair or President)

.....  
(print name of second office bearer)

..... / ..... / .....  
(date)

..... / ..... / .....  
(date)

### WARREN CATCHMENTS COUNCIL INC

.....  
(signature of Chairman)

.....  
(signature of a second office bearer)

.....  
(print name of Chairman)

.....  
(print name of second office bearer)

..... / ..... / .....  
(date)

..... / ..... / .....  
(date)

# VERTEBRATE PEST MANAGEMENT GROUP FIELD OPERATOR AGREEMENT

*This **Agreement** summarises the code of practice to which the field operators (accredited trappers) deployed by the Vertebrate Pest Management Groups agree to work and the standards which they agree to uphold and strictly maintain while participating in and so representing the **South West Feral Pig Control project 2013 – 15**.*

---

**The signatory parties to this Agreement are:**

(A) [PRINT NAME] The..... Vertebrate Pest Management Group, and

(B) [PRINT NAME] ..... Field Operator (accredited trapper).

---

**Statement of Agreement:**

I [PRINT NAME] ..... agree to undertake the role of Field Operator

(accredited trapper) for the..... Vertebrate Pest Management Group.



1. I have read and will adhere to the **Feral Pig Control Industry Code of Practice version 2.5(\*)**.  
(\*)sect 4.1.6 of the code The “buddy” safety work system, may be replaced with a suitable Standard Operating Procedure of reporting intended whereabouts and safe return to ensure the field operators safety during pig control activities.
2. I understand that I represent the ..... Vertebrate Pest Management Group and that at all times my actions may be viewed as representative of the Group’s values, and therefore I will work and act in such a way as to protect those values and the reputation of the Group.
3. I understand that I also represent the general community-based feral pig control sector in the eyes of the broader community and therefore I will work and act in such a way as to protect the reputation of the sector.
4. I will act only according to the instruction of my Group committee of management.
5. I understand that my Group committee of management has the authority to suspend my services or discharge me from my work duties on immediate notice if I am in breach of this Agreement.

---

**Signed and dated:**

..... (field operator)  
..... (date)

..... (Group Chair)  
..... (date)

---

**Field Operator Role:**

*To control or eradicate feral pigs in the Group’s area of operation using approved methods and thus reduce the agricultural, environmental, social and economic impacts which feral pigs cause within the Group’s area, and to keep records of all control activities and make accurate and timely reports to the Group committee.*

## **Appendix 6: Working Arrangements for the control of introduced animals for the Albany Branch of the Sporting Shooters Association Hunting and Conservation program Australia**

These guidelines are to be used by the Albany Branch of the Sporting Shooters Association of Australia under the guidance of the Department of Environment and Conservation (DEC). All participants in this program must understand the potential for this project to become controversial and that all due care must be taken to ensure the program is executed as per these guidelines.

### **OBJECTIVE**

To carry out feral animal control within the Walpole Wilderness Area and within additional areas nominated by the Frankland DEC Feral control officer

### **1. RESPONSIBLE AGENCY**

1.1 DEC will be responsible for the coordination of feral animal control projects within DEC managed lands. For areas adjoining DEC managed lands, DEC may take a role in feral animal control, where significant biodiversity values are being directly affected. Feral animal control programs will be developed in consultation with the Department of Agriculture and Food (DAFWA), Police, Local Authorities and other relevant stake holders.

### **2. METHODS OF CONTROL**

2.1 Methods of control that will be permitted on DEC lands include:

- Trapping (covered in Section 15)
- Tracking and shooting without the use of dogs

2.2 Poisons/ baits are not to be used.

### **3. MEMBERSHIP**

3.1 All participants in this program must be members of the Sporting Shooters Association of Australia ,WA INC. (SSAA) and registered by the Albany Branch of the Association as participants in this program.

3.2 The Sporting Shooters Association of Australia (WA) INC. "Hunting and Conservation Program Operational Procedures" should be strictly adhered to, specifically in regards to sections 1 through to 5

### **4. FIREARMS**

#### **4.1 Permits**

4.1.1 Written authority (permits) to carry and use firearms within DEC estate is required under Section 12 for the Conservation and Land Management Regulations 2002.

4.1.2 Written authority is valid for a time period of 12 months or until expiry of the permittee's personal firearm licence.

4.1.3 Renewal of the written authority to carry and use firearms within DEC estate is the responsibility of each SSAA member using firearms on lands managed by DEC.

4.1.4 Written authority to carry and use firearms within DEC estate must be carried at all times when carrying or using firearms on lands managed by DEC.

4.1.5. Application for permits to carry firearms on DEC land, are to go through the invasive species project officer.

## 4.2 Animal Ethics

4.2.1 A strict rule of one shot, one kill must be applied to all hunting practices. The appropriate “kill zone” for each animal is to be targeted to ensure this process is successful.

4.2.2 A shot of 100m is the recommended maximum distance from shooter to target.

4.2.3 The following table should be taken into consideration when dispatching animals:

Recommended calibre and ranges for the use of firearms to shoot animals

Species	< 30m	30-100m	>100m
Pig	.44 Mag.	.44 Mag	≥ .243
	12 Gauge	≥ .243	
Deer	≥ .222	≥ .222	≥ .222
Dog	.17	≥ .222	≥ .222
	.22 Hornet		
	12 Gauge		
Cat	.17	≥ .222	≥ .222
	.22		
	12 Gauge		
Fox	.17	≥ .222	≥ .222
	.22 Hornet		
	12 Gauge		
Rabbit	.17	.17	.22 Hornet
	.22	.22 Hornet	
	12 Gauge		

4.2.4 A second shot should be used to confirm the kill

## 4.3 Firearms Training

4.3.1 DEC (or equivalent) Firearms Training is a prerequisite for any one in the SSAA using firearms on land managed by DEC. (Note: Until such time this training is formally available from DEC or DEC accredited trainer, SSAA accreditation processes will be acceptable.)

## 4.4 Shoot plans

4.4.1 SSAA, in conjunction with DEC, must complete shoot plans for areas where firearms are to be used. These plans must be in place prior to the use of firearms on DEC estate.

4.4.2 Shoot plans will be adhered to in the field during any operation involving the use of a firearm.

4.4.3 Shoot plans must be carried when firearms are being used on DEC estate and must be produced for a DEC officer upon request.

## **4.5 Fire arm safety**

4.5.1 All fire arms must be used in accordance with the Firearms Act 1973

4.5.2 “Always assume that a firearm is loaded” and apply muzzle awareness techniques.

4.5.3 No shooting from a moving vehicle

4.5.4 No shooting across or down roads

4.5.5 Never shoot over the brow of hills or on ridges

## **4.6 Other**

4.6.1 The Sporting Shooters Association of Australia (WA) INC. hunting and conservation program operational procedures should be strictly adhered to, specifically in regards to sections 11 through to 14 as follows

*<sup>(1)</sup>11. When in transit to and from a hunting area, firearms are to be carried unloaded and out of sight, preferably in a gun bag or box. No Ammunition belts or large knives are to be worn when traveling to a hunting area. When hunting on land controlled by the department of conservation and land management (CALM), participants may only take fire arms for which they have the relevant permits.*

*12. Firearms are to be carried with an empty chamber. This instruction applies when hunting on foot or from a vehicle. Cartridges are not to be loaded into a firing chamber until immediately prior to a shot being fired. Any additional safety instructions from the team leader must be complied with.*

*13. Each participant must have their firearm checked and cleared by another person prior to that firearm being packed away at the completion of a hunt.*

*14. No participant may consume alcohol or drugs prior to or during an activity involving firearms. If a participant is taking prescribed medication that may affect their ability to safely handle a firearm then that person is obliged to inform the team leader who will then make a decision as to that members continued participation.*

*<sup>(1)</sup>Sporting Shooters Association of Australia (WA) INC. Hunting and Conservation program, operational instructions.17/2/2004*

## **5. INSURANCE AND LIABILITIES**

5.1 Insurance of personnel, vehicles and other equipment is the responsibility of the Sporting Shooters Association or registered individuals. Details of insurance arranged through the SSAA should be given to DEC and include:

- Policy name and number
- Policy holders name and address
- Insurers name and address
- Expiry date of policy

## **6. OPERATIONS**

6.1 The following PPE will be worn when carrying out operation on DEC land

- Hearing protection class 5 or above shall be worn when using a firearm
- Eye protection (medium impact)
- Hi Visibility vest or hat
- Sun protection
- Safety boots
- Gloves when removing carcasses

6.2 All bullet shells dispensed during hunting operations shall be collected, so no trace is left.

6.3 The Sporting Shooters Association of Australia (WA) INC. hunting and conservation program operational procedures should be strictly adhered to, specifically in regards to sections 6 through to 8 and section 15 as follows:

*<sup>(2)</sup> 6. all formal Hunting & conservation activities will be supervised by a team leader who will be completely in charge and take responsibility for the conduct of that activity.*

*7. Any breach of safety or failure to follow a team leader's instructions will result in disciplinary action against the member/s involved.*

*8. All participants are expected to display a high standard of safety, hunting ethics and environmental awareness. All provisions of relevant wildlife and firearms legislation are to be adhered to at all times.*

*15. All participants are to advise the team leader of any medical condition or allergy they may have or any medication they may be using that may affect their safety or well being during the activity.*

*<sup>(2)</sup>Sporting Shooters Association of Australia (WA) INC. Hunting and Conservation program, operational instructions.17/2/2004*

6.4 All operations are to follow each section within this document, as per the sections 17 and 18 of the Sporting Shooters Association of Australia (WA) INC. hunting and conservation program operational procedures. Failure to do so, may cause cancellation of firearm licenses and access to DEC estate for feral animal control operations.

## **7. COSTS**

7.1 DEC will supply sufficient materials to construct four traps, provide grain and molasses for free feeding purposes, map or copies of maps for field work and mobile signs for placement on tracks as required. The SSAA or participants in this program will be responsible for all other costs incurred.

## **8. NOTIFICATION / REPORTING**

### **8.1 Notifications of operations**

8.1.1 DEC is to be notified by fax/ email or phone call, 2 days prior to SSAA carrying out any operations on DEC estate, to enable the identification of any potential issues/ conflict with existing operations and to inform DEC law enforcement staff of the legitimate use/ carriage of firearms. Where operations are occurring adjacent to private property, see section 8.2.3 for additional notification requirements.

8.1.2 The notification should include

- Vehicle details
- Number of people involved
- Team leader name and contact number
- Area of operations
- Duration of operations
- Location of camping spot ( see section 17)

8.1.3 Notification is to be given to the feral project officer. If the project officer is not available notification is to be given to the Nature Conservation coordinator and if the Nature Conservation coordinator is not available, notification must be sent to the District Manager.

8.1.4 Approval must be granted once a notification has been given. This will be either an email or phone call from the Project Officer or Nature Conservation coordinator.

## **8.2 Private property access**

8.2.1 Where feral animal control activities are planned to occur adjacent to private property, DEC will be responsible for all notifications to Private Property owners, unless an agreement has been reached between DEC and SSAA

8.2.2 Notification to Private Property owners of the intention to carry out the programs/ projects adjacent to properties shall be given at least three days prior to activities occurring.

8.2.3 If access to Private Property is required to complete feral animal control activities affecting biodiversity values on adjacent DEC managed land, the Dept of Agriculture and Private property owner should be consulted and written permission obtained from the PP owner. In this instance, DEC will undertake relevant consultation with the Dept of Agriculture and the PP owner. Where work on private property is required, 2 weeks notice must be provided to DEC by the SSAA to allow for relevant consultation. DEC will not coordinate feral animal control activities on private property unless there are specific biodiversity values at risk.

## **8.3 Reporting safety incident**

8.3.1 Any near miss or safety incidents on DEC estate need to be reported to the DEC project officer within 24 hours of the occurrence. If required, a safety investigation will be carried out by DEC.

## **8.4 Firearm safety incident**

8.4.1 All incidents no matter how minor they may seem must be reported to the DEC project officer within 24 hours, which may be followed up with investigation. Examples of incidents include damage to firearms, property, unintentional discharge, injury or potential damage.

## **8.5 Monthly reporting of Field operations**

8.5.1 Monthly reports need to be communicated to the DEC project officer of any operations that have been carried out on DEC estate.

8.5.2 The operations report should include:

- Number of dispatches any associated data i.e. weight, sex, location of dispatch etc
- Any sightings and any associated data
- Area of operations
- Number of kilometers traveled

## **8.6 Other Reports**

8.6.1 Reports of any illegal activity seen whilst in DEC estate should be reported as soon as possible to a DEC project officer or regional wildlife officer.

## **9. MEDIA AND PUBLICITY**

9.1 All media contact will be the responsibility of DEC

9.2 DEC will deal with the publicity (proactive and reactive) in consultation with SSAA

## **10. ACCESS**

10.1 Vehicle access is permitted along public access forest tracks and roads. New roads/ tracks are NOT to be constructed. Access to certain roads and tracks may be restricted due to dieback hygiene and surface management issues. Where access to these areas is required, the DEC feral animal project officer should be contacted to arrange for a relevant permit.

10.2 Roads that require a Disease Risk Area (DRA) permit can only be accessed under dry soil conditions, unless otherwise specified in the permit conditions.

10.3 If a DRA permit is issued, the permit must be kept with the vehicle at all times when accessing DRA

10.4 DEC to supply an annual map of access for the SSAA.

10.5 Vehicles movement is to be confined to the surface of designed roads and tracks unless otherwise approved by DEC.

## **11. DISEASE HYGENE**

11.1 Vehicles must be cleaned of mud, soil and plant material, prior to entering any Disease Risk Area

11.2 Footwear must be cleaned with a Methylated spirits solution prior to leaving the road surface to access ridgeline vegetation areas.

11.3 To protect creek lines, swamps and wetlands against the spread of chytrid fungus, boots must be clean prior to entry into these areas. Footwear must be scraped or washed to remove any mud and disinfected using 1%bleach for 1 minute; Cleaning of footwear should be carried out at a safe distance from surface water and outside of PDWSAs.

## **12. TRAINING AND SKILLS**

12.1 DEC on request from the SSAA will provide basic training in

- Phytophthora management
- Map reading
- Firearm safety ( compulsory see section 4.3.1)

## **13. HEALTH**

13.1 Transportation of live pigs is not permitted

13.2 Carcasses of dispatched animals are to be left in the bush at a suitable location.

13.3 Carcasses of dispatched animals are not to be left within 50 m of surface waters or riparian systems

13.4 Correct PPE should be worn when moving or handling dispatched animals to prevent transfer of disease.

## **14. NON NATIVE SPECIES**

14.1 Participants may shoot non-native species if they are seen, eg wild Dogs, Goats, Deer, Cats and Pigs as long as they are recorded as per part 8.5.2.

14.2 Stock animals such as cattle, sheep and horses are not to be shot, but a description of the animal(s), number, location and distinguishing marks or brands should be reported.

## **15. TRAPPING**

- 15.1 Trapping of pigs can be carried out by using silo mesh traps
- 15.2 Traps must be checked every 24 hours when set or prefeeding is occurring
- 15.3 The traps must have a source of water and shade for any potentially trapped animal
- 15.4 The type of baits to be used in the pig traps are to be approved beforehand by DEC

## **16. FIRE**

16.1 Participants in this program shall observe and comply with the provisions of the Bush Fire Act 1954, the Bush Fire Amendment 1992, the Bush Fire Regulations and any relevant DEC restrictions on campfires.

16.2 The Sporting Shooters Association of Australia (WA) INC. hunting and conservation program operational procedures should be strictly adhered to, specifically in regards to section 17 as follows

<sup>(3)</sup>17. All CALM rules and regulations regarding fires, vehicle access, littering or any other matter are to be obeyed.

<sup>(3)</sup>Sporting Shooters Association of Australia (WA) INC. Hunting and Conservation program, operational instructions.17/2/2004

## **17. CAMPING**

17.1 Camping is permitted in formal DEC camping areas. Camping outside of these areas may be allowed on a case by case basis where feral animal control activities are in more remote parts of the national park.

17.2 Proposed camping locations must be included in notifications to allow for assessment and approval/ refusal. Camping outside of DEC designated areas may only be undertaken with written approval from a DEC officer with delegated powers from the DEC Frankland District Manager

17.3 "Leave No Trace" principles should be applied to camping on DEC land.



**Appendix 7: Monitoring protocols implemented by Parks and Wildlife personnel (Stewart *et al.* 2011).**

FRANKLAND DISTRICT FERAL FORM (Sightings, Trap details, Dispatch details).

Date:.....		Assessor (s).....		GPS Track saved to file (tick) ..... <u>or</u> Highlighted map attached (tick) .....		Page....of.....	
------------	--	-------------------	--	--------------------------------------------------------------------------------------	--	-----------------	--

SIGHTINGS							TRAP INFO					
Species	Location	Activity Level	Activity Type	Reactivity	Damage Description	Comments (pre feed, # of animals, etc)	Site #	Trap #	Location	Status	Trap Type	Comments (activity, pre feed, camera, sow scent etc)
	GPS: Block:								GPS: Block:			
	GPS: Block:								GPS: Block:			
	GPS: Block:								GPS: Block:			
	GPS: Block:								GPS: Block:			
	GPS: Block:											

DISPATCH										Pre Feed Notes
Species	Site #	Trap #	Dispatch Initials	Within Trap?	Sex	Age	colour	condition	status	Comments (location details if an opportunistic dispatch)

Observations (illegal activities - rego, vehicle description etc)
-------------------------------------------------------------------

## Sightings Section

Species codes	
Pig	P
Cat	C
Fox	F
Other	O

Location	
Latitude/Longitude	
Also record forest block	

Activity Level Codes	
High	1
(Activity over long period)	
Medium	2
(More than one animal present)	
Low	3
(One animals set of prints)	

Activity Type Codes	
Scats	1
tracks	2
Scats and Tracks	3
Diggings/Wallows	4
Diggings/ tracks and scats	5
Actual sighting	6

Recency Codes	
Fresh ( within 2 days)	1
Within last two weeks	2
Older than two weeks	3
Older than this season	4

Damage type/ size (wallows and diggings)			
Activity area	Code	Activity area	Code
0 to 2 m <sup>2</sup>	1	25 to 50 m <sup>2</sup>	5
2 to 5 m <sup>2</sup>	2	50 to 100m <sup>2</sup>	6
5 to 10 m <sup>2</sup>	3	100 to 200m <sup>2</sup>	7
10 to 25 m <sup>2</sup>	4	200m <sup>2</sup> plus	8
m <sup>2</sup> = length x width of area affected			

Trap number	Location
Number on trap	Latitude/Longitude and Forest Block

Trap Status Codes		Trap type Codes	
Closed	C	Victor Soft Jaw	1
Open	O	Sheffield	2
Moved to a new location	M	Victor Soft Jaw inside native animal enclosure	3
Open and set	S	Figure of 6 pig trap	4
Open and Pre feeding	P	Other pig trap	5
		Opportunity dispatch	6
		Other	7
		Camera	8

**Observation Box: Any other comments on dispatch trap or sighting**

**Before Dispatch Please Complete Shoot Plan**

**Sightings that fall below the red line in the damage type/size table needs to be tracked by a GPS**

## patch

Species codes	
Pig	P
Cat	C
Fox	F
Other	O

Site Number and Trap Number
Lat and Long should already be recorded in trap info section

Dispatcher's initials
persons initials

Within Trap?	
Yes	Y
No	N

Sex Codes	
Male	M
Female	F

Age Codes	
Juvenile	J
Sub Adult	SA
Adult	A

Colour Codes	
Brown	B
Black	BL
White	W
"Other" (leave comment)	

Condition Codes	
Good	G
Fair	F
Poor	P

Status Codes	
Dispatched	D
Released	R
Escaped	E

Also Consider	
When Cat trapping, recording stomach contents	

Appendix 8: Feral pig monitoring sheet used by South West Catchment Council field operators.



## Feral Pig Monitoring Sheet

Landholder Name: \_\_\_\_\_

Property Address: \_\_\_\_\_



Date	Location on property: (e.g. paddock name. If possible please provide a sketch map of your property with identifying roads etc)	GPS coordinates (if known)	Pig sign observed (tick appropriate boxes)	Pig damage observed (tick appropriate boxes)	Estimated age of damage (e.g. <1 week, <1 month, > 1 month)	Description and estimated area of damage (e.g. wheat crop trampled by mob of 10-15 pigs, 1ha damaged)	Estimated cost of damage (e.g. through lost crop yield, added cost of re-sowing paddock etc)	Pigs Dispatched (Yes or No) and by whom?
			<input type="checkbox"/> Pig digging <input type="checkbox"/> Pig tracks <input type="checkbox"/> Pig wallows <input type="checkbox"/> Pig sightings <input type="checkbox"/> Pig dung	<input type="checkbox"/> Damage to infrastructure (e.g. fences) <input type="checkbox"/> Crop damage (trampling or consuming) <input type="checkbox"/> Diggings (soil disturbance) <input type="checkbox"/> Damage to native vegetation <input type="checkbox"/> Lamb predation <input type="checkbox"/> Fouling of water sources <input type="checkbox"/> Other				
			<input type="checkbox"/> Pig digging <input type="checkbox"/> Pig tracks <input type="checkbox"/> Pig wallows <input type="checkbox"/> Pig sightings <input type="checkbox"/> Pig dung	<input type="checkbox"/> Damage to infrastructure (e.g. fences) <input type="checkbox"/> Crop damage (trampling or consuming) <input type="checkbox"/> Diggings (soil disturbance) <input type="checkbox"/> Damage to native vegetation <input type="checkbox"/> Lamb predation <input type="checkbox"/> Fouling of water sources <input type="checkbox"/> Other				
			<input type="checkbox"/> Pig digging <input type="checkbox"/> Pig tracks <input type="checkbox"/> Pig wallows <input type="checkbox"/> Pig sightings <input type="checkbox"/> Pig dung	<input type="checkbox"/> Damage to infrastructure (e.g. fences) <input type="checkbox"/> Crop damage (trampling or consuming) <input type="checkbox"/> Diggings (soil disturbance) <input type="checkbox"/> Damage to native vegetation <input type="checkbox"/> Lamb predation <input type="checkbox"/> Fouling of water sources <input type="checkbox"/> Other				

**Appendix 9: Field operator data sheet used by Warren Catchment Council field operators.**

Warren Catchments Council - Ph: (08) 9771 8180

State Natural Resource Management - South West Catchments Council

New reporting

0001

**FERAL PIG CONTROL**

**Field Operator Sheet**

Date: \_\_\_\_\_

Operator	Start Time	End Time	Total time out (hours)	Kms Travelled	Locality	Weather

Description of <b>pigs dispatched</b> <i>i.e. number of pigs, male/female, etc.</i>	Camera/Map Ref	Weights (kg)

Camera/Map Ref	Description of <b>activity</b> <i>i.e. monitoring damage, setting and checking traps, trap types, pre feed types, or road name ,property location etc.</i>

## **WCC- Instructions for field operators using GPS cameras in reporting on pig damage, trapping and pig dispatch.**

### **GPS photos and Reporting**

Photo numbers need to be recorded in your log books with a brief description (one or two words) so the person inputting the data at WCC knows what the photo is, (e.g. pig damage).

You could enter this information after returning from the field.

When you're in the field take photos of:

- **General location shots**- this enables us to plot the areas you are working in, and gives your group evidence of field operator activity and in the case of an audit, proof of your log sheets.  
The photos could be of a water point, road junction, property boundary etc. About six to ten shots per field trip would be good.
- **Traps set**- initial shot of the trap when installed and could be a 'general shot' at later visits particularly if there has been pig activity.
- **Pig damage** – new and old, noting in the log book approximate age of the damage. This helps build the picture of pig activity.
- **Pig dispatch**- at the site of dispatch with appropriate data.
- **Significant photos** – Anything unusual E.g. site of a quokka sighting or other feral animals evidence and notation in log book. Photos could also be evidence of illegal pig hunting.

When downloading photos onto a disc to post to WCC choose **the** "use disc as a usb" from the drop down menu.

More photos are better than less as we can always archive them for future reference if required. Photos will be strictly confidential and not for general display.

## Appendix 10: List of existing stakeholders and contact details

Organisation	Contact, Email and Phone Number	Website/ Postal Address
South West Catchments Council SWCC	Biodiversity Programme Manager (08) 97614184 Derani Sullivan, Biodiversity Project Manager derani.sullivan@swccnrm.org.au 97614184	www.swccnrm.org.au PO Box 5066 Bunbury WA 6230
Southern Feral Pig Advisory Group	Frank Camarri, Chairman frank.camarri@inet.net.au (08) 97562024	
Warren Catchments Council	Andrew Pound, Project Officer andrew.pound@warrencc.org.au 97718180	www.warrencc.org.au 52 Bath Street Manjimup WA 6258
West Arthur Landcare	Michelle Gooding landcare@westarthur.wa.gov.au (08) 9736 2004	27 Burrows Street Darkan WA 6392
Lower Blackwood Landcare	Yasaman Mohammadi, NRM Officer lowerblackwood@bigpond.com (08) 9758 4021	
Lake Muir Denbarker Community Feral Pig Eradication Group	Mark Muir mmuir@bordnet.com.au 9769 1001 Jo Wills, Secretary willsyj@westnet.com.au 9855 1590	
Northcliffe Declared Species Group	Wally Bettink, Co-convenor bettink@westnet.com.au (08) 9776 7011	
Preston Community Vertebrate Pest Management Group	Richard Walker, Chairman wambenger@westnet.com.au (08) 9766 1051	
Middle Blackwood Community Pest Vertebrate Management Group	Greg Kennedy, Field Operator greg.kennedy@talisolithium.com 0427577821	
Donnelly Community Vertebrate Pest Management Group	Les Dunnet, Field Operator 0427 449 144	
Lower Blackwood Community Pest Vertebrate Management Group	Peter Dickens pgdickens@hotmail.com (08) 9756 0311	
DoE (Federal)	(02) 6272 3933	www.environment.gov.au GPO Box 787 Canberra ACT 2601
DoA (Federal)	(02) 6272 3933	www.agriculture.gov.au Department of Agriculture 18 Marcus Clarke Street Canberra ACT 2601
DAFWA Manjimup	Jason Dearle, Invasive Species Officer Biosecurity & Regulation Jason.dearle@agric.wa.gov.au (08) 97770141/ 0429085795	www.agric.wa.gov.au Locked Bag 7 Manjimup WA 6258
DAFWA Bunbury	Lindsay Strange, Manager Biosecurity & Regulation lindsay.strange@agric.wa.gov.au (08) 97806231/0428930428	www.agric.wa.gov.au DAFWA, Verschuer Place, Bunbury WA 6231

<b>Organisation</b>	<b>Contact name, Email &amp; Phone Number</b>	<b>Postal Address/web address</b>
Parks and Wildlife South West Region	Kim Williams, Regional Nature Conservation Leader Kim.Williams@dpaw.wa.gov.au	www.dpaw.wa.gov.au South West Hwy Bunbury WA 6231
Parks and Wildlife Warren Region Manjimup	Brad Barton, Regional Leader Nature Conservation and Sustainable Forest Management Bradley.barton@dpaw.wa.gov.au 97717933/0427717923	www.dpaw.wa.gov.au Brain Street Manjimup WA 6258
Parks and Wildlife Frankland District	Allison McGilvray, District Nature Conservation Allison.mcgilvray@dpaw.wa.gov.au (08) 98400400	www.dpaw.wa.gov.au South Coast Highway Walpole WA 6398
Parks and Wildlife Donnelley District	Ian Wilson, District Nature Conservation ian.wilson@dpaw.wa.gov.au (08) 97717988/0429105860	www.dpaw.wa.gov.au Brain Street Manjimup WA 6258
Parks and Wildlife Blackwood District	John Carter, District Nature Conservation John.carter@dpaw.wa.gov.au (08) 9752 5555/0429920174 Clare Forward, Nature Conservation Officer Clare.forward@dpaw.wa.gov.au 0427525009	www.dpaw.wa.gov.au 14 Queen St Busselton WA 6280
Parks and Wildlife Wellington District	Simon Martin, District Nature Conservation Simon.martin@dpaw.wa.gov.au (08) 9735 1988	www.dpaw.wa.gov.au 147 Wittenoom St Collie WA 6225
WCWA Bunbury	Steve Collins, Water Team Leader (08) 97910499	www.watercorporation.com.au PO Box 305 Bunbury WA 6321
Aqwest	(08) 9780 9500	www.aqwest.com.au 5 MacKinnon Way Bunbury WA 6230
DoW South west Region	(08) 97264111	www.water.gov.au 35-39 McCombe Road Bunbury WA 6230
Shire of Manjimup	(08) 9771 7777	www.manjimup.wa.gov.au PO Box 1 Manjimup WA 6258
City of Bunbury	(08) 9792 7000	www.bunbury.wa.gov.au 4 Stephen Street Bunbury WA 6231
Shire of Capel	(08) 9727 0222	www.capel.wa.gov.au PO Box 369 Capel WA 6271
City of Busselton	(08) 9781 0444	www.busselton.wa.gov.au Locked Bag 1, Busselton WA 6280
Shire of Augusta- Margaret River	(08) 9780 5255	www.amrshire.wa.gov.au PO Box 61 Margaret River WA 6285
Shire of Boyup Brook	(08) 9765 1200	www.boyupbrook.wa.gov.au PO Box 2, Boyup Brook 624(partial postcode)
Shire of Collie	(08) 9734 9000	www.collie.wa.gov.au 87 Throssell Street Collie WA 6225
Shire of Nannup	(08) 9756 1018	www.nannup.wa.gov.au PO Box 11, Nannup WA 6275

<b>Organisation</b>	<b>Contact name, Email &amp; Phone Number</b>	<b>Postal Address/web address</b>
Shire of Bridgetown-Greenbushes	(08) 9761 1555	<a href="http://www.bridgetown.wa.gov.au">www.bridgetown.wa.gov.au</a> PO Box 271, Bridgetown WA 6255
Shire of Harvey	(08) 9729 0300	<a href="http://www.harvey.wa.gov.au">www.harvey.wa.gov.au</a> PO Box 500 Harvey WA 6220
Shire of Dardanup	(08) 9724 0000	<a href="http://www.dardanup.wa.gov.au">www.dardanup.wa.gov.au</a> PO Box 7016 Eaton WA 6232
Shire of Donnybrook-Balingup	(08) 9780 4200	<a href="http://www.donnybrook-balingup.wa.gov.au">www.donnybrook-balingup.wa.gov.au</a> PO Box 94, Donnybrook WA 6239
Murdoch University	Peter Adams (08) 9360 6000	South Street Murdoch WA
Feral Scan		<a href="http://www.feralscan.org.au">www.feralscan.org.au</a>
Pigpass Industry traceability system of Pigs through Australia		<a href="http://www.pigpass.com.au">www.pigpass.com.au</a>
Western Australian Shooting Association	Neil Wallhead, WASA President <a href="mailto:b.n.wallhead@optusnet.com.au">b.n.wallhead@optusnet.com.au</a>	PO Box 768 Morley WA 6943 <a href="http://www.washooting.org.au">www.washooting.org.au</a>
Invasive Animals Cooperative Research Centre	<a href="mailto:pestsmart@invasiveanimals.com">pestsmart@invasiveanimals.com</a>	<a href="http://www.feral.org.au">www.feral.org.au</a>
Conservation Council WA	(08) 9420 7266	<a href="http://ccwa.org.au/">http://ccwa.org.au/</a> City West Lotteries House 2 Delhi Street, West Perth WA 6005
Invasive Species Council	Andrew Cox, CEO 0438 588 040	<a href="http://www.invasives.org.au/">www.invasives.org.au/</a> PO Box 166, Fairfield Vic 3078
Farm Biosecurity Advisory Group		<a href="http://www.farmbiosecurity.com.au">www.farmbiosecurity.com.au</a>
Emergency Animal Disease Hotline	1800 675 888	
WIN News	(08) 9721 9900	<a href="http://www.wintv.com.au">www.wintv.com.au</a> Unit 13 Block C, Citygate Homemaker Centre, 42 Strickland St Bunbury WA 6230
WA today News dissemination		<a href="http://www.watoday.com">www.watoday.com</a>
GWN News Regional Television	GWN Bunbury	<a href="https://au.gwn7.yahoo.com/">https://au.gwn7.yahoo.com/</a> Roberts Cres, Bunbury WA 6230
West Australian Farmers Federation Agricultural lobby group	<a href="mailto:reception@wafarmers.org.au">reception@wafarmers.org.au</a> (08) 9486 2100	<a href="http://www.wafarmers.org.au">www.wafarmers.org.au</a> 125 James Street, Guildford 6055 PO Box 68, Guildford WA 6935
Southern Forest Food Council	<a href="mailto:laura@southernforestsfood.com">laura@southernforestsfood.com</a> (08) 9772 4180	<a href="http://www.southernforestsfood.com">www.southernforestsfood.com</a> PO Box 1258, Manjimup WA 6258
Pastoralists & Graziers Association WA	(08) 9212 6900	<a href="http://www.pgaofwa.org.au">www.pgaofwa.org.au</a> PO Box 889 West Perth WA 6872
South West Land and Sea Council	Ted Heart <a href="mailto:reception1@noongar.org.au">reception1@noongar.org.au</a> (08) 9358 7400	<a href="http://www.noongar.org.au">www.noongar.org.au</a> 1490 Albany Highway Cannington WA 6107