DEPARTMENT OF
Conservation
AND LAND MANAGEMENT
Conserving the nature of WA

Feral Pig Management Strategy

for

Departmental Managed Land

Western Australia

DRAFT

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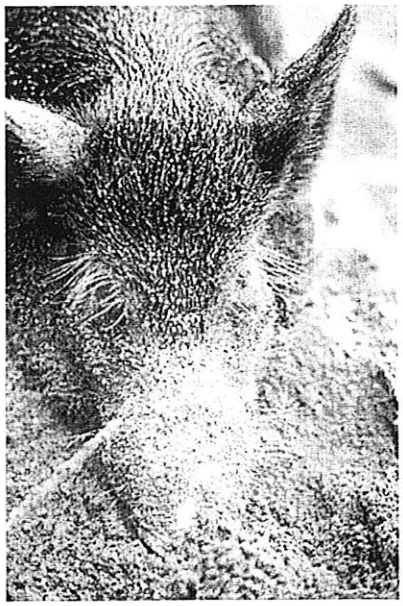

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1 Executive Summary

To be written.

2 Introduction

The resources available to the Department of Conservation and Land Management for feral pig control are limited. This management strategy aims to provides guidance to help target specific locations for feral pig control where the likelihood of improving or maintaining nature conservation, environmental or cultural values is high. Such locations include threatened fauna populations and their habitat, declared rare flora populations, threatened ecological communities, high profile tourism sites, sites of cultural significance and areas important for water quality. Targeting these locations means that maximum gain is obtained from the limited resources available.

At a national level, a Threat Abatement Plan is being developed for feral pigs to address the listing of the "predation, habitat degradation, competition and disease transmission by feral pigs" as a threatening process under the *Environmental Protection and Biodiversity Conservation Act 1999*.

This management strategy concentrates on the feral pig problem within conservation estate and state forest in Western Australia. It also applies to other lands managed by CALM such as unallocated crown land. The majority of previous work on feral pigs in Western Australia has focused on their actual and potential impacts on agriculture. This strategy will complement existing strategies and the national Threat Abatement Plan.

An accompanying document to this management strategy is a field manual which contains information and suggestions on feral pig control and monitoring techniques (in preparation).

3 Objectives

1. Develop a feral pig management strategy that promotes the protection and recovery of conservation values, in particular, threatened species and ecological communities that are impacted by feral pig activity.

2. Ensure strategic allocation of resources by identifying target sites of high conservation, environmental or cultural value, promoting good neighbour relations with adjacent landholders experiencing feral pig problems and where practicable limiting the geographic spread of feral pigs.

3. Coordinate and integrate existing work by fostering cooperative relations within and between government departments, research institutions and the community.

4. Provide information to the Department, other government agencies and the community for the planning and implementation of control techniques at high conservation value sites.

5. Provide information and methodologies required to monitor the success of feral pig control efforts and the impacts of feral pigs at high conservation value sites.

6. Collect information to improve our understanding of feral pigs and their impacts on nature conservation values.

4 Legal Requirements for Control

The Department is responsible for controlling pest animals on land it manages under Section 33(1)(d) of the Conservation and Land Management Act. The Department also has responsibilities in regard to management plan requirements (Section 56 of the Conservation and Land Management Act) or in cases where there is no management plan as a necessary operations under Section 33(3)(b) of the CALM Act.

Under the Agriculture and Related Resources Protection Act 1976 the Department has responsibilities on CALM managed land for control of animals that are "declared" under Sections 39-41. The feral pig is a Declared Animal under Categories A4 (Entry subject to Department of Agriculture permits and/or conditions), A5 (Numbers will be reduced/controlled) and A6 (Keeping subject to Department of Agriculture permits and/or conditions).

5 An Overview of the Biology and Ecology of Feral Pigs in WA

5.1 Habitat Requirements

Feral pigs are found in a wide variety of habitats but they have strict requirements that limit their distribution within these habitats. Feral pigs require daily access to water and suitable shelter particularly at times when temperatures regularly reach 30°C (Oliver *et al.*, 1991; Baber and Coblentz, 1986). These strict requirements mean that the majority of feral pigs are found along watercourses, around swamps and in the dense vegetation often associated with these landscape features (Caley, 1997). In south-west Western Australia the movement and dispersal of feral pigs occurs primarily along water courses and only rarely between catchments (Hampton, 2003). Feral pigs have not been reported in areas receiving less than 300 mm annual rainfall in Western Australia (Oliver *et al.*, 1991).

Feral pigs habitually use trails, feeding areas, sheltering sites, wallows and rubbing and tusking trees (McGaw and Mitchell, 1998). They are most active at night or at cooler times of the day but will also become active in response to disturbances such as hunting.

5.2 Physical Characteristics

The appearance of feral pigs depends on how recently they were domesticated. Feral pigs from long established populations are smaller than domestic pigs being shorter in length with longer limbs, large snouts and heavier forequarters. Hair on the body and tail is longer and ears are smaller than domestic pigs. Feral pigs of recent domestic origin are usually larger and heavier with white or piebald coat rather than the typical black coat of long established feral pig populations (Masters, 1979).

The size and weight of adult feral pigs varies between locations and is affected by season, environmental conditions and reproductive status (Masters, 1979; Mawson, 1986; Oliver *et al.*, 1991). Sows in particular can rapidly gain or lose weight, with rapid weight loss associated with lactation and rapid weight gain associated with weaning (Masters, 1979). Feral pigs are heaviest in winter and lightest in autumn suggesting the period between autumn and winter is most favourable for feral pigs to gain weight. Masters (1979) reports an average adult weight of 59.8 kg for males and 39.6 kg for females. Mawson (1986) showed that the average weight of feral pigs varies between sites in Western Australia and suggests feral pigs are heavier in the wetter south west of the state.

5.3 Reproduction

Feral pigs have the ability to reproduce all year round but food availability and environmental factors cause seasonal peaks in reproduction.

Masters (1979) found a peak of pregnant sows during winter in south west Western Australia, which correlates with the peak in sow condition. Sows can reproduce when their weight reaches at least 25-30 kg which occurs around 8 months (Oliver *et al.*, 1991). Adult sows have

a 21 day oestrus cycle and a 112-114 day gestation period, which means they have the ability to produce two litters each year. Environmental conditions restrict this to an average of one litter per year in south west Western Australia (Masters, 1979).

Baber and Coblentz (1986) have reported that the average litter sizes for feral pigs from various studies to range from 4.9 to 7.4. Masters (1979) observed litter sizes between one and 10 piglets with an average of 5.3 and noted that larger litter sizes were associated with sows that had access to farmland.

5.4 Social Structure

Feral pigs are usually found in groups consisting of adult females and their litters. Males become increasingly solitary with age whilst females and juveniles remain gregarious (Masters, 1979). The size of groups depends on the habitat and availability of food. Group size in jarrah forest rarely exceeds 12 individuals and usually consists of 1 or 2 females with their most recent young (Masters, 1979). Subadult females are generally loosely associated with groups of females and their young whilst subadult males form small "bachelor" groups (Masters, 1979).

Recent studies by Hampton (2003) and Spencer *et al.* (2003) have shown that feral pigs are adaptable in their spatial and social activity patterns resulting in different behaviours in different environments. In comparison to semi-arid Queensland, large (>90 kg) boars in south-west Western Australia have greater reproductive success, the distance travelled by boars to secure paternity is much less (16.3 ± 31.5 km vs 52.2 ± 9.1 km) and there was no evidence for multiple paternity in litters (Hampton, 2003; Spencer *et al.*, 2003). The density of feral pigs in south-west Western Australia is 2-4 pigs/km^2 (Masters, 1979) whereas in semi-arid Queensland the density is much lower at 0.09 pigs/km^2 (Spencer *et al.*, 2003).

Feral pigs occupy distinct home ranges but overlap between adjacent home ranges can occur. Males generally have larger home ranges than females but according to Saunders and McLeod (1999) this is more closely related to body mass than sex. Reports of feral pig home range size varies considerably in the literature. Reported home range size in Western Australian habitats are much smaller than those reported for other locations in Australia (Table 1).

Table 1: Home ranges of feral pigs in Western Australia

Area	Habitat type	Home range (km^2)		Source
		Male	Female	
Margaret River, WA	Jarrah Forest	1.2	2.0	Marsack (1989)
Northampton, WA	Sandplain scrub heath and farm land	0.3-1.3	0.3-2.3	Mawson (1986)
Dwellingup, WA	Jarrah Forest	0.3	0.4	Mawson (1986)

5.5 Diet

Feral pigs are opportunistic omnivores (McGaw and Mitchell, 1998). The majority of their diet consists of plant matter but they will opportunistically feed on animal matter. Changes in the diet of feral pigs between seasons is largely related to availability rather than preference for food types.

Masters (1979) studied the diet of feral pigs in south west Western Australia and found the summer diet is dominated by roots and carrion, autumn diet by zamia palm nuts and crops, winter diet by grass and the spring diet by roots, fungi and *Persoonia* berries. The berries of *Persoonia* appear to be important for young pigs during the weaning process (Masters, 1979).

Grass and roots were the most significant components of the diet of feral pigs in south west Western Australia and were present in 65.7% and 62.9% of stomach contents inspected respectively (Masters,1979).

At times of environmental stress feral pigs are known to kill and consume their own piglets. They will also feed on the carcasses of dead adults. Animal matter generally constitutes less than 15% of the diet of feral pigs (Masters, 1979). Females suckling young require 15% of their diet to be crude protein to produce enough milk to successfully raise their young and this protein is mostly obtained by consuming animal matter.

6 The Need for Control

There are a number of reasons why control of feral pigs will be desirable.

6.1 Conserve Soils

Often the first indication of the presence of feral pigs in an area is the observation of disturbed soil from their digging and rooting activities. This activity impacts on the ecosystem in a variety of different ways including destruction of vegetation, reduction in vegetation cover, changes in successional events, alteration of nutrient cycles, mixing of soil horizons and changes in species composition of the area (Synatzske, 1993; Mitchell and Mayer, 1997). The digging and rooting activities of feral pigs are not evenly distributed across the landscape with a greater concentration of activity usually observed along water courses and in swampy areas. Rooting from feral pigs has the potential to expose areas of land to erosion by wind and water. This can cause subsequent problems including siltation in waterways.

6.2 Protection of Fauna

Feral pigs impact fauna directly through the destruction of habitat, competition for resources and predation.

Diet studies of feral pigs provide an indication of the potential for competition with other species utilising the same food resources. The omnivorous and adaptable diet of feral pigs means that they have the potential to out compete species with more specific diet requirements. Feral pigs may have the ability to displace native fauna such as woylies, quokkas, quenda and potentially bilbies and boodies.

The fauna component of the diet of feral pigs includes both vertebrates and invertebrates and has been reported to make up 6.6% of the annual diet of feral pigs (Taylor, 1999). Masters (1979) showed that the percentage varied throughout the year but was generally less than 15%.

Feral pigs are known to eat the eggs and hatchlings of green turtles (*Chelonia mydas*) (Coblentz and Baber, 1987). Sea turtles including the Vulnerable green turtle and flatback turtle (*Natator depressus*) nest along the Western Australian coast and could potentially come into conflict with feral pigs in the Kimberley region.

Feral pig damage is often associated with damp areas and there are a number of threatened species that utilise similar habitat. Feral pigs have been identified as a threat in the recovery plan for orange-bellied and white-bellied frogs. The sunset frog, a vulnerable species, is also potentially threatened by feral pig activity. There are three species of burrowing crayfish (*Engaewa spp.*) on the list of threatened fauna that live in habitat that has the potential to be disturbed by feral pigs.

Feral pigs are known to eat the eggs of ground and swamp nesting birds (Tisdell, 1982; Rollins, 1999). There is one vulnerable and three priority species of birds that nest in wetlands or in riparian vegetation in Western Australia. These are the Australasian bittern, black bittern, little bittern and the purple-crowned fairy-wren.

Invertebrates may be directly consumed by feral pigs or the vegetation, soil and leaf litter in which they live may be disturbed through their digging and rooting activities. Several threatened invertebrate species are short range endemics (Harvey, 2002) whose distribution is often limited to the cooler and damper places upon which feral pigs tend to focus their activities.

6.3 Protection of Flora

Feral pigs are known to impact on threatened flora populations by consuming all or part of the plant or by disturbance from their rooting and digging activities in pursuit of other food sources in the area. Soil disturbance can also impede plant recruitment (Mitchell, 2001). A number of threatened plant species occur in areas where feral pig activity is likely to be most severe. Feral pigs have a major impact on transition zones, particularly riparian vegetation.

In addition to directly affecting threatened flora through disturbance or consumption, feral pigs have the potential to exacerbate weed invasion and *Phytophthora cinnamomi* infection which are recognised as threatening processes for many species of threatened flora.

6.4 Restoration of Ecological Communities

Some threatened ecological communities are restricted to damplands and other wetland habitats that are particularly favoured by feral pigs. The digging and rooting behaviour of feral pigs can destroy ecological communities. It is hoped that these communities can regenerate after the removal of feral pigs from the area. Of particular importance are Threatened Ecological Communities such as the *Reedia spathacea* communities in the south west and mound springs.

6.5 Minimise the Spread of Weeds

Weeds are often disturbance specialist and are therefore able to colonise areas disturbed by feral pigs before native species can re-establish. Underwood (2000) observed the weed Scotch Thistle (*Cirsium vulgare*) dominating old pig rooting sites. Feral pigs can also facilitate the spread of weeds through dispersal of seed attached to their bodies or in faeces. Weed invasion degrades the habitat for fauna and reduces the floral diversity as less competitive species are unable to persist.

6.6 Minimise or Prevent the Spread of Disease

Feral pigs have been identified as potentially facilitating the spread of *Phytophthora cinnamomi* in the forest of the south-west either by transporting the fungal spores or by increasing the susceptibility of the forest to the natural spread of the disease (Masters, 1979; King, 1985). Brown (1976) found evidence that feral pigs wallowing in mud spread *P. cinnamomi* in Queensland rainforest. The spread of *P. cinnamomi* in soil is well known as shown by studies of the spread of the disease in road making gravel (Weste, 1975; Weste and Ruppin, 1975) and by the experimental movement of infected clods of soil (Batini and Cameron, 1971). Weste and Ruppin (1975) found that the greatest impact of the disease is associated with areas of poor drainage and frequent waterlogging, which are the same environments that are used extensively by feral pigs. *P. cinnamomi* significantly changes the ecology of forests by reducing the number of plant species present in the understorey and ground cover and eventually causes a reduction in the number of trees (Weste and Ruppin, 1975). These changes have a significant impact on the fauna (Garkaklis *et al.*, 2003) and on the value of the area for tourism, forestry and nature conservation. The management plan for Strzelecki National Park, Flinders Island, Tasmania states that feral pig control is a fundamental component of any disease management program in the park due to the potential for feral pigs to spread *P. cinnamomi* (Parks and Wildlife Service, 2000)

Feral pigs pose a potential threat to livestock and human health by being a potential carrier or amplifier of many endemic and exotic diseases (Table 2).

Table 2: List of endemic and exotic diseases carried by feral pigs

Endemic	Exotic
Brucellosis (*Brucella suis*)	Foot and Mouth Disease (FMD)
Tuberculosis (*Mycobacterium spp.)*	Classical Swine Fever
Porcine Parvovirus	Aujeszky's Disease
Leptospirosis (*Leptospirosis spp.)*	Japanese Encephalitis
Melioidosis (*Pseudomonas pseudomallei)*	Swine Vesicular Disease
Sparganosis (*Spirometra erinacei*)	African Swine Fever
Murray Valley Encephalitis	Trichinosis (*Trichinella spiralis*)
Ross River Fever	Surra (*Trypanosoma evansi*)
Hydatids (*Echinococcus granulosus*)	Rabies
Q Fever (*Coxiella burnetii*)	Nipah Virus
	Cysticercosis (*Taenia solium*)
	Screw-worm Fly (*Chrysomya bezziana*)

6.7 Protection of Water Quality

Water quality may be significantly affected by the activities of feral pigs increasing the turbidity of the water and causing siltation effects downstream. Water quality will affect aquatic species of plants and animals as well as those that require fresh drinking water. The impacts on the banks of rivers and streams may increase erosion and make clean water difficult to access for native fauna due to large muddy areas or unstable banks.

The quality of water for drinking in catchment areas could be compromised by the potential for feral pigs to excrete water-borne pathogens into water supplies. *Giardia* and *Cryptospiridium* have been isolated from faeces of feral pigs caught in metropolitan water catchments (A. Thompson, *pers. comm.* in Hampton, 2003).

6.8 Protection of Sites of Cultural Significance

Destructive activities by feral pigs have the potential to damage sites of cultural significance such as aboriginal heritage sites. Feral pigs are known to cause problems at archaeological sites by disturbing layers of deposits.

6.9 Minimise Impacts on High Value Tourism Sites

The activities of feral pigs can destroy the visual and aesthetic appeal of landscapes. Tourism is an increasingly important industry in Western Australia. It is therefore important to protect areas of interest to tourists to ensure they are maintained for the future. The Murchison Gorge, Kalbarri, is an example of a location where damage by feral pigs affects visitor experiences in the area. Comments are often received from the public regarding the presence or damage by feral pigs (and feral goats) in the area.

6.10 Good Neighbour Relations

To maintain or establish support for conservation objectives it is important to respond to complaints or requests for assistance regarding feral pigs by adjacent landholders, and participate in cooperative control operations across different land tenures where appropriate.

7 Identification of Target Sites

There are a number of key criteria that can be used to identify target sites for control efforts.

7.1 Protection of Values

It is necessary to identify locations where feral pigs are having the greatest impact on the values of an area (environmental, ecological or cultural) to most efficiently allocate resources. The aim is to reduce impacts, rather than concentrating solely on reducing numbers of feral pigs.

Target sites may be where feral pigs are impacting or threatening to impact:
Threatened flora populations
Threatened fauna habitat
Threatened ecological communities
High profile tourism sites
Sites of cultural significance
Sites important for water quality

The greater the value of an area, the higher priority it should be given for feral pig control. Target sites that fit more than one category should be given a higher priority that those fulfilling only one. However in cases of critical threatened fauna habitat or declared rare flora population this is enough justification to give these locations a high priority for feral pig control.

One method to assist in the prioritising of target sites is to utilise GIS packages such as ArcView. Layers of information such as threatened flora or fauna populations and threatened ecological communities can be added to maps of the district. The distribution of feral pigs in the district can then be used to help prioritise control and monitoring efforts where their distribution overlaps values. Identified zones for priority could be water catchments. The results of Hampton (2003) show that feral pigs move along water courses but rarely between them.

A large amount of knowledge of values and threats within a district rests with individuals living and/or working in the district. This knowledge is valuable and should be utilised wherever possible, especially if it can be collated and stored electronically and graphically using GIS.

Target sites may also be chosen as a result of neighbour complaints, as feral pigs readily cross tenure boundaries. Cooperative relations are beneficial to effective control programs. However, responding to neighbour complaints needs to be balanced against district priorities.

7.2 New or Isolated Populations and Island Populations

Eradication of introduced pest species is difficult, time consuming and costly. The resources required to achieve eradication are not usually available and therefore population control is the favoured option to minimise impacts. Western Australia is particularly vast with many inaccessible areas that would make eradication near impossible. However, there are two situations where eradication may be attempted. These are new or isolated populations and island populations.

Strong anecdotal evidence has suggested that feral pigs are transported and released into new areas (or restocked into existing areas) by recreational hunters. This illegal activity has recently been proven by genetic analysis (Hampton, 2003). It is possible that some of these populations may be eradicated before numbers get established. Such eradications should be considered a high priority.

Island ecosystems are particularly sensitive to disturbance. Islands are possible candidates for feral pig eradication as immigration can be assumed to be non-existent and as long as a greater number of pigs are killed than recruited the population will decline and eventually be eliminated. Populations of feral pigs on any island off the coast of Western Australia should be considered for eradication.

In Western Australia feral pigs are known to inhabit Sir Graham Moore Island, and this has been identified by Burbidge and Morris (2002) as a future eradication challenge.

7.3 Site Access Considerations

The accessibility of a site may determine what control techniques are appropriate for a location. For example transporting traps and disposing of carcasses after a control operation requires good vehicular access.

Target sites that are in disease risk areas (ie potentially infected with *Phytophthora cinnamomi*) will limit the movement of staff in those areas and affect the timing of any control efforts. Summer may be the best time to undertake control efforts in disease risk areas as the potential for spread of the disease is reduced when tracks are dry. Feral pigs are also concentrated around water sources during summer months making locating and controlling them easier.

Areas targeted for control that are publicly accessible will need to consider the visibility of traps. Visible traps may be targeted for vandalism or stolen or they may be distressing for some members of the public. Signage may be required to explain the purpose of the traps. Signage may be placed on the trap and at access points nearby but consideration must be given to ensuring the location of signage does not give away the location of the traps/bait.

The distance between traps must be considered when planning a control operation to ensure that all the traps can be checked early in the day before temperatures rise to ensure animal welfare concerns are adequately addressed.

8 Control Methods

8.1 Alternatives Considered and Dismissed

8.1.1 Public Hunting

Hunting of feral pigs by members of the public using firearms with or without the assistance of dogs is not recommended under this management strategy.

The Code of Practice for the Capture and Marketing of Feral Animals in Western Australia is supported by the Animal Welfare Act and allows the use of trained dogs to locate and flush feral pigs from thick vegetation as long as the operators are experienced and the dogs well trained. The Code of Practice does not support the use of dogs to bring down feral pigs. The inadequate care of dogs used to hunt feral pigs may be prosecutable under the Animal Welfare Act

The use and possession of firearms and dogs is not desirable on conservation estate, especially national parks, recreation areas or tourist attractions. There is a risk of disturbance to native wildlife and potential danger to members of the public using the area for leisure activities. The dogs also pose a disease risk to native animals. For example, dogs have been implicated in the transfer hydatids to a population of kangaroos in forested areas near Perth.

The use of dogs in conservation estate that is baited for control of foxes (and cats) places these animals at risk of poisoning and this is unacceptable if the hunting has been authorised by the Department.

8.1.2 Snares

This technique involves the use of a strong wire loop with a sliding lock device that allows the loop to easily close but not open. Snares are often set in holes in fences or on pathways through vegetation. Snares are inexpensive and reusable but must be checked regularly. They are not considered appropriate for use in Western Australia because of the risk to non-target animals and they have serious animal welfare implications. The use of snares is prohibited under Regulation 54(b) of the Wildlife Conservation Regulation 1970 without written authority.

8.1.3 Leg-hold traps

Leg-hold traps are inexpensive and reusable. They must be checked regularly. Jawed traps are prescribed as "inhumane devices" under Section 19 (2) (b) of the Animal Welfare Act. Section 8 of the Act does however provide for circumstances under which their use is acceptable. Other more humane and effective methods are available for control of feral pigs in Western Australia and so their use is not recommended under this strategy.

8.1.4 Poisoning with Warfarin or Yellow Phosphorus

Poisoning can rapidly and significantly reduce the numbers of feral pigs in an area.

Yellow phosphorus has been widely used in New South Wales and Queensland as an alternative to 1080. However, It is not recommended for use as it is relatively slow-acting and considered inhumane. The risk to non-target animals is high.

Warfarin is an anticoagulant that has been trialed to determine its effectiveness as an alternative to 1080 and yellow phosphorus (Hone and Kleba, 1984; McIlroy *et al.*, 1989; Choquenot *et al.*, 1990; Saunders *et al.*, 1990). This poison poses a significant risk to non-target animals and is not considered humane.

Warfarin and yellow phosphorus are also not registered for use to control feral pigs in Western Australia.

8.1.5 Swine Diseases

Diseases of swine could be used to control numbers. For example, hog cholera was introduced to Santa Cruz Island (USA) in the 1950's and achieved a reduction in feral pig numbers of over 75% (Channel Islands National Park, 2001). The risk to domestic livestock is high and there is a possibility of transmission to native animals and to humans. For these reasons it is not considered a suitable technique for use in Western Australia.

8.1.6 Explosive Bait

This technique involves an explosive capsule contained in bait material that explodes when bitten. This technique is under development and currently not available. It has serious animal welfare considerations if it can not guarantee an instantaneous death.

8.1.7 Chemical or Immunological Contraception and Drugs Which Prevent Lactation

Contraception and drugs which prevent lactation are unproven techniques. Procedures are under development but this option is not yet available. If such techniques were available it would take time before the effects of such a program were observable. Current methods for administering the drugs for these methods would require either capture or free feeding and there are other more efficient alternatives for disposing of feral pigs that are captured or habituated to free feeding (see Preferred Alternatives).

Contraceptives are effective for species with a low reproductive rate or species for which injection boosters can be readily readministered at the required time. Feral pigs do not meet either of these criteria. Sows can produce two litters a year with an average of 5.3 piglets in each litter and they can be widely dispersed making administering contraceptives difficult. Even if a low contraception failure rate was achieved, populations would most likely still be able to persist given their ability to rapidly reproduce.

Contraception is a relatively humane method of controlling feral pig numbers. Researchers are encouraged to develop humane alternatives for the control or eradication of feral species. With further development this technique may become useful, however it will not reduce the impact of existing feral pigs in the short term.

8.1.8 Aerial Baiting

Research into aerial baiting for feral pigs has been undertaken in Queensland and New South Wales (see Mitchell and Kanowski, 2003; Fleming *et al*, 2000; Mitchell, 1998). Aerial baiting has the advantage that it can be implemented in difficult situations where ground-based techniques may be impractical. It can be used over large areas and is faster than the most commonly used control techniques. However, Pigs require a large dose of 1080 which is hazardous to non-target animals. Fleming *et al* (2000) reports very high levels of bait take by non-targets (>90%) of baits distributed aerially. Aerial baiting does not allow for free feeding to occur and this can significantly reduce the number of pigs attracted to the bait. The disadvantages of this technique make it inappropriate for use in Western Australia.

8.2 Alternatives for Occasional or Experimental Use

8.2.1 Ground-based Shooting

Ground-based shooting should not be used as a primary control technique where feral pig numbers are high as it has the potential to disperse pigs. It is an effective method to remove individual animals. The costs of shooting increase greatly as pig numbers decrease.

The use of dogs to assist hunting is not recommended. There is a risk of the dogs getting lost, non-target fauna may be harassed and the dogs are at risk of taking poison baits in baited areas. The movement of hunters may also spread *Phytophthora*. The technique is not efficient or cost effective (see Table 3).

The assistance of hunting organisations or professional shooters may be employed in some control operations eg The Sporting Shooters Association of Australia (Table 3) and WA Field and Game Association. Such control operations may require the limiting of public access during the operation.

Table 3: Results of feral pig control efforts by the Albany Branch of the Hunting and Conservation Discipline of the Sporting Shooters Association of Australia collated from end of season reports.

Season	Number of trips	Km traveled	Time (hours)	Number of weeks for one person	Number of pigs	Cost per pig ($)*
1994/1995	28	6500	1150	29	10	**2658**
1995/1996	15	3500	355	9	6	**1504**
1996/1997	12	3110	291	7.25	5	**1506**
1997/1998	17	3360	420	10.5	9	**1139**
1998/1999	17	4300	N/A	11.5	2	**N/A**
1999/2000	24	6320	438.5	18.5	6	**3041**
2000/2001	16	4543	515.5	12.9	30	**427**
2001/2002	13	3894	300	7.5	13	**626**
2002/2003	12	3883	392.5	9.78	6	**1661**

* calculated based on a rate of 55c/km and a labour cost of $20/hour

From the results in Table 3, the average cost per pig over the nine years was $1570 and the average amount of time required per pig was over 45 hours.

8.2.1 "Judas" Pigs

The use of radio-collared individuals to locate mobs for eradication and allowing the radio-collared pig to join up with another mob is a technique that has been effectively used for

controlling feral goat, donkey and cattle populations. Feral pigs are not as gregarious and so the technique may not be as effective for feral pigs or at least on both sexes.

The shape of feral pigs makes fitting radio-collars difficult but, techniques have been developed to help keep the collars on the pig (Peter Mawson *pers. comm*). Large changes in body weight and condition make it difficult to safely fit radio-collars for long periods (Peter Mawson *pers. comm*).

"Judas" pigs have been trialed in the Kimberley where four feral pigs were captured, radio-collared and released along a 30km section of the river below Lake Argyle resulting in about 400 feral pigs being killed over a year (R. Watkins, *pers comm.* in Martin and Wheeler, 2000).

"Judas" pigs may be used to eradicate small colonies or sparsely distributed or wary pigs. This technique could be considered for experimental cases but is not suitable as a standard technique.

8.2.2 Habitat Modification

Removal of water points, damp areas or other areas used for refuge can discourage feral pigs from using an area. This method could only be used in select areas where the method does not affect the goal/s of the feral pig control program (eg protecting native species). This method could be used in highly degraded areas that require significant restoration work or where the water point/shelter area is artificial. Use of this technique must consider where the feral pigs will relocate and what impact modifications may have on non-targets.

8.2.3 Macro-encapsulated Cyanide

This technique has been developed for use in controlling deer (*Cervus elaphus*), goats (*Capra hircus*) and possums (*Trichosurus vulpecula*) in New Zealand (Martin and Wheeler, 2000). It is not considered suitable for use on feral pigs in Western Australia until it has been extensively trialed but could be very useful. Its use may depend on a selective bait product.

8.3 Preferred Alternatives

8.3.1 Trapping

This technique has been extensively used and there are numerous effective trap designs available. Trapping is effective at reducing feral pig numbers where they are at low to medium densities. Risks to non-target animals can be minimised by trap design.

There are several different trap designs for feral pigs, but all have the basic feature of an enclosed area with a one-way entrance. Most are designed to be easy to erect, reusable, transportable and able to be constructed using everyday materials. To comply with animal ethics requirements, traps should be built using designs researched by the Department of Agriculture, Western Australia.

Trapping has many advantages and these are outlined as follows:

- Does not interfere with normal pig behaviour
- Traps can be re-used and moved to different target locations.
- Details of feral pigs trapped and destroyed can be recorded.
- Technique is species specific if appropriate trap designs are used.
- Technique can be used by community members.

Disadvantages of trapping include:

- The technique is labour intensive.
- Destruction of pigs requires their attraction into the traps.
- Loss of equipment though theft or damage.
- Potential to catch non-targets.
- Disturbance in area can affect trapping success.

Signage on or near traps may be required to ensure that if the traps are inadvertently encountered, the traps' purpose is clear.

Bait material can have a significant effect on the success of trapping efforts. The use of bait that is locally familiar to feral pigs may be more attractive than other baits which they may not recognise or be attracted to. Bait material used in trapping will depend on the location and previous experience of trappers. Commonly used baits include fermented grains (wheat, oats, corn etc), fruit (apples, bananas, rock melon etc), processed pellets and carrion. Alternative bait materials and attractants are under development by the Western Australian Department of Agriculture.

8.3.3 Aerial Shooting

Aerial shooting of feral pigs may be employed where there is extensive or otherwise inaccessible areas where the density of feral pigs is high. It is not suitable where feral pig numbers are low or in areas where vegetation inhibits visibility of the pigs on the ground (eg forest). Shooting from helicopters can be used for rapid population knock-down in open habitat. Aerial shooting requires a skilled shooter, a pilot and a spotter/counter to locate and record pigs shot.

Aerial shooting can be used to simultaneously target a range of feral species including goats, donkeys and feral livestock. Feral pigs are often shot from helicopters during routine feral donkey control operation in the Kimberley by Department of Agriculture staff.

Feral pigs can be difficult to locate or seek shelter in dense vegetation and therefore cause shooting from helicopters to be ineffective. Success of aerial shooting is limited by weather, rough terrain and dense vegetation. There is also a high cost inherent hazards of low-level flying must also be considered when choosing this control method.

8.3.4 Poisoning With 1080

1080 is currently the only toxin registered for use to control feral pigs in Western Australia. Poisoning with 1080 is an effective method for reducing feral pig numbers in an area. It is difficult to monitor the success or failure (in terms of numbers of pigs killed) of baiting operations as pig deaths can occur significant distances from bait stations. However, indications of success can be obtained from the amount of poisoned bait taken and subsequent observations of vegetation recovery or pig activity.

As with trapping, the bait material used can have a significant affect on the success of the control effort. The outcome may also be improved by undertaking a period of free-feeding prior to poison baiting. Disturbance in the area will reduce the effectiveness of free-feeding and the baiting period.

The amount of 1080 required to kill a feral pig is relatively high due to their body weight so it is important to choose a bait material that is least attractive to non-target fauna and/or is presented in a way that minimises access by non-targets. The 1080 dosage in a standard fox bait used under *Western Shield* is not sufficient to kill an adult feral pig. The National Registration Authority for Agricultural and Veterinary Chemicals is currently reviewing the registration of 1080 the results of which may have implications for the use of 1080 in controlling feral species including feral pigs.

9 Other Management Tools

9.1 Fencing

Fencing can be used to:

- Exclude feral pigs from high value sites such as DRF populations and TEC's.
- Create short-term manageable units during control programs.

- Exclude feral pigs from water points to encourage them to use other water points where they can more easily be trapped.
- Create exclosures where vegetation can regenerate and create a seed bank.
- Limit access to areas not already occupied by feral pigs.
- Direct feral pigs into traps.

The cost of fencing is high and maintenance is required for the fences to remain effective. Various fence designs have been used. Electrification significantly improves the ability of a fence to exclude feral pigs (Hone and Atkinson, 1983).

9.2 Legislation and Policies

The legislation that currently covers issues such as the capture, transport and release of feral pigs is dated (e.g. *Wildlife Conservation Act 1950, Wildlife Conservation Regulations 1970* and *Agriculture and Related Resources Protection Act 1976*). The sentiments espoused in those pieces of legislation do not adequately address current community views. In addition the penalties attached to those pieces of legislation are small and more importantly discretionary.

Legislation and policies can be used as a preventative control measure by raising awareness of the issues associated with feral pigs and the consequences of illegal activities such as transport and release of feral pigs for the purpose of recreational hunting. The legislation and policies must be enforced for this technique to be effective. This is particularly important in regard to the illegal transport and release of feral pigs for recreational hunting. Despite the existence of provisions in the various regulations for penalties for the illegal transport and release of feral pigs, there have not been any prosecutions initiated or completed for such offences. The reasons for this could be either that no offences have been detected by authorities (see Hampton (2003) for confirmation that such illegal activities take place), or that the low penalties and high costs associated with prosecuting such illegal acts deters authorities from taking action, or there is simply an inadequate response by authorities to this issue, or a combination of these.

Relevant acts and regulations include:
Conservation and Land Management Act 1984
Conservation and Land Management Regulations 2002
Wildlife Conservation Act 1950
Wildlife Conservation Regulations 1970
Agriculture and Related Resources Protection Act 1976
Agriculture and Related Resources Protection (Declared Animals) Regulations 1985
Stock (Identification and Movement) Act 1970
Stock (Identification and Movement) Regulations 1972
Land Administration Act 1997
Environmental Protection and Biodiversity Conservation Act 1999
Animal Welfare Act 2002

Potential offences under current legislation include:

- Failure to brand stock
- Removing unbranded stock from a run
- Moving stock without a waybill
- Releasing from confinement any animal not naturally found in that part of the State
- Bringing an animal onto CALM land without authority
- Damaging native flora and fauna
- Leaving anything on Crown Land
- Causing significant impact on matter of national environmental significance
- Introducing non-indigenous animals into a nature reserve
- Holding declared animals in declaration A6 without a permit
- Taking a non-indigenous animal from CALM land
- Taking an animal from a nature reserve

Deterrents and penalties must be sufficient to achieve compliance by the majority of the population. Currently deterrents and penalties are not sufficient to dissuade illegal transport and release of feral pigs under either the *Wildlife Conservation Act* 1950 or the *Agriculture and Related Resources Protection Act* 1976. Consideration needs to be given to adopting penalty systems similar to those used in current fisheries legislation penalties which are much higher and are mandatory.

The proposed Biodiversity Conservation Bill and any proposed amendments to the agriculture legislation should consider including tougher mandatory penalties.

9.3 Community Liaison and Collaboration

Public education is a preventative measure. It can be used to raise awareness of issues and gain community support for control and monitoring efforts. Production of pamphlets and information boards at key locations would assist in raising awareness of the issues associated with feral pigs and their impacts on the environment. Public education needs to be both proactive and reactive.

Education of staff within the department will also improve the knowledge of and support for the strategy and improve monitoring efforts by encouraging the reporting of incidental sightings. Establishing a local contact person to collect and collate sighting information would assist in collecting this data and ensuring that it is made available for decision making regarding target sites for control and monitoring operations.

Collaborative control operations between different land managers may provide the opportunity to share information that could be beneficial to all involved.

10 Monitoring Methods

Monitoring methods should be aimed at observing changes in the distribution and level of impact of feral pigs over time rather than assessing actual pig population size. Other monitoring techniques have also been explored such as sand plots and aerial survey but these techniques are aimed at estimating populations size and distribution but do not assess impacts. Management objectives are best aimed at reducing impacts of feral pigs rather than reducing numbers as the number of feral pigs is not necessarily directly proportional to the level of impact. Control efforts need to continue until the desired reduction in impact is achieved. This does not require prior knowledge of population size.

Monitoring efforts should be focused on areas of high conservation (threatened fauna habitat, declared rare flora population etc), environmental (water catchments etc) or cultural value (high value tourism sites, sites of cultural significance etc) as these are the areas of greatest significance and therefore represent the most strategic allocation of resources.

Reasons for monitoring include:

- To determine the distribution of feral pigs and changes over time.
- Assess the impacts of feral pigs.
- Assess the effectiveness of control programs.
- Identify when control efforts are required or should cease.
- Assess the recovery or further degradation of habitat or populations of flora and/or fauna.
- Assess seedling survival or vegetation regeneration in areas impacted by feral pigs.

Timing must be considered when planning monitoring operations. For example some areas may become inaccessible during winter due to the risk of spreading *Phytophthora cinnamomi*. Monitoring may be required following disturbances that are likely to attract feral pigs (eg fire)

Different monitoring techniques are suited to different situations and purposes. Local conditions will determine what technique or combination of techniques is most suited. Photoplots, transects, incidental sightings and exclusion fencing are all possible techniques.

8.1 Photoplots

Photoplots require photographs to be taken from the same location at set time intervals using a standardised method. Photoplots can be used to provide a visual reference to enable changes in vegetation cover and species composition to be recorded over time. They also assist the relocation of a previously established monitoring site. Photoplots are best used in conjunction with other monitoring techniques.

8.2 Transects

Transects are generally straight lines of a set length, along which vegetation cover, vegetation composition, signs of animals or other habitat values can be recorded. Transects can be used to monitor the distribution of feral pig activity across the landscape. They can be used to monitor other species at the same time eg observations of tracks, scats and other signs. Transects may be located along waterways, across valleys or along walk trails or tracks. Results can be entered into FaunaFile.

8.3 Incidental Sightings

Sightings of feral pigs or signs left by them are very useful in determining the distribution of feral pigs in a region. These records can identify the location of feral pigs that other monitoring techniques fail to pick up. Sightings can be recorded using the Fauna Report Form. Records can be entered into FaunaFile.

8.4 Fencing

Fencing to exclude feral pigs can be used to assess the impacts feral pigs are having on an area. Vegetation cover and species composition inside and outside the fenced area, needs to be assessed over time. Fenced areas used in conjunction with photoplots have the potential to visually show changes over time.

Electric fences also have some value in excluding pigs from high value areas (eg declared rare flora population), where they are residing in adjacent vegetation.

11 Management of the Impacts of Feral Pigs

The following paragraphs provide advice on options and points to consider when managing the impacts of feral pigs on values.

11.1 Declared rare flora populations

- Monitor feral pig activity as part of the monitoring program for the plant population. Use Rare Flora Report Forms to notify where and when feral pigs are impacting on a population.
- A large number of the declared rare flora species affected by feral pigs are geophytes (eg orchids). Consideration needs to be given to the time of year and frequency of flowering of these species when monitoring such populations.
- Consider establishing landscape and/or vertical photoplots of the area. Success of control operations may be assessed by observed changes over time as shown by the photographs.
- Consider establishing an activity transect to assess the impact on plant populations and to help predict encroachment of feral pig activity on them.
- Consider establishing a fenced exclosure to protect the population if considered necessary. Success of control operations may be assessed by observed changes over time inside and outside the fenced exclosure.
- If feral pig activity is noted to be significantly impacting, or likely to impact, on the population a control operation should be implemented.

- If trapping or poisoning to remove feral pigs from the vicinity of a population it may also be possible to use the free-feeding period to gradually lure the pigs away from the population until the trap or poisoned bait is laid.

11.2 Threatened and priority fauna habitat

- An activity transect established through the threatened fauna habitat may be the best option for monitoring the impact of feral pigs. The transect may also be used to predict the encroachment of feral pig activity on the habitat.
- Fenced exclosures will not be a favoured option for most situations but could possibly be useful to protect frogs or water birds but fences must not significantly inhibit the movement of non-target animals.
- If feral pig activity is noted to be significantly impacting on essential threatened fauna habitat in the absence of direct evidence of impact on the fauna then a control operation should be implemented.
- If trapping or poisoning to remove feral pigs from the vicinity of a population it may also be possible to use the free-feeding period to gradually lure the pigs away from the population until the trap or poisoned bait is laid.

11.3 Threatened ecological communities

- Monitor feral pig activity as part of the works program to monitor the threatened ecological community. This may involve establishing an activity transect that is also used to assess the vegetation composition/health of the threatened ecological community and may also be used to predict the encroachment of feral pig activity on the community.
- If feral pig activity is noted to be significantly impacting, or likely to impact, on the threatened ecological community then a control operation should be implemented.
- If trapping or poisoning to remove feral pigs from the vicinity of a ecological community it may be possible to use the free-feeding period to gradually lure the pigs away from the community until the trap or poisoned bait is laid.

11.4 Sites of cultural significance

- The impact of feral pigs on sites of cultural significance is likely to be observed as a result of incidental sightings.
- Control efforts should be employed if feral pigs are identified as causing damage to sites of cultural significance or potentially destructive activity is found nearby.
- Care will need to be taken to ensure that control activities do not cause further impact to cultural sites.

11.5 High value tourism sites

- Consider establishing a walk trail transect to monitor feral pig activity.
- Baiting with 1080 may need to be conducted in conjunction with consultation and public education to ensure risk to domestic pets is minimised.
- An education program may be included in the visitor interpretation of the tourism site to raise awareness of the issues associated with introduced species. This may be considered a preventative or long term control measure.
- Effectiveness of the program could also be monitored through visitor surveys and comments.
- Particular attention needs to be made to the disposal of carcasses following control operations at these sites. Decomposing carcasses have the potential to devalue the recreation experience.

11.6 Sites important for water quality

- An activity transect may be established to monitor feral pig activity.
- Consideration also needs to be given to the fact that the activity of feral pigs upstream may affect the habitat quality for species living downstream.

- Ongoing feral pig control efforts should be continued in consultation/cooperation with the Water Corporation to ensure the catchment areas for good quality drinking water are maintained.
- Control efforts will need to be continued upstream and downstream from identified problems areas to minimise recolonisation from along the watercourse. Pigs will travel along watercourses but rarely between them in south-west Western Australia (Hampton, 2003).
- Particular attention needs to be made to the disposal of carcasses following control operations in these areas. Decomposing carcasses have the potential to pollute water sources.

12 Implementation

The implementation of this management strategy may need to be tailored to local conditions in each district.

12.1 Staff Training

Staff involved in the implementation of feral pig control and monitoring efforts will require a range of skills. There are several relevant training courses run by CALM. Other skills such as identification of feral pig sign will require instruction and experience in the field.

Areas of formal training include:
- Field surveying/map reading
- Firearms safety and use (preferably including hunting techniques)
- Volunteer management
- 1080 authorisation – use and possession with an endorsement for feral pig baiting.
- 4WD training
- Identification of tracks, scats and other signs (some training in this area is included in the Fauna Management Course).
- Law enforcement

Areas of informal training include:
- Identification of tracks, scats and other signs.
- Trap construction
- Bait mixing
- Manual lifting
- Reports and data management

Refer to the latest version of the Department's Training and Development Manual for information on available courses. Other agencies or training providers may also hold course of relevance.

12.2 Animal Ethics Committee Approval

The welfare of animals should be considered at all times when implementing control or monitoring operations described in this management strategy.

The management strategy and the actions that it suggests do not require approval from the CALM AEC because they relate to feral animals and they are considered standard operating procedures that have been researched by the Department of Agriculture, Western Australia. However, AEC clearance may be necessary for research projects.

The *Animal Welfare Act* 2003 and Regulations 2003 do apply to feral pig control activities.

12.3 Disposal of Carcasses

Feral pig carcasses resulting from poisoning and shooting operations may be left on site provided that:

- The carcass is at least 50 m away from a water source (a greater distance may be required in some areas to comply with Water Corporation recommendations).
- The carcass is not visible from any public access.
- The carcass does not impede the continuation of the control operation in the area.

Where carcasses are required to be moved this should be done in accordance with Occupational Health and Safety guidelines. Vehicles fitted with appropriate lifting aids may be required. The carcass should ideally be moved to a well-drained area away from water to ensure the rapid decomposition of the carcass.

Incineration and deep burial are also options for the disposal of carcasses.

The removal of carcasses for consumption by humans or pets is not acceptable for health reasons.

12.4 Funding/Budget Allocation

Districts will need to allocate resources for implementation of the management strategy. The allocation of resources for control efforts will depend on the identified priorities for the District and those of the Director of Nature Conservation via the Output Purchase Provider scheme.

It is essential that the costs of implementing feral pig control and monitoring activities are recorded in such a way that reports can be produced detailing where money has been spent.

Monitoring of the impacts of feral pigs can be incorporated into existing monitoring efforts or designed to achieve multiple outcomes for multiple species. For example a transect could be inspected for signs of other species such as quokkas and western ringtail possums. Other monitoring efforts will need to be targeted at feral pigs.

Some feral pig monitoring or control operations may be undertaken as a result of recommendations in recovery plans (see Table 4).

Table 4: Western Australian species of flora and fauna with recovery plans that include feral pigs as a threat.

	Common Name	Scientific Name	Reference
Flora	Long-leaved Myrtle	*Hypocalymma longifolium*	Interim Recovery Plan No 88
	Cinnamon Sun Orchid	*Thelymitra manginii ms*	Interim Recovery Plan No 45
	Northampton Midget Greenhood	*Pterostylis sp. Northampton*	Interim Recovery Plan No 68
	Elegant Spider Orchid	*Caladenia elegans* ms	Interim Recovery Plan No 63
	Majestic Spider Orchid	*Caladenia winfieldii* ms	Interim Recovery Plan No 15
Fauna	Sunset Frog	*Spicospina flammocaerulea*	Sunset Frog Recovery Plan: Wildlife Management Program No 35
	Orange-bellied Frog	*Geocrinia vitellina*	Orange-bellied and White-bellied Frogs Recovery Plan: Wildlife Management Program No 19
	White-bellied Frog	*Geocrinia alba*	Orange-bellied and White-bellied Frogs Recovery Plan: Wildlife Management Program No 19

12.5 Research and Collaboration

Districts are encouraged to support research proposals that complement or support the objectives of the department. These proposals may come from university students, other departments (eg Department of Agriculture), within the Department or from other institutions or agencies. It is recommended that any research project be discussed with the Principal Zoologist, Wildlife Branch to ensure all necessary licenses are issued and the project outcomes can be maximised.

Several areas have been identified as requiring further research. These include:

- Confirmation that feral pigs transport *Phytophthora cinnamomi.*
- Diet of feral pigs in south west Western Australia.
- The impact on other species or interactions between feral pigs and other species, particularly threatened species.
- The relationship between pig density and level of damage.
- Calibration of an index of pig abundance

Other researchers should be approached to explore opportunities to include nature conservation outcomes in research objectives.

Feral pigs occur across all tenure boundaries and therefore effective control may rely on the efforts and cooperation of several land managers. Collaboration is encouraged to achieve desired outcomes.

12.6 Use of Volunteers

Policy Statement No. 15 Community Involvement (Public Participation and Volunteers) and Administrative Instruction No. 43 Operation Guidelines for Volunteer Activities encourage the use of volunteers where their activities complement or assist CALM objectives. However these documents do not refer to the use of volunteers in feral animal control.

The use of volunteers poses public liability and occupational health and safety concerns for the Department. The CLM 205 volunteer registration form provides the volunteer with personal accident and public liability insurance, however the volunteer must ensure they act in a manner authorised by the Department. That is, the activity performed must be an activity that falls within the scope of what the volunteer has been requested, or authorised to undertake.

Volunteers could not rely on protection if:

1. The activity in which the volunteer is engaged at the time at which an incident occurs is outside the activities authorised by the Department.
2. The activity is associated with an unlawful act, or
3. The activity involves dishonesty, serious and/or willful misconduct, willful default, or willful neglect or gross negligence.

If volunteers are used their activities should be closely supervised and records kept of the time spent, kilometres traveled, details of feral pigs captured, shot or observed (as well as other species of interest if possible).

12.7 Staff Allocation

The table below summarises the tasks to be completed to implement this strategy along with the timing, frequency or duration of the tasks and the person/s responsible. Staff requirements are likely to vary between seasons with the highest demand in the summer months. Managers should be aware of the potential for feral pig control activities such as trapping to be affected by fire duties and the subsequent animal welfare concerns if trapping is the control method being used.

Table: Summary of the actions required for implementation of the management strategy.

Action	Timing/Frequency/Duration	Responsibility
TRAINING		
Staff training	As required	District
1080 authorisation – use and possession	2 days every 3 years	
Firearms safety		
Introductory course for volunteer management	2 days	
Driver training (light vehicles 4x4)	4 ½ days	
Law enforcement training	5 days	
Field engineering	3 days	
PLANNING		
Identification of target sites		
Identification	Ongoing	District
Review	As required	District
Animal Ethics Committee Approval	AEC meetings occur bi-monthly. Proposal must be sent 3 weeks prior to each meeting	District
CONTROL		
Feral pig control (Poisoning)		
1080 application and approval paperwork	As required	Authorised (1080) Officer
Establish free feed stations	As required	District
Free feed period	At least 10 days with at least 3 days of stable consumption at the end	District
Bait period	Continue until no more poisoned bait is taken (usually 1-2 days)	Authorised (1080) Officer
Cleanup	After operation complete (~30 min)	Authorised (1080) Officer
Record results in FaunaFile	Ongoing with data analysis every 6 months (minimum)	District

Feral pig control (Trapping)		
Establish free feed stations	–As required	District
Free feed period	At least 10 days with at least 3 days of stable consumption	District
Trapping period	Traps checked daily	District
Record results in FaunaFile	Ongoing with data analysis every 6 months (minimum)	District
Feral pig control (Shooting)		
Locate pigs	Ongoing	District
Record results in FaunaFile	Ongoing with data analysis every 6 months (minimum)	District
MONITORING		
Monitoring of feral pigs		
Recording incidental sightings in FaunaFile	Ongoing with data analysis as required.	District
Establishing transects	2005-2006	District
Re-survey transects	Annually Winter (subject to DRA constraints) and Summer months	District
Monitoring vegetation		
Establish photo points	2005-2006	District
Return to photo points	Minimum annually (at same time of year)	District
Establish transects	2005-2006	District
Resurvey Transects	Annually Winter months (subject to DRA constraints)	District
Fencing to protect values		
Establishment	As required	District
Maintenance	As required, but inspected every 6 months (minimum)	District
REVIEW		
Review of management strategy	As required	District
District operational procedures	Annually (minimum)	District
Data collection in each district Full	Every 5 years (or earlier if considered necessary such as the identification of feral pigs as a key threat in the recovery plan of a species)	Wildlife Branch in consultation with Districts

12.8 Data Management

Data management should consider the needs at both the district and corporate levels.

FaunaFile should be used wherever practical to store information on control and monitoring operations. Districts are encouraged to suggest improvements to the database to make it appropriate and easy to use for this purpose (contact the database custodian).

13 Review

Review of the management strategy is required to ensure that it is kept up to date with information and practices.

Below are points to consider when reviewing various areas of the management strategy as well as suggestions of measurable criteria by which success or failure could be assessed.

Identification of target sites

- Potential target sites have been identified and inspected.
- Identified target sites have been prioritised.

Eradication

- New and/or isolated populations have been identified.
- Control efforts have removed all pigs from the area.

Control/Management

- Monitoring shows a recovery in vegetation cover, species diversity, seedling survival or numbers of flora or fauna.
- The effectiveness of control operations should be determined by the reduction in the level of feral pig damage, and not on the number of pigs killed.
- Information on time spent, kilometres traveled and captures/feral pig deaths has been collected, collated and copies sent to head office.

Monitoring

- Monitoring sites have been identified, inspected and assessed using techniques described in the field manual.
- Monitoring program implemented and adhered to.

Public Relations

- Number of good neighbour operations undertaken and the outcome (eg number of pigs trapped, level of support for control efforts by neighbour etc).
- Reduction in number of letters/complaints about feral pigs in or coming out of conservation estate.
- Community awareness of the impacts of feral pigs and the Departments control and monitoring efforts has been raised.

Whole Strategy

- The conservation status of flora and fauna species improves or does not change as a result of the management of feral pigs.
- The distribution of *Phytophthora cinnamomi* does not expand as a result of feral pigs.

District operational procedures should be altered as required. Changes in response to observations in the field or suggestions by staff should be considered.

Each district is encouraged to review data collection at least annually to allow assessment of operational procedures and appropriate changes to be made.

A full review of the management strategy will occur every five years, or earlier if considered necessary, such as the identification of feral pigs as a key threat in the recovery plan of a species. The full review will be undertaken by the Wildlife Branch in collaboration with Districts.

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13 Appendices

APPENDIX I

List of Fauna Potentially Affected by Feral Pigs

Threatened Species

MAMMALS
Isoodon auratus auratus, Wintarru, Golden Bandicoot
Setonix brachyurus, Quokka

BIRDS
Botaurus poiciloptilus, Australasian Bittern
Erythrura gouldiae, Gouldian Finch

REPTILES
Pseudomydura umbrina, Western Swamp Tortoise

FROGS
Geocrinia alba, White-bellied Frog
Geocrinia vitellina, Orange-bellied Frog
Spicospina flammocaerulea, Sunset Frog

MOLLUSCS
Austroassiminea letha, Cape Leeuwin Freshwater Snail
Undescribed Rhytidid sp (WAM#2295-69) Stirling Range Rhytidid Snail

CRUSTACEANS
Engaewa pseudoreducta
Engaewa reducta
Engaewa walpolea

Specially Protected Fauna

BIRDS
Tadorna radjah, Radjah Duck, Burdekin Duck

REPTILES
Crocodylus porosus, Saltwater Crocodile
Crocodylus johnstoni, Australian Freshwater Crocodile

Priority Species

MAMMALS
Isoodon obesulus fusciventer, Quenda or Southern Brown Bandicoot
Hydromys chrysogaster, Rakali or Water Rat

BIRDS
Ixobrychus flavicollis, Black Bittern (SW Population)
Ixobrychus minutus, Little Bittern
Charadrius rubricollis, Hooded Plover (western subspecies)
Malurus coronatus coronatus, Purple-crowned Fairy-wren (western subspecies)

FROGS
Geocrinia lutea, Nornalup Frog
Uperoleia marmorata, Marbled Toadlet
Uperoleia minima, Small Toadlet

FISH
Craterocephalus helenae, Drysdale Hardyhead
Craterocephalus lentiginosus, Prince Regent Hardyhead
Galaxiella munda, Mud Minnow
Galaxiella nigrostriata, Black-stripe Minnow
Hannia greenwayi, Greenway's Grunter
Hephaestus epirrhinos, Long-nose Sooty Grunter
Hypseleotris aurea, Golden Gudgeon
Kimberleyeleotris notata, Drysdale Gudgeon
Kimberleyeleotris hutchinsi, Mitchell Gudgeon
Leiopotherapon ahenius, Fortescue Grunter
Leiopotherapon macrolepis, Large-scale Grunter
Melanotaenia pygmaea, Pygmy Rainbowfish
Nannatherina balstoni, Balston's Pygmy Perch
Syncomistes rastellus, Drysdale Grunter

MOLLUSCS (freshwater)
Westralunio carteri
Glacidorbis occidentalis

MITES
Pseudohydraphantes doegi, Doeg's Watermite
Acercella poorginup, Poorginup Swamp Watermite

CRUSTACEANS
Branchinella apophysata
Branchinella basispina
Branchinella denticulata
Branchinella simplex
Branchinella wellardi
Daphnia jollyi
Daphnia occidentalis
Calamoecia elongata
Fibulacamptus bisetosus
Cherax tenuimanus., Margaret River Marron
Parartemia contracta

DRAGONFLIES
Antipodogomphus hodgkini
Nososticta pilbara

APPENDIX II

List of Flora Potentially Affected by Feral Pigs

Declared Rare Flora

Acacia brachypoda
Andersonia gracilis
Caladenia barbarella
Caladenia bryceana subsp. cracens
Caladenia christineae
Caladenia dorrienii
Caladenia elegans
Caladenia harringtoniae
Caladenia hoffmanii subsp. hoffmanii.
Caladenia wanosa
Caladenia winfieldii
Diuris micrantha
Diuris drummondii
Drakaea concolor ms
Eremophila denticulata subsp. denticulata
Eremophila micrantha
Grevillea humifusa
Hypocalymma longifolium
Kennedia glabrata
Laxmannia jamesii
Lechenaultia chlorantha
Meziella trifida
Microtis globula
Paracleana dixonii
Ptychosema pusillum
Pterostylis sp. (Northampton)
Senecio leucoglossus
Stachystemon nematophorus
Stawelia dimorphantha
Thelymitra manginii ms

Priority 1

Eryngium sp.Lake Muir

Priority 2

Acacia stereophylla var cylindrata
Alexgeorgea ganopoda
Apodasmia ceramophila
Caladenia starteorum
Caladenia lodgeana
Chordifex jacksonii
Cryptandra glabriflora
Diuris heberlei
Drosera binata
Eremophila brevifolia
Euphrasia scabra
Malleostemon sp Kalbarri
Scholtzia sp Ross Graham Lookout
Scholtzia sp Z Bend
Verticordia galeata.
Wurmbea sp Cranbrook

Priority 3

Acanthocarpus parviflorus
Boronia anceps
Boronia virgata
Calytrix formosa
Chamelaucium marchantii
Chordifex gracilior
Grevillea costata
Lasiopetalum oppositifolium
Lomandra ordii
Rhodanthe pyrethrum
Scholtzia sp Ajana
Stylidium rhipidium
Synaphea intricata

Priority 4

Aponogeton hexatepalus
Astartea sp. Scott River
Baeckea arbuscula
Calytrix harvestiana
Diuris recurva
Lysinema lasianthum
Microtis media subsp. quadrata
Microtis pulchella
Reedia spathacea
Schoenus natans
Stachystemon namatophorus ms
Verreauxia verreauxii
Verticordia densiflora var. roseostella
Villarsia submersa

APPENDIX III

List of Threatened Ecological Communities Affected by Feral Pigs

Scott River ironstone association (Community 19) 39 occurrences. (Category of Threat: Endangered)

Two Reedia communities
Reedia spathacea - Empodisma gracillimum – Sporadanthus rivularis dominated floodplains and paluslopes of the Blackwood Plateau. (Community 100) (5 occurrences) Category of Threat: Critically Endangered
Reedia spathacea - Empodisma gracillimum - Schoenus multiglumis dominated peat paluslopes and sandy mud floodplains of the Warren Biogeographical Region. (Warren Region) Community 101 (23 occurrences) (Category of Threat: Endangered)

Shrublands and woodlands on Muchea Limestone (Community 11) (Category of Threat: Critically Endangered)