# Midwest Feral Animal Plan 2008

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## 1.0 Pigs

### 1.1 Background

Whilst the establishment of feral pig populations is not well documented, domestic pigs have certainly been present in the Midwest Region since early European Settlement. Feral pigs have been evident in Kalbarri National Park since the 1950's, however their early distribution appears to have been fairly limited. Prior to the year 2000 pigs were present in just six or so of the fifty six conservation reserves managed by the Department of Environment and Conservation (DEC) across the Midwest, namely Kalbarri National Park, Bella Vista Nature Reserve (NR), Chillimony NR, Galena NR, Wokatherra NR and Howatharra/Oakajee NR.

Pigs have since been detected in at least 18 conservation reserves in the Midwest Region. Some natural colonisation regularly occurs through bush corridors, however deliberate translocations have also been made by recreational pig hunters (Marshall, 2002). For example East Yuna, Wandana, Bindoo, and Burma Rd Nature Reserves now harbour feral pigs despite having been relatively isolated from natural pig movements.

Pig control activities were initiated by the Geraldton District Wildlife Officer (Kevin Marshall) following the explosion in pig numbers and distribution which occurred prior to 2000. Baiting, trapping and shooting programs were conducted across half a dozen reserves in a five year period to 2005.

Following from these measures the Stop the Rot project carried out surveillance and 1080 baiting of six known pig locations on conservation estate and neighbouring private property throughout 2006-2008.

Pig control is resource intensive, costly and success depends on neighbour participation, site accessibility and pig population mobility. Control programs need to prioritise where to spend a limited operations budget to maximise effectiveness.

## 1.2 Population numbers and distribution

It is difficult to determine the exact number of pigs in any one area due to their shy nature and nocturnal habits. Pigs are also highly mobile, and local population densities fluctuate. Anecdotal evidence suggests that feral pig populations have been spreading rapidly throughout the Midwest in the last 10-15 years (Marshall, 2002). Certainly there has been an increase in the number of DEC managed reserves infested with pigs since the year 2000. The following table gives pig numbers across reserves in the Geraldton and Jurien Districts as estimated from field inspections by Kevin Marshall in 2002.

| **DEC Reserves** | **Numbers** |
|---|---|
| East Yuna | 600 |
| Bindoo Hill | 200-400 |
| Oakajee | 150 |
| Chillimony | 100 |
| Howatharra | 50 |
| Bella Vista | 40 |
| Wokatherra | 50 |
| Beetalyinna | 150 |
| Galena | 50 |
| Wandana | 40 |
| Cutubury | 30 |
| Indarra | 15 |
| Wongoondy | 5 |
| Wicherina (Shire reserve) | 200-400 |
| Beekeepers | 50 |
| Depot Hill | 10 |

The Stop The Rot project (2006-2008) actively searched for signs of pig habitation in DEC managed reserves, and again located numerous and widespread occurrences of recent pig activity. Contact was also sought with private landholders adjoining conservation estate and reports of pig activity were investigated.

Stop The Rot's field research identified pig populations in broad areas of the Northern Agricultural Region including East Yuna / McGauran's Nature Reserve, Bindoo Hill Nature Reserve, Beekeepers Nature Reserve, Eradu Nature Reserve, Galena Nature Reserve and Kalbarri National Park.

Dispersal of pig populations generally occurs over winter but during the drier summer months pigs need to water every day and thus are confined to permanent water pools over this time. Once a family group becomes established in an area their group rapidly increases and disperses further afield (Coquenot, McIlroy, Korn, 1996). Preferred habitat includes rivers, creeks and gorges sheltered by remnant native vegetation, largely within the agricultural zone.

Pigs are omnivorous and able to adapt to varying foods and climate, and are able to modify their behaviour to suit conditions (Pers. Comm. C Tuesley).

## 1.3 Impacts on native vegetation / native fauna

Feral pigs upturn soil in search of food, with plant material making up the bulk of their diet, supplemented by invertebrates, reptiles and amphibians (Pavlov, 1983). Underground tubers and bulbs are a staple carbohydrate source for feral pigs, with Haemodorum species (bloodroot) being a common seasonal food of feral pigs in south-west Western Australia (Marsack, 2000). Feral pig diggings can become quite extensive with soil being overturned to a depth of 20cm. This activity can be destructive not only to the plants being targeted for food but to all plants that rely on the integrity of their surrounding environment. Rooting disrupts soil fauna, and may change the composition of local plant communities. This digging also makes the soil more prone to degradation including erosion and an increased level of weed colonization. Feral pigs may be involved in the spread of diseases which affect plants, animals and man. There is evidence that pigs have increased the spread of the plant pathogen Phytophthora cinnamomi, the cause of dieback in a number of Australian native species (Marsack, 2000).

Repeated monitoring of Declared Rare Flora (DRF) sites in Kalbarri National Park since 1986 has observed increasing pig disturbance in areas directly impacting DRF. Many DRF species grow on the banks of the Murchison River and the slopes above the gorge, where feral pig activity is quite intensive. DRF species in Kalbarri National Park include five species of orchid which can be sought after by pigs for their tubers. (Forward, 2002).

The ‘Stop The Rot’ project (2006-2008) found intensive disturbance in pig infested areas including pads, tracks and rooted up soil. Frequent use of water holes by pigs is also causing visible degradation of waterways and contributing to poor water quality. (Pers comm. C.Tuesley).

## 1.4 List of DEC managed estate under threat

Known current pig populations:

- Beekeepers Nature Reserve (NR)
- Beetalyinna NR
- Bella Vista NR
- Bindoo Hill NR
- Burma Road NR
- Chillimony NR
- Cutubury NR
- Depot Hill NR
- East Yuna/McGauran's NR
- Eradu NR
- Galena NR
- Howatharra NR
- Indarra NR
- Kalbarri National Park
- Moresby Range NR
- Oakajee NR
- Wandana NR
- Wicherina shire reserve
- Wokatherra NR
- Wongoondy NR

(Along with private property adjoining above reserves).

## 1.5 Prioritisation of species for management actions

Pigs have a high level of impact on the nature conservation values of reserves. Persistent pig populations are a threat to conservation and wildlife management objectives. It is widely recognised that successful pig control can only be carried out with the cooperation of surrounding landholders. As a significant landholder in the district DEC has an obligation to support community pig control measures by tackling feral pigs on DEC managed conservation estate.

## 1.6 Previous management actions – results, lessons learned

### *1080 Baiting*

The technique described below has been widely used and is recognised as the most time and cost efficient way to control feral pig populations.

- Pre feed the feral animals with an appropriate food source for 1-4 days prior to baiting to ensure good up take of the bait.
- Check the pre feed daily to ensure bait is being taken, if not create another station in a different location to target the feral pigs.
- Monitor the stations in an attempt to determine the number and size of the pigs that are using the bait station.
- Bait the station with 1080 black concentrate (100ml per 6kg of food).
- Monitor the station to ensure uptake is occurring and if uptake is significant re-bait the area to ensure that the entire population has been baited.
- After a determined period of time wash the bait stations out with water to break down any remaining 1080 poison.

**Results:**

2003-2005 (District Wildlife Officer):

- East Yuna: 60 confirmed kills.
- Wicherina: unknown.
- Beekeepers 5 occasions: 40-50 confirmed kills.
- Beetalyinna several occasions: 30-40 kills.

Total: 150 confirmed deaths, with more suspected.

2006-2008 (Crown Reserves Officer/Stop the Rot):

- East Yuna/McGauran's Nature Reserve: 17 confirmed kills, numerous signs of uptake of poison leading to death.
- Bindoo Hill Nature Reserve: 9 confirmed kills.
- Bee Keepers Nature Reserve: numerous signs of uptake of poison leading to death.
- Various pockets of private property surrounding NR: 28 confirmed kills, numerous signs of uptake of poison leading to death.
- Beetalyinna: unconfirmed.

Total: 54 confirmed deaths, with more suspected.

## *Trapping*

An intensive trapping program was carried out by Wildlife Officer Kevin Marshall during the period 2002-2005 using eight mobile traps. Traps were designed to be transportable via trayback utility vehicle, and could be setup by one or two people. Trapping successfully caught pigs where numbers were high, with over 30 pigs trapped in the proposed Moresby Ranges Conservation Park, and 25 pigs trapped at Oakajee Nature Reserve. All animals were shot in traps. Traps were checked everyday and this limited the useful deployment of traps to within

an hour's travel time from Geraldton. Sites such as East Yuna and Chillimony Nature Reserves proved to be too far away to work the traps effectively.

Recently traps have been set up in partnership with landholders on private property adjoining conservation estate in the Moora District. Landholder participation removes the obligation of DEC staff to check the traps everyday and allows for longer, more effective trap deployment. (Pers. Comm. Steve Buitenhuis).

## 1.7 Guiding principles of future management actions

- Small populations are easier to eradicate than large ones
- Isolated populations are easier to eradicate than connected ones
- Recent populations are easer to eradicate than long established ones
- Pig habitat is limited by availability of fresh water
- Small reserves are easier to treat than large ones
- Populations contained in DEC estate are easier to control than populations shared across boundaries with private landholders
- Natural dispersal is slow and limited by landscape connectivity
- High rainfall periods aid dispersal and fertility
- Drought restricts mobility and fertility
- Baiting with follow up is an effective means of control
- Shooting and trapping are not effective for eradicating entire pig populations
- Eradication measures are most effective when aimed at fringe distributions and isolated populations
- Repeated measures are more effective than single measure
- Key conservation assets such as DRF populations may deserve special priority for pig control actions

## 1.8 Statement of objectives for feral pig management

A feral management plan can be aimed at total eradication, local eradication, strategic management, commercial management, crisis management or no management (Sharp and Saunders, 2004).

In the context of highly mobile pig populations, fluctuating pig numbers and widespread distribution throughout the landscape, strategic management is the only option. Strategic management is necessary where local eradication is not achievable, but where it is clear that pest damage will require continuing management. Strategic management is indicated where it is decided to reduce and sustain pest density, and pest damage, to a low level.

## 1.9 Prioritisation of key sites for management action

| | Key assets at stake | Reserve | | | Population | | | | Priority for control action |
|---|---|---|---|---|---|---|---|---|---|
| | | Size ha | Isolated | Adjoining PP | Pig No.s | Estab. | Permanent water | Recent Control | |
| Beekeepers NR | | 66500 | No | Yes | Low | 2000 | limited | 2008 | High |
| Beetalyinna NR | | 200 | No | Yes | | 2000 | On the Greenough | 2005 | Low |
| Bella Vista NR | | 70 | Somewhat | Yes | | 1990s | No | | Low |
| Bindoo Hill NR | | 650 | No | | | 2000 | Greenough 4.5km away | 2005 | High |
| Chillimony NR | | 146 | Yes | Yes | | 1990s | | None | Low |
| Cutubury NR | | 15 | No | Yes | | 2000 | Chapman R | | Low |
| Depot Hill NR | | 63 | Somewhat | Yes | mobile | | No | | Low |
| East Yuna / McGauran's NR | Rare | 2500 | No | Yes | | 2000 | On the Greenough | 2008 | High |
| Eradu NR | | 62 | No | Yes | | | On the Greenough | None | Low |
| Galena NR | | 216 | No | Yes | | 1990s | Murchison 4km away | None | Low |
| Howatharra NR | | 70 | No | Yes | | 1990s | No | | High |
| Kalbarri NP | Rare Orchids in gorges | 183000 | No | PP on two sides | | 1950 | Yes | Shoot / bait | Low |
| Moresby Range CP | | ?? | No | Yes | | 1990s | No | Traps | Low |
| Oakajee NR | | 123 | Somewhat | | | 1990s | | 2002 | High |
| Wandana NR | | 54800 | No | | | | No | | |
| Wicherina reserve | | Large | | | | 2000 | | 2005 | Low |
| Wokatherra NR | | 112 | Somewhat | | | 1990s | No | | |
| Wongoondy NR | | 305 | Yes | Yes | | | No | | |

## 1.10 Recommended management actions

| Objective | Action | Priority |
|---|---|---|
| 1. Dedicated pig control program | Designate a position such as the District Reserves Officer, Conservation Employee or other officer to be responsible for managing all ongoing pig control activities. | High |
| 2. Knowledge of where pigs are | • Regular surveillance program of known pig habitats - pig tour circuit<br>• System to record ad hoc pig sightings (Dedicated to Crown Reserves position?).<br>• Maintain Regional Pig Atlas, indicating areas of high, medium, low, zero pig activity and control measures<br>• Determine whether populations are growing and spreading or remaining static.<br>• Determine the dependence of pig populations on reserves versus private property, and the level of mobility between property boundaries. | |
| 3. Protect key conservation values eg DRF | Fence key DRF habitats? Where threat level is highest. Produce a map of the key conservation values under threat eg areas of high impact and high cons value along the Murchison river. | |
| 4. Coordinate with other stakeholders | Form a team made up of those who will be involved in developing and implementing the pig control operations (Rep from Kalbarri NP, Reserves, Flora, Wildlife, APB?) | |
| 5. Limit resource waste on unsuccessful control actions | Avoid eradication actions proximate to bottomless pig reservoirs, also apply principles listed in section 1.7 | |

| | | |
|---|---|---|
| 6. Present a consistent message regarding recreational shooting on public lands | For the benefit of field staff clarify DEC policies re recreational shooting, and provide protocols for responding to recreational shooting enquiries.<br>Specifically, the legality and effectiveness of shooting of pigs on DEC Estate, on UCL, on Private Property, on other reserves. | |
| 7. Manage the timing of control actions to take best advantage of climatic factors | A coordinated approach in the summer months is likely to have the best results as the pigs are restricted in their distribution to permanent water in the landscape, and may be weaker due to heat stress. (Pers Comm, Marshall, 2006) | |
| 8. Preserve water quality in pools and streams | Identify the permanent pools of water along water courses in the Region.<br>Determine level of use and degradation by feral pigs<br>Target control measures towards highly degraded pools if the location is judged to give a high rate of success based on other criteria in section 1.7 | |
| 9. Education / Public awareness | Develop program | |

# 2.0 Goats

## 2.1 Background

## 2.2 Population numbers and distribution

Goats were introduced to Western Australia by European pastoralists for use a source of meat and milk, and for the mohair wool industry. The first recorded release in the Midwest was in 1870, when the Victorian Acclimatisation Society exported 50 goats to Shark Bay. By 1894, some 4,500 goats were present in WA, and thereafter rapidly became established in the arid rangelands of Western Australia. Numbers were boosted by large releases from pastoral stations following the collapse of the mohair industry, early 1900's. (APBWA, 1993).

By 1928, the WA state government acknowledged the pest status of feral goats and the destructive impacts of goats on the environment, with declaration under the Vermin Act 1918. Feral goats are now declared animals under the Agriculture and Related Resources Protection Act 1976 throughout Western Australia. A commercialisation policy was introduced in 1973 in an attempt to encourage stock management of goats, however it proved to be ineffective at controlling goat numbers. (APBWA, 1993).

In 1987 and 1990 the Australian National Parks and Wildlife Service and CALM undertook an aerial survey of kangaroos in WA, and also recorded numbers of feral goats in the survey. It was observed that goats were the most widespread and numerous of the large feral animals. A 64% increase in feral goat numbers was recorded over the 3 years between surveys. (APBWA, 1993).

In 1991 the Feral Goat Eradication Program began implementation, a review of which was conducted in 1996. (Feral Goat Eradication Program Review Committee, 1996).
The review reported that 1.6 million feral goats had been removed from the rangelands by goat control activities. Success was reported where landholders were motivated by concerns for the wellbeing of the rangelands and ecological sustainability of the pastoral industry. Results were less successful where the pastoralist's focus was on commercialisation of goats for economic gain.
The report recognised eradication of feral goats to be an unattainable goal, and the review committee accepted that the use of the term, whilst impractical, was used to provide impetus to the program. The lesser goal of reducing the impact of feral goats on rangelands to a negligible level also failed to be achieved. Fears were expressed that a cessation of control efforts following the initial five years of goat number reduction would result in a rapid return to high goat numbers across the rangelands. The numbers remaining however were not quantified.

It was recommended that recalcitrant landholders should be required to remove feral goats by enforcement of the relevant Acts by the Pastoral Board, the Agricultural Protection Board and the Soil and Land Conservation Council.
Further it was recommended that all aspects of the eradication program must be fully funded, including the use of the helicopter to assist landholders in removing "non-commercial" goats. There was widespread acknowledgement that uncoordinated ad hoc control measures were a waste of money due to continuous reinfestation by goats. The program was deemed unlikely to succeed if sufficient funding was not allocated.

One can only presume sufficient funding was not subsequently allocated.
Over the past decade commercialisation of goats has continued to provide a significant source of income for pastoralists as a welcome addition to their declining sheep operations, and at times goats have commonly fetched more per head than sheep at the saleyard. The change in attitude towards goats as stock rather than as feral pests has been extensive throughout the pastoral region. It has become difficult during this period for DEC to engage neighbouring pastoralists in effective feral goat eradication. The recent slump in goat prices (2007) may present a new opportunity for DEC to re-engage with the pastoral community in goat control measures.

## 2.3 Impacts on native vegetation / native fauna

The following extract from Paxman and Pearson (2008) neatly describes the problem:
"Intuitively, we would expect goats in large numbers to have a major impact on natural vegetation and a short stroll along the Murchison Gorge provides plenty of evidence of the impacts of grazing. There is little undergrowth; most shrubs are large, woody and lack growth on their lower portions with prominent graze lines on palatable species; many of the surviving shrubs are spiny, broken branches are frequent and there is apparently little recruitment of shrubs. However, we cannot just attribute the condition of the vegetation to goats as several other herbivores are present: rabbits, Euros, feral pigs and insect grazers. Separating out the relative impacts of the various grazing species poses significant problems for monitoring.
We need to understand the impacts of goat grazing to guide the recovery of the vegetation, to promote conditions that are suitable for improving the conservation of threatened flora and to permit the reintroduction of locally extinct fauna such as the Black-footed Rock-wallaby."

The Peron Peninsula report (Hepburn Brown, 2001) lists the following main reasons for controlling feral goats :

- Direct competition with native browsers for food
- Risk of selective grazing of native species and plant communities
- The spread of weed species

- Destruction of cover and habitat for native fauna
- Soil erosion caused by walking pads
- Visual impact of feral goats to tourists visiting a World Heritage Property.

## 2.4 List of DEC managed estate under threat

There are three different situations in which feral goat populations occur in the Midwest Region. It is worth considering each as a separate problem with potentially separate control programs, as follows.

***Zone 1: Moora District – Northern Agricultural Region***

Isolated pockets of feral goat numbers exist deep in the Agricultural Region where significant areas of native vegetation remain to provide protection and habitat. One such population has become established in the Northern End of Beekeepers Nature Reserve around the Arrowsmith River, and a second in the combined Watheroo National Park, Pinjarrega and Capamauro Nature Reserves. These populations are present year round and in addition to ephemeral pools and streams they have ready access to stock water on neighbouring properties. The relatively isolated position of these populations promotes successful control, however they are highly mobile and not confined within DEC conservation estate boundaries.

***Zone 2: Geraldton District – Northern Agricultural Region***

Numerous Nature Reserves in the Geraldton District contain goats for all or part of the year. The reserves in the Northern end of the Agricultural Region tend to be smaller than the southern reserves described in Zone 1, and are more isolated within a broader farming landscape. Goats are only present where water is available which limits their distribution in the drier parts of the year. Neighbouring farm water supplies again provide a means of extending their range into otherwise dry conservation reserves. The cultivated agricultural landscape does partially limit the mobility and viability of goat populations, as significant feral goat infestations are not tolerated by farmers. The Nthn Ag Region is also partly protected from Rangelands reservoir populations by the State Barrier Fence. In very broadscale control campaigns this can help to reduce reinvasion of the Agricultural Zone.

Kalbarri National Park is a major feature of this Zone. It contains numerous Declared Rare Flora and threatened fauna species which merit special protection. An extensive gorge system provides ideal shelter and habitat for feral goats and limits management options. Kalbarri National Park is partially isolated from re-infestation as it is bordered on one side by Ocean, on another by agricultural lands, and in part by the Australian Bush Heritage Fund's conservation estate, Eurardy station. Collaboration with neighbours is a key component of any control efforts.

### *Zone 3: Semi-arid Rangelands of the Midwest Region*

Semi-arid rangelands occupy the greater portion of the Midwest Region in the Northern and Eastern quarters. Some twenty five or so pastoral leases have been purchased for conservation estate in the Gascoyne-Murchison rangelands covering over three and a half million hectares of land. Most DEC managed estate in the rangelands maintains some level of goat habitation. Numbers can expand rapidly after rainfall through breeding and mobilisation, however persistant populations require permanent water. The density of goat numbers across DEC managed conservation estate is dependent on both the availability of permanent water and the reservoir of goats available for recolonisation from surrounding properties.

## 2.5 Prioritisation of species for management actions

Goats are the single most significant herbivorous pests of native vegetation. The two aerial surveys conducted in 1987 and 1990 by the Australian National Parks and Wildlife Service and CALM illustrated both the extent of goat distribution and their capability for rapid population increase (APBWA, 1993).

## 2.6 Previous management actions – results, lessons learned

### *Decommissioning of windmills and tanks*

Typically rangelands properties receive irregular rainfall and natural permanent water is greatly restricted. Pastoralists have historically used deep wells to supply stock watering points. Goats need a permanent source of water to survive in a landscape, unlike many drought adapted native fauna species which can eke out an existence on the water they obtain from food and dewfall. Goat populations in the semi-arid rangelands survive by using artificial stock watering points and natural permanent or semi-permanent pools where they exist.

Goat control in these areas is assisted on conservation estate by the decommissioning of wells and windmills to reduce the availability of permanent water. Goats do persist on these properties despite DEC's management of watering points. Eradication is not possible where significant populations exist on neighbouring properties, particularly where stock watering points are provided in close proximity to the reserve boundary.

The status of watering points on DEC managed rangelands properties is summarised in the following table.

| Property | Mill status | Other water available |
|---|---|---|
| Muggon | All mills removed | No |
| Burnerbinmah | All mills removed | 5 Permanent pools |
| Woolgorong | 18 mills are being phased out | Permanent pools |

| | | |
|---|---|---|
| Waldburg | Mills removed except house paddock | Permanent spring |
| Karara / Kadji / Lochada | 11 mills retained for trapping purposes, all other mills removed | Permanent spring |
| Dalgaranga | Mills yet to be removed | Permanent pools |
| Thundelarra | Mills yet to be removed | Permanent pools |
| Barnong | Mills yet to be removed | Permanent pools |
| Peron | 2 bores retained for trapping | No |
| Dirk Hirtog Island | Mills yet to be removed | No |
| Nanga | Mills yet to be removed | No |

### *Aerial shooting*

Aerial shooting of feral goats from a helicopter is used in inaccessible areas, and to manage low density populations or remove survivors from other control programs. It has also been used for broadscale population reductions when prices for goats are low and / or mustering uneconomic. Teams involved in shooting from a helicopter include a shooter, a pilot and a spotter/counter who locates the goats as well as records the location and number of animals shot. A separate spotter plane is also commonly used to perform the spotting function.
Aerial shooting can be a humane method of destroying feral goats when it is carried out by experienced and skilled shooters and pilots; the animal can be clearly seen and is within range; the correct firearm, ammunition and shot placement is used; and wounded animals are promptly located and killed. (Saunders and Sharp).

Historically (early to mid 1990s), aerial shooting exercises were extensively carried out by the Agricultural and Pastoral Board (APB) across all rangelands tenures, including conservation managed estate – in particular Muggon, Kalbarri, Cape Range and Kennedy Renges. Recently the Biodiversity Conservation Initiative and its successor, the Save Our Species program funded two successive years of aerial goat shooting in the Kennedy Ranges, Kalbarri National Park (Midwest Region) and Cape Range National Park (Pilbara Region). Pre and post shoot monitoring was carried out as part of the program to help evaluate the effectiveness of aerial shooting for goat control on DEC managed estate.

<u>Kalbarri</u>
(Summary of Paxman and Pearson, 2008.)
A four day aerial shooting exercise was conducted in Kalbarri National Park in February 2006 and again in February 2007 with the following results:

| | | | | |
|---|---|---|---|---|
| 2006 | 1400 goats | - | - | - |
| 2007 | 1353 goats | 17 pigs | 40.6 helicopter hrs | 43 fixed wing hrs |

The majority of animals were shot within one or two kilometres of the Murchison Gorge. Ground shooting was undertaken on the last two days of the program at specific sites which had already been shot over by the helicopter, with a total of 61 animals being destroyed. A shoot planned for 2008 was cancelled, however a further shoot is proposed for 2009.

Monitoring of goat numbers was carried out using a standard and repeatable aerial survey methodology. The aerial survey which was flown after the 2007 shoot revealed much lower goat densities within the Park (including the gorge system), with higher densities recorded on the adjoining Murchison House pastoral lease.

Vegetation monitoring plots were installed in 2006/2007 at two sites near gorges in the Kalbarri National Park. Monitoring sites consist of fenced goat exclosures and unfenced control plots. Vegetation surveys of these exclosure sites have been undertaken by David Pearson (DEC Science Division) in order to assess biodiversity impacts of goats on near-gorge habitat. Surveys seek to identify native flora at these sites and monitor changes in species composition (floristics), species diversity, shrub condition, recruitment and survival in grazed and ungrazed study plots. The numbers of faecal pellets of each grazing species will also be counted and removed in permanent plots as a surrogate measure for grazing pressure.

Results of vegetation survey and monitoring are not yet known, however preliminary observations appear to demonstrate an increase in species diversity and abundance within the fenced exclosure plots.

### *Poison - 1080*

A comprehensive review of the use of 1080 poison for feral goat control was published by the Agriculture Protection Board of WA (APBWA) in 1993.
1080 is recommended by the review as the poison of choice, due to its low toxicity to native animals relative to goats, low toxicity to humans relative to goats, the fact that it is readily biodegradable, non bio-accumulative, tasteless and water soluble, and inflicts a relatively humane death. The review reports of extensive trial work carried out by the APB and CALM in 1993 in the Upper Gascoyne, Leonora and Peron Peninsula, which developed an effective method of poisoning feral goats using water troughs. The method was researched and designed so as not to place other species at risk, and involves placing temporary poisoned artificial watering troughs while excluding goats from pre-existing troughs which are favoured by birds for ongoing use. A set of 16 protocols was recommended for use of the method, including the restriction of 1080 goat control operations to designated Agricultural Protection Board officers who have completed the 1080 Feral Goat Control training.

## *Peron Peninsula experience*

(Adapted from Hepburn Brown, 2001.)

The Peron Pastoral Lease was purchased in 1990 for inclusion in WA's conservation reserve system. Initial contract destocking in 1990 removed approx 15, 378 sheep, 423 goats, 19 horses and 7 cattle. CALM staff shot and removed a further 2,458 sheep in the mopup. Anecdotal evidence suggests that the reduced sheep numbers following destocking allowed feral goat numbers to increase. The following control measures were used in the Peron Peninsula Stock and Goat eradication program between 1990 and 2000.

### *Trapping*

Summer trapping of goats commenced in 1991 and continued until 1994, with the following success:

| | | |
|---|---|---|
| 1991 | 706 sheep, | 3823 goats |
| 1992 | 1000 goats | |
| 1993 | 2500 stock | |
| 1994 | 1039 goats | |
| 1998 | 78 goats | |

Trapping made use of existing stock mustering yards from pastoral days. Stock were mostly destroyed in the traps in a humane fashion using high powered firearms. This took on average one person approximately one hour to destroy 100 goats. After the initial five years of trapping, residual goats were estimated at 400-500 on the Peron Peninsula, however the low numbers and wary behaviour prevented further summer trapping. It is thought that resting the traps for 3-4 years improved their effectiveness once again.

Permanent traps and yards have been maintained at Monkey Mia and New Bore and can be used when staff resources are available and weather conditions are appropriately hot and dry. Permanent controlled watering points have been reduced from 35 to 4.

### *Fencing*

The Peron Peninsula is surrounded by ocean on three sides, and is connected to the mainland by a narrow neck. In 1995 the entire peninsula was fenced off at the boundary of the Peron and Nanga Stations by a 2.5 m high chain mesh barrier fence along a 3km alignment coast to coast. Stock grid crossings are installed at road entrances. The fence in this location is a highly effective barrier to the re-entry of sheep and goats.

### *1080 Poison*

In 1993 a 1080 poison trial was conducted on Peron Peninsula by the Agriculture Protection Board (APB). Two trough watering sites were used to supply 1080 poisoned water to feral stock. The poison was supplied daily for 5 days between 6am and 12 midday, and was constantly under surveillance of CALM Ranger staff on site. The trial is thought to have killed the 421 goats and 98 feral sheep which were observed drinking from the two troughs over the trial period. No

wallabies or kangaroos visited the troughs during the trial and birds were observed to water exclusively from a fenced nearby dam.
Although judged successful, the exercise generated public complaint largely due to the carcass remains being left on site. The method has not been used again.

*Helicopter shooting*
Following the intitial three years of destocking and summer trapping on water, many of the remaining goats had learnt to avoid artificial waters.
A joint exercise by CALM and the APB used fixed wing spotter aircraft and helicopter for aerial shooting of goats in 1994, 1995, 1996 and 1999.
Success was reported for the following numbers of goats (note additional sheep were also shot):

| | | |
|---|---|---|
| 1994 | 1277 | goats |
| 1995 | 1016 | goats |
| 1996 | 271 | goats |
| 1999 | 119 | goats |

This method was reported as particularly effective when goats attempted to escape in rugged terrain such as steep coastal cliffs. Ground mustering or shooting was judged to have been impossible in these circumstances.
Judged to be effective but expensive, total costs per shoot ranged between $4,000 and $17,500.

*Opportunistic ground shooting by CALM staff*
During the period 1990 to 2000 it was considered acceptable for ground staff to carry out a limited amount of opportunistic ground shooting. Small mobs encountered during day to day operations were able to be shot on sight. This is no longer a valid option following the tightening of firearms procedures within the Department of Environment and Conservation. At the time it was judged to be cost effective if carried out in association with radio collared “Judas” goats, skilled staff and low goat numbers, and in conjunction with other field tasks. Ground shooting of goats by DEC staff is permitted subject to the lodgement and approval of an appropriate shoot plan.

## *Trapping on ex-pastoral leases*

The following code of practice for the humane trapping of feral goats was produced by the NSW Department of Primary Industries (Saunders and Sharp, 2004):

To minimise the possibility of starvation and stress, all traps must be inspected at least once daily. Goats must be provided with water at all times and appropriate feed must be made available if captured goats are to be held more than 24 hours. More frequent checking may be necessary during extreme weather conditions. Traps should be constructed to provide goats with shade and shelter

and should be large enough to avoid overcrowding. Capture and handling should be avoided when females are kidding or have young at foot. Kids that do not accompany their mother into the trap may be separated and die of starvation or if trapped can get trampled underfoot.

Goat traps can have a significant negative impact on native non-target species (especially macropods) by inadvertently trapping them and also by excluding them from water sources.

Mustering, capture and handling increase stress in feral goats as they are not used to confinement or close contact with humans. Consequently, these procedures can result in mismothering, feeding disruption, social disruption, heat stress and also abortion in heavily pregnant females. Metabolic, nutritional and parasitic diseases and also changes in environmental conditions are common causes of mortality and morbidity in confined feral goats, especially when confined for long periods. The removal of trapped feral goats off-property for either sale to abattoirs, live export, or for domestication, involves additional stress to animals. Therefore the most humane option is to destroy goats on the property where they are caught.

### *Trapping - Karara, Lochada and Kadji Kadji*

These pastoral leases were purchased as addition to the Midwest conservation estate in 2001, 2000 and 2003 respectively. Destocking occurred immediately and was carried out by the departing lease holders as part of the purchase contract agreement. Goat trapping has been carried out by DEC staff and caretakers for five of the last six years, with the following success (Pers. Comm. G. Kitson):

| | |
|---|---|
| 2003 | 152 goats sold |
| 2004 | 160 goats sold |
| 2005 | no trapping occurred due to unseasonable summer rains |
| 2006 | 600 goats sold |
| 2007 | 380 goats euthanased |

The choice between euthanasia and selling trapped goats was an economic one dependent on the goat and hay prices in that particular season.
The number of goats trapped escalated four fold following the wet season where no trapping occurred. This may be due to the optimal breeding conditions which followed the wet summer season, but may also reflect the results of suspending trapping pressure for a year. The repeated success of trapping efforts on these three leases does support the continuation of the trapping program.

### *Trapping and contract mustering*

Most of the DEC managed ex-pastoral leases have contracts in place to permit mustering, trapping and removal of goats by specific operators. The contracts operate for a limited period of time, after which they are generally readvertised to attract new operators. This practice encourages the current contractor to exert maximum goat control efforts during the limited contract term, and discourages the practice of building up stock numbers by releasing juvenile and breeding animals. DEC pays a premium on the contract for each goat sold and each unsaleable goat disposed of in traps.

*Summary of current trapping activity on ex-pastoral leases 2008 (Pers. Comm. D. Blood).*

| PROPERTY | CURRENT CONTROL ARRANGEMENT | EFFECTIVENESS |
|---|---|---|
| Barnong | Mitchells have until 2013 to muster and trap goats. | Newly purchased property – not yet assessed. |
| Burnerbinmah | Annual muster conducted by Tom Morrissey from Thundelarra and John Morrissey and Muralgarra. Persistent shooting on rockholes by caretaker. | Numerous permanent rockholes attract and retain goats despite closure of mills. Numbers and impacts remain consistently high, control ineffective to date. |
| Dalgaranga | Condition of sale: Previous owners have until 2012 to muster and trap goats. | Efforts so far have been minimal and numbers remain moderate to high. |
| Doolgunna | None | No goats because of wild dog presence. |
| Kadji Kadji | Caretaker traps 2 rockholes | Trap sites on rockholes, numbers remain moderate to low. |
| Karara | Caretaker traps ~10 mills and shoots occasionally. | Some mills remain for trapping, overall numbers are low to moderate. Effectiveness is fair but could be improved by persistent and more targeted shooting in summer |
| Lochada | Caretaker traps 2 rockholes | Trap sites on rockholes, numbers remain moderate to low. |
| Mooloogool | None, although occasionally rare on SW boundary. | Goats rare because of dog presence. Moderate numbers on western neighbours may reinfest if dog numbers change. |
| Muggon | No active arrangement, although verbal agreements with Curbur, Mt Narryer and Meeberrie to muster from semi permanent pools within Muggon. | Very high historical numbers and extreme impact - 18,000 removed between 99-04. Last trapping 04 was very thorough, waters closed. Numbers consistently low since 04 except on eastern boundaries, where eastern neighbours have mustered ~2000 in last 2 years. Recent filling of lake will attract goats over summer 08/09 and make removal difficult except by mustering. |
| Narloo/ Pt Twin Peaks/ Tardie | Written agreement with 2 Twin Peaks and Yuin to trap and muster. | Neighbors muster and trap on 1 remaining mill. Numbers remain moderate to high; despite effects of trapping/mustering. |
| Noongal | Condition of sale: Previous owners have until 2012 to muster and trap goats. | Joins Dalgaranga. Efforts so far have been minimal and numbers remain moderate to high. Southern half being sold to neighbour. |

| | | |
|---|---|---|
| Thundelarra | Condition of sale; Previous owner has rights to take goats until 2010. | 40 odd mills plus equipped with traps; numerous permanent rockholes make trapping problematic. Owner maintains persistent effort and numbers remain moderate. |
| Warriedar | Tendered agreement with private individual to trap and muster. | Has removed 800 head in 12 months. Stringent performance measures in contract to reduce chance of releasing undersize animals. Numbers are persistently lower than before regular trapping began, although areas difficult to trap retain higher numbers. |
| Wooleen (Part) | Verbal agreement with Wooleen and Meeberrie to muster eastern paddocks of Muggon. | Joins Muggon, no waters inside, but 4 on or near boundary and rugged landscapes make the Errabiddy block a regional goat Mecca. Large and persistent numbers but extremely difficult to muster due to terrain and hard to trap because of scattered rockholes in the range. |
| Woolgorong | Contract agreement with property caretaker with stringent performance measures. | Intensive program of trapping and aerial muster in summer 0607 and 0708 removed 2200 animals. Numbers since then have been consistently very low. |

### *Feral proof fence exclosure of ex-pastoral lease Burnerbinmah*

The use of exclusion fencing is generally regarded as a humane, non-lethal alternative to lethal control methods. However, fencing of large areas is expensive to construct and maintain and is eventually breached by feral goats. Fences can be of limited use in feral goat control by restricting access to sensitive areas, and excluding goats from some water points to concentrate them at others where they can be trapped. They have also been used to break up large areas into manageable blocks during eradication programs. Exclusion fencing can have negative effects on non-target species by restricting access to natural watering points, altering dispersion and foraging patterns, and causing entanglement. It can also create a significant hazard to wildlife in the event of a bushfire (Saunders and Stacey, 2004).

Burnerbinmah Pastoral lease was purchased as an addition to the Midwest conservation reserve. A fencing contract was completed in 2008 to completely enclose the Burnerbinmah reserve with a total of 87 km goat proof fencing. Funding was provided by DEC's Save Our Species initiative. Fencing consists of 8 line fast lock with barb bottom wire and single plain top wire, with one-way trap gates to allow stock and goats to move outwards to neighbouring properties. The cost of approximately $323,000 to protect an area of 60,000 ha is initially expensive, but should prove cost effective in the long term by preventing reinfestation from neighbouring properties. The pre-existing goat population on the property is still to be eradicated.

### *Fenced exclosure monitoring – various locations*

In 2007 an exclosure monitoring program was funded by the DEC Biodiversity Conservation Initiative, to establish monitoring sites on five DEC managed pastoral properties (Muggon, Woolgorong, Burnerbinmah, Doolgunna and Kalbarri National Park).
Sites have been located in prime feral goat habitat (ridges, gorges and breakaways) to maximise exposure of the sites to grazing pressure. Each site contains three fenced plots in different landscape positions, each paired with an unfenced control plot (total 6 plots per site). Each plot contains 3 transect lines of 50m (where possible) – a total of 18 transect lines per site. Transects were monitored for baseline records in 2007/2008 using standard Western Australian Rangelands Monitoring System (WARMS) methodology, developed by the Department of Agriculture and Food. The plots will be re-monitored every 2-5 years to establish data on the impact of grazing on native vegetation species composition, species diversity, shrub condition, recruitment and survival. Faecal pellet counting within fenced and unfenced plots can also be used as a surrogate measure to determine grazing pressure. Data analysis may be used to relate pellet densities with grazing impact, and this can provide a measure of grazing impact which can then be applied at other locations.

Measured grazing impacts can be used as a trigger for initiating control measures when feral goat densities become unacceptably high.
The fenced exclosure monitoring program is attempting to answer some of the questions about the impacts of feral goat grazing on plant crown cover, plant growth, species composition, seedling recruitment and landform condition.
The implications for management relate to how we monitor grazing impacts, how much grazing impact should we tolerate, what is the appropriate trigger to initiate control measures, what is the right control measure, how do we fund it and how do we evaluate success.

## 2.7 Guiding principles of future management actions

- Goat control measures should be guided by levels of feral grazing impact - ongoing monitoring should trigger control measures to begin when damage becomes unacceptable
- Goat habitat is limited by availability of fresh water
- High rainfall periods aid dispersal and fertility
- Drought restricts mobility and fertility
- Mustering is effective only for commercially high population densities and in amenable landscapes
- 1080 poison can be successful for goat control however it requires application to drinking water which must then be carefully managed to protect non-target species, this method has previously provoked negative reactions from the public. Restrictions and regulations associated with the technique make it impractical to use on a broad scale, however it may be useful for some inaccessible areas
- Aerial shooting can be an effective control action especially in rugged terrain with large numbers of goats, aerial shooting never removes all goats, cost effectiveness requires evaluation
- Ground shooting incorporating radio collared “Judas” goats can be effective for controlling populations when numbers are low, eg after aerial shooting or commercial de-stocking
- Trapping is an effective action where watering points are limited, permanent traps are most effective because stock can become accustomed to watering at open traps throughout the year in between trapping efforts
- Goat proof exclusion fencing can be highly effective at preventing reinfestation from neighbouring properties after local control measures, its expense may be justified as a one off cost which continues to be effective for an extended period
- Key conservation assets such as DRF populations may deserve special priority for goat control actions
- Cost per head of goat control increases as population numbers decrease

## 2.8 Statement of objectives for feral goat management

A feral management plan can be aimed at total eradication, local eradication, strategic management, commercial management, crisis management or no management (Sharp and Saunders, 2004).
In the context of highly mobile goat populations, fluctuating goat numbers, ubiquitous distribution throughout the landscape and clear evidence of environmental damage, strategic management is the only option. Strategic management is necessary where local eradication is not achievable, but where it is clear that pest damage will require continuing management. Strategic management is indicated where it is decided to reduce and sustain pest density, and pest damage, to a low level.

## 2.9 Recommended management actions

A dedicated goat control program designated to a permanent position such as the District Reserves Officer, Conservation Employee or Wildlife Officer, to be responsible for managing all ongoing feral goat control activities.

***Zone 1: Moora District – Northern Agricultural Region***

- Routine ongoing suppression of goat numbers in the two major areas of Beekeepers NR / Hill River / Arrowsmith cluster and the Watheroo NP / Capamauro NR / Pinjarrega NR cluster.
- Aerial shooting is not a good option as goats are hard to spot under heavy vegetation cover
- Trapping using mobile and /or permanent traps and in partnership with adjoining landholders.
- Establishment of monitoring procedures to guide the frequency of control efforts in response to goat population numbers

***Zone 2: Geraldton District – Northern Agricultural Region***

- Regular monitoring of the numerous conservation reserves scattered throughout the Northern Agricultural Region to check goat population numbers.
- Special protection of Kalbarri National Park in response to valuable biological assets. Maintain ongoing control measures to keep numbers down.
- Suppression of goat numbers in response to evidence of high numbers or high impacts on particular reserves.
- Trapping using mobile and /or permanent traps and in partnership with adjoining landholders.

### *Zone 3: Semi-arid Rangelands of the Midwest Region*

*Direct control measures*

- Regular inspection of the twenty five rangelands properties to determine goat numbers and level of visible grazing impacts.
- Ongoing vegetation measurements of the rangelands monitoring exclosures to quantify grazing impacts at those particular sites.
- In response to inspection and monitoring data, determine a trigger level for grazing impact which initiates immediate feral goat control measures.
- Suppression measures in response to evidence of high numbers or high impacts can include aerial shooting, trapping at water points or ground shooting depending on the geography and location of the site.
- Maintain program of contracts with adjoining landholders to permit mustering of saleable and non-saleable animals from DEC property.

*Ongoing Management Options*

- Exclusion fencing of DEC managed estate
- Consolidation of contiguous reserve areas with conservation minded neighbours to extend fenced area (eg. WA Wildlife Conservancy, Mining companies and Australian Bush Heritage).
- Strategic land purchase to fill out existing conservation estate for better boundary management
- Removal of artificial water sources – mill decommissioning program
- Retention of a limited number of artificial water sources and provision of permanent traps at these sites
- Opportunistic trapping program to coincide with dry times when goat numbers are centred around few remaining watering points

# 3.0 Rabbits

## 3.1 Background

Wild European rabbits were introduced into Australia as a 'harmless' addition to hunting sport in 1859, when Victorian grazier Thomas Austin imported 24 rabbits from England and released them on his property. The rabbits soon multiplied and spread throughout Victoria, New South Wales, southern Queensland and South Australia. By 1894, they had advanced across the Nullarbor Plain and reached Western Australia's border.
The increasing rabbit population impacted severely on farmers, with rabbits eating crops and pastures, and costing the farming community. Damage was undoubtedly also inflicted on native vegetation.
The threat to farmers became so serious that a Royal Commission was held into the situation in 1901. As a result, explorer and surveyor with the Lands and Survey Department, Alfred Wernam Canning, examined the country under threat and determined a survey line for a barrier fence broadly separating the agricultural areas from the pastoral rangelands. (Also known as the Rabbit Proof Fence, State Vermin Fence, and Emu Fence). (DAFWA 2008).

Rabbits along with other vermin currently occupy lands cheerfully on both sides of the barrier fence. Rabbits are widespread throughout the Agricultural Zone and are a pest for both Nature Conservation and farming. Conservation Reserves are vulnerable to rabbit infestation along boundaries with private farming properties, as rabbits can feed in the paddocks and retreat to the protection of dense vegetation cover in adjacent reserves. Rabbits are less of a problem in the rangelands zone where the irregular availability of water and feed prevents a build up of numbers. (Pers. Comm. K. Marshall).

## 3.2 Population numbers and distribution

Rabbit populations respond seasonally to water and feed availability, and numbers can fluctuate dramatically. Distribution is ubiquitous throughout the Agricultural Zone, and there is no expectation of eradication ever being achieved. Evidence of high rabbit numbers can be observed by the extent of warrens, tracks and diggings, and also the grazing damage to low shrubs and seedlings.

## 3.3 Impacts on native vegetation / native fauna

Rabbits compete with native animals for food, damage native vegetation and promote soil erosion. Their digging activity may also be associated with the spread of diseases such as Phytophthora dieback in native vegetation.

## 3.4 List of DEC managed estate under threat

All reserves have some exposure to rabbits, however the worst rabbit infestations occur where reserves are entirely landlocked by agricultural land and where the boundary shape is complicated, with a number of adjoining landholders. Softer sandy soils also allow rabbits to construct breeding warrens, particularly in the Geraldton Sandplain.
Reserves in this category tend to exhibit obvious signs of rabbit damage along the boundary interface. Numbers can build up rapidly in the winter season if control measures are not applied. The following reserves particularly fit the above conditions: (Pers. Comm. K. Marshall)

- Burma Road Nature Reserve (NR) High priority
- East Yuna NR High priority
- Indarra Springs NR High priority
- Moresby Conservation Park
- 44 Mile Reserve
- Beetalyinna NR
- Mingenew NR
- Chillimony NR
- East Latham NR
- Wongoondi NR
- Kockatea NR
- Bindoo Hill NR
- Willroy NR
- West Perenjori NR
- Galena NR
- Wandana NR

## 3.5 Prioritisation of species for management actions

Wild European Rabbits are a declared pest under the Agriculture and Related Resources Protection Act 1976, which requires numbers to be reduced and controlled. The Department of Environment and Conservation has a duty to reduce and control rabbit numbers on DEC managed land. Rabbit damage to native vegetation also threatens nature conservation values on DEC managed estate, and can hamper revegetation efforts.

## 3.6 Previous management actions – results, lessons learned

## *Poison measures*

There are two toxins available for controlling rabbits in Western Australia: 1080 and Pindone. 1080 is generally the preferred toxin for rabbit control in Western Australia. Pindone is an anticoagulant and is less selective in action than 1080, it has been known to cause the death of kangaroos, bandicoots and is also toxic to birds. In contrast, native fauna have some dgree of resistance to the poison 1080 as it is a naturally occuring plant toxin in WA. Pindone is also more costly and requires repeated doses to be ingested before it is effective. The effects of Pindone can be reversed via an antidote (vitamin K), however there is no effective antidote for 1080 once it has been ingested. This property makes Pindone safer for use around domestic / urban areas. (DAFWAa 2008.)

1080 baiting is more effective in late summer / early autumn where feed availability is limited. Can be very useful before seedling planting or bush regeneration efforts. Dry weather is required as the toxin is water soluble and dispersed by rain.

Warren fumigation is a labour intensive exercise which can be useful if rabbits are underground in inaccessible or scattered areas. Cannot be used where rabbits live above ground or where warrens cannot be sealed. May be useful before seedling planting for bush regeneration. (DAFWAa 2008).

Rabbit proof fencing is an expensive, very labour intensive option and it requires regular checking to maintain its effect. It can be useful for preventing reinfestation of treated areas, and can protect special values such as threatened Flora species, or vulnerable revegetation seedlings. (DAFWAa 2008).

## *1080 Poisoning Program*

In 2005 and 2006 a 1080 rabbit baiting program was used to protect key assets within the proposed Moresby Range Conservation Park, Burma Road Nature Reserve, and Coorow Shire reserve 21175. A large scale revegetation program was implemented in 2006 to conserve Nature Conservation values. The success of the revegetation project was threatened by the impacts of rabbit damage, observed in previous years. The baiting program was designed to reduce rabbit numbers at the planting site prior to and after planting. Ribbon baiting took place with 1080 impregnated oats (‘One Shot Oats’ 4.5mg/oat ) mixed with 6 kg of oats on all access tracks in the reserve (toal 13 km of track). The number and quantities of baits taken was monitored, as well as evidence of dead animals. Rabbit carcasses were disposed of by burial. (Lee, 2006).

## *Exclosure monitoring*

Grazing exclosures have been established in Kalbarri National Park in 2007 at two gorge sites to monitor the impact of grazing on native vegetation. Outside the fence is similar vegetation which will be scored the same way to document grazing impacts. The larger 100m X 50m plots have been designed to exclude goats and other large grazers from the native vegetation. A smaller 2.5m X 10m

plot within each of these has been enclosed with rabbit netting to examine in detail the impact of rabbits on low shrubs and seedlings, in comparison with the other grazed and ungrazed plot sections. (Pearson and Paxman, 2008).
Surveys seek to identify native flora at these sites and monitor changes in species composition (floristics), species diversity, shrub condition, recruitment and survival in grazed and ungrazed study plots. The numbers of faecal pellets of each grazing species will also be counted and removed in permanent plots as a surrogate measure for grazing pressure. Results of vegetation survey and monitoring are not yet known, however preliminary observations appear to demonstrate an increase in species diversity and abundance within the fenced exclosure plots.

## 3.7 Guiding principles of future management actions

1080 is the preferred method of control in WA, and is commercially available in a premixed form as “One-shot” oats, also commonly called pickled oats.
Populations are vulnerable during late summer, when baiting is most effective due to low feed availability. An effective ongoing control program should aim to reduce numbers in target areas prior to the start of the winter breeding season. (Pers. Comm. K. Marshall).

## 3.8 Statement of objectives for feral goat management

Given that eradication is not achievable, rabbits should be strategically managed to reduce and maintain population density to a low level, which limits asset damage.

## 3.9 Recommended management actions

- A dedicated rabbit control program designated to a permanent position such as the District Reserves Officer, Conservation Employee or Wildlife Officer, to be responsible for managing all ongoing feral goat control activities.
- Monitoring of rabbit numbers in problem reserves.
- Regular control activities in areas with observed high rabbit numbers, with a 1080 baiting program aimed at late summer.

# 4.0 Bees

## 4.1 Background

Honey bees were introduced into Western Australia in 1846 to pollinate plants grown by early settlers for food. Before the bees were used, many of these crops failed to produce fruit or vegetables, unless they were pollinated by hand. (DAFWA, 2008b)
Beekeeping is a small but significant industry in WA with an average annual total income or around $9 million per annum. Around 96 apiarists hold a total of some 3050 permits for registered apiary sites on various categories of public land, for which the Department of Environment and Conservation (DEC) is the registration authority.
Feral bees have long since escaped from apiarist hives, and are now established throughout most of the South West land division of Western Australia and some other parts of the state. (CALM, 2005).

Increased canola production throughout the agricultural area has led to an increase in the number of feral bees through the provision of an additional food source for breeding. Canola also stimulates feral bees to swarm, resulting in a major nuisance to farmers and pastoralists.
Feral honey bees are generally aggressive, inbred, and have a high propensity to swarm. (DAFWA, 2008b)

## 4.2 Population numbers and distribution

## 4.3 Impacts on native vegetation / native fauna

Feral bees have been to have effects on pollination of native plants.
Feral bees compete with native bees, other insects and birds for plant nectar.
Feral bees compete with native birds and animals for nesting hollows in which to build hives.
Feral bees are a visitor risk management issue, particularly around caves and natural waters.

## 4.4 List of DEC managed estate under threat

## 4.5 Prioritisation of species for management actions

## 4.6 Previous management actions – results, lessons learned

A series of field trials were conducted at three sites in the South West to develop a methodology for the control of feral honey bees (*Apis mellifera*). These were located at Garden Island, Yellagonga Regional Park and the DEC managed Woodvale Research Centre reserve. The pesticide used in the trials under research permit was fipronil.

Trials were conducted to determine the best means of attracting feral bees to feed stations, and a successful method was identified, so long as excessive amounts of natural food were not available. This demonstrated that the optimum time for bee control operations is outside of the major spring flowering season, depending on the particular site.

Feral hive destruction within the study areas ranged from 67% to 100% during the trial. The success of the project has prompted an application for registration of the pesticide for use against feral bees with suitable label conditions. (Mawson, 2008).

## 4.7 Guiding principles of future management actions

## 4.8 Statement of objectives for feral bee management

## 4.9 Recommended management actions

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