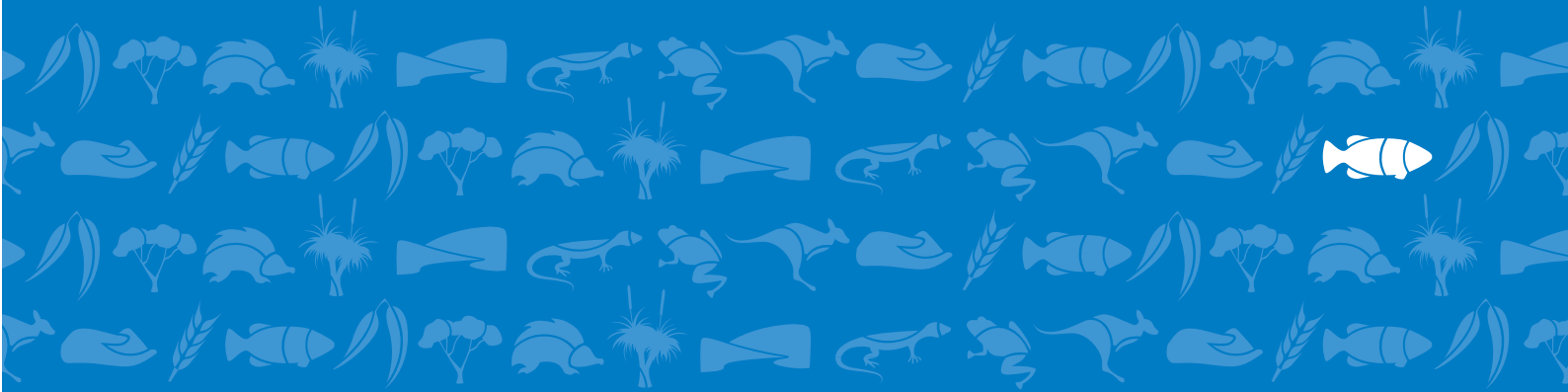


RABBITS & DESTRUCTION GO HAND IN HAND

Information Booklet For Land Managers

2007



Government of South Australia

South Australian Murray-Darling Basin
Natural Resources Management Board



ACKNOWLEDGEMENTS

Staff of the South Australian Murray-Darling Basin Natural Resources Management Board initiated the development of this book. They recognised a need in the community for comprehensive information about the the introduction of rabbits into Australia, its rapid spread and impact on the environment and agriculture, rabbit behaviour, ecology and control. In addition, many people have most kindly contributed to this book through inspiration, knowledge sharing, advice, encouragement and support. This book is aimed at land managers, students and anyone else that may have an interest in controlling rabbits and protecting our unique country. We hope you find it interesting and beneficial.

We would like to gratefully acknowledge the following people for their wonderful enthusiasm, support and contributions:

- Dr Brian Cooke Senior Research Scientist CSIRO, Dr Peter Allen Chairman, Foundation For Rabbit Free Australia.
- Mark Williams Senior Technical Advisor Animal and Plant Control Group, DWLBC.
- Greg Mutze and Ron Sinclair, Senior Research Officers Animal and Plant Control Group, DWLBC

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Rabbits – Know the Enemy

INTRODUCTION

The deliberate introduction of European rabbits into Australia illustrates the lack of consideration or concern about the potential devastating impacts an introduced animal can have in an environment previously free of rabbits and containing a landscape that has evolved over time to provide unique flora, fauna and ecosystems. Rabbits have both directly and indirectly resulted in the loss of some of Australia's unique flora and fauna through their feeding of and damage to native vegetation, digging of burrows and warrens and utilisation of existing burrows belonging to native fauna. In addition they have damaged countless crops and cost the country millions of dollars in foregone earnings, land rehabilitation programs and rabbit control.

Although more than 200 years has passed since the first introduction of rabbits, we the Australian community are still battling to remove them from our landscapes.

This book has been developed to help land managers enhance their rabbit control programs and reduce the environmental, agricultural and economic impacts of these pests. We sincerely hope you find it a useful tool in your endeavour to be free of the rabbit.

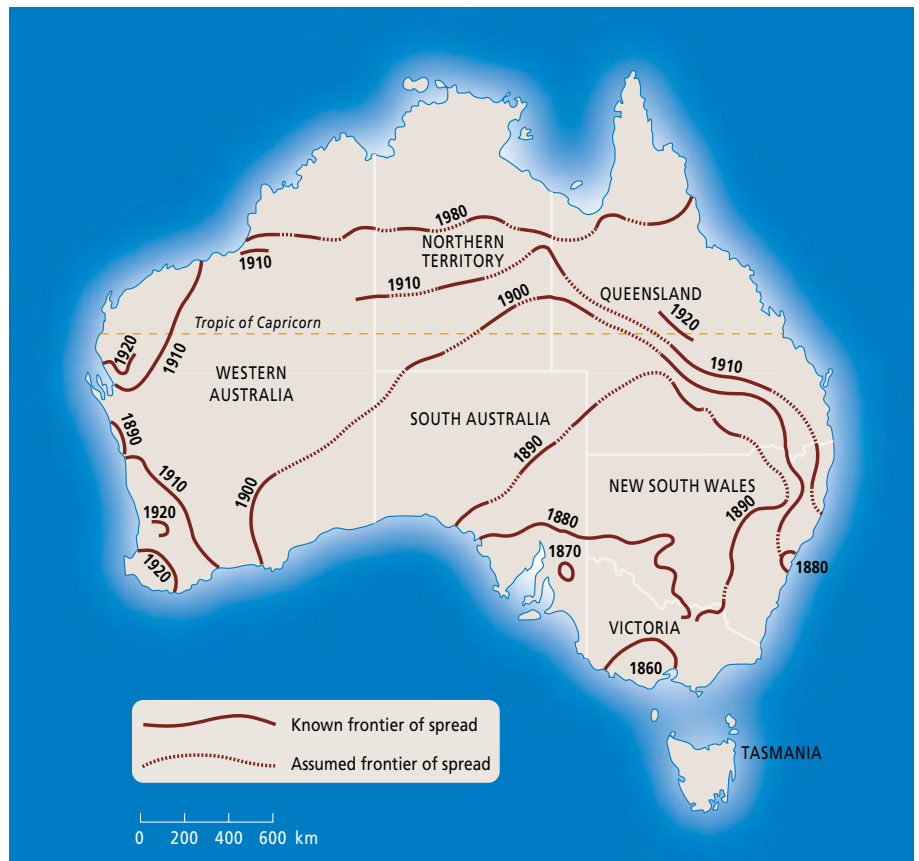
ORIGIN OF THE RABBIT

The European rabbit (*Oryctolagus cuniculus*) is believed to have originated in Spain and Southern France (McLeod 2004). Over the last approximately 2000 years it has become established widely in Southern Europe and North Africa. Early records of rabbits were made by a Greek historian in 200BC and they appeared in the coins of Emperor Hadrian about 130AD. Rabbits were considered a great delicacy by the Romans. They were imported to many areas

where they were domesticated and kept in walled enclosures called warrens. Rabbits were probably first imported into the United Kingdom about 1000 years ago.

INTRODUCTION OF RABBITS INTO AUSTRALIA

Domesticated rabbits were first introduced into Australia in 1788, with the arrival of the First Fleet (McLeod 2004). Although little is known about the spread of rabbits in Australia, by 1827, thousands of feral rabbits were observed on some estates in Tasmania (McLeod 2004).





In 1837 the Everard family of Glenelg, South Australia listed 14 rabbits amongst their livestock. Five years later in 1842, John Daw listed a warren amongst his capital assets in his property in what is now suburban Adelaide. In 1859, twenty four wild rabbits travelled to Australia on the clipper “Lightning”. These were introduced by Thomas Austin of “Barwon Park”, Geelong, Victoria, for hunting. It is thought that these rabbits are the ancestors of the many thousands that were soon observed throughout the State (McLeod 2004).

By 1865, (within 6 years) 20,000 rabbits had been killed on ‘Barwon Park’ (McLeod 2004). By 1886 they had spread to Queensland and New South Wales (Williams et al. (1995 – currently in aust gov website.) Almost certainly, the spread of rabbits was assisted by people who established them locally for meat and sporting purposes, unaware of the potential damage that would result. By 1900, rabbits had spread to Western Australia and the Northern Territory (McLeod 2004). A 1700 kilometre rabbit proof fence was built in Western Australia between 1901 – 1907 to stop the spread of rabbits. However, rabbits can dig under such fences and they can now be found in every Australian State. (refer map page 1) They can be found in many different habitats and range from coasts to deserts.

ENVIRONMENTAL AND AGRICULTURE IMPACTS OF RABBITS

The rate of spread of the rabbit in Australia is believed to be the fastest of any colonising mammal in the world. Their colonisation was aided by the presence of burrows belonging to native species and the modification of the natural environment for farming (McLeod 2004).

Today, although rabbit numbers are difficult to assess and can change very rapidly due to environmental conditions, many thousands can be observed in every Australian State, primarily due to their enormous reproductive capacity and adaptability to the Australian environment.

Rabbits have had and continue to have devastating effects on the Australian environment. They selectively graze on native vegetation, crops and pastures, removing the most palatable species and leaving behind the least palatable.

They also dig below grasses to reach roots and seeds (Australian Government publication). Grazing on native vegetation can result in the composition of native plant communities being drastically changed which in turn has damaging flow-on effects for all the animals such as insects, birds and mammals that feed on the plants or depend on them for habitat. Rabbits are particularly severe on the seedlings of some woody shrubs including sheoaks, native pines and many acacias. They can completely prevent regeneration of these species even at very low rabbit densities. Grazing on crops reduces crop yields whilst grazing on pastures increases competition for feed with stock such as sheep and cattle. This can affect the carrying capacity of livestock on a property.

Although estimates of the economic cost of rabbits prior to the release of the biological control agent Rabbit Haemorrhagic Disease Virus (RHDV) vary, it is clear that the cost of rabbits to Australian agriculture has been significant.

Table 1: Estimated economic costs of rabbits to Australian Agricultural Productivity.

\$/Annum	Category	Author
40-73,000,000	Temperate region wool producers	Vere et al. 2004
300,000,000	Wool production	ACIL 1996
70,000,000	Sheep meat	ACIL 1996
150,000,000	Cattle	ACIL 1996
80,000,000	Crops	ACIL 1996
130,000,000	Australian Wool Industry	Sloane et al. 1988



The economic costs of rabbits have declined with the introduction of RHDV (Saunders et al. 2002). Simulation studies for example show reduced costs in the pastoral (25%), wheat-sheep ((5%) and high rainfall zones (2.5%).

INTRODUCTION OF BIOLOGICAL CONTROL AGENTS

In 1952-1953 myxomatosis, a biological control agent was introduced into rabbit populations. Myxomatosis is caused by a virus which is transmitted from one rabbit to another by biting insect vectors such as mosquitos, and fleas. Myxomatosis is considered to be a generalized acute disease which affects the skin and mucous membranes. It has resulted in the deaths of many thousands of rabbits and significantly reduced rabbit populations throughout Australia. The reduction in rabbit numbers caused the average weight of the wool cut, per head of sheep, in Australia to increase.

In addition, the reduced competition for pasture allowed an extra two million sheep to be carried in the existing sheep area. Major agricultural benefits were also gained by the grain and cattle industries. Now, many decades later the effectiveness of myxomatosis as a rabbit killer has diminished. Rabbits have developed some genetic resistance to the disease and less virulent strains of the virus have evolved. It is however still considered to be one of two very important biological controls.

The Rabbit Haemorrhagic Disease Virus (RHDV) is another biological control which was introduced into Australia in 1995. This virus is also spread by vectors, through rabbit-rabbit contact or when a rabbit contacts excreta. RHDV can cause a disease which damages the liver and blocks the circulatory system, thus, eventually killing the rabbit.

Rabbits under eight weeks of age are more likely than adult rabbits to survive infection by the RHDV virus.

These rabbits then become immune breeding stock. RHDV has been very effective in arid areas and less effective in more humid, higher rainfall areas (McLeod 2004).

Although both of these biological control agents have helped to reduce rabbit numbers, integrated rabbit management programs are required to effectively control them in Australia (refer page 8).

REPRODUCTION

Rabbits are excellent breeders. They normally breed from autumn to late-spring but breeding can be extended by factors such as the availability of green grass. They become sexually mature at three months of age, with most reaching sexual maturity between six to 10 months of age. In the optimum breeding period each female (doe) typically produces three to seven young per litter, with the number increasing during the breeding season and with doe age.



Rabbit affected with Myxomatosis



Warren destruction: deep cross ripping technique





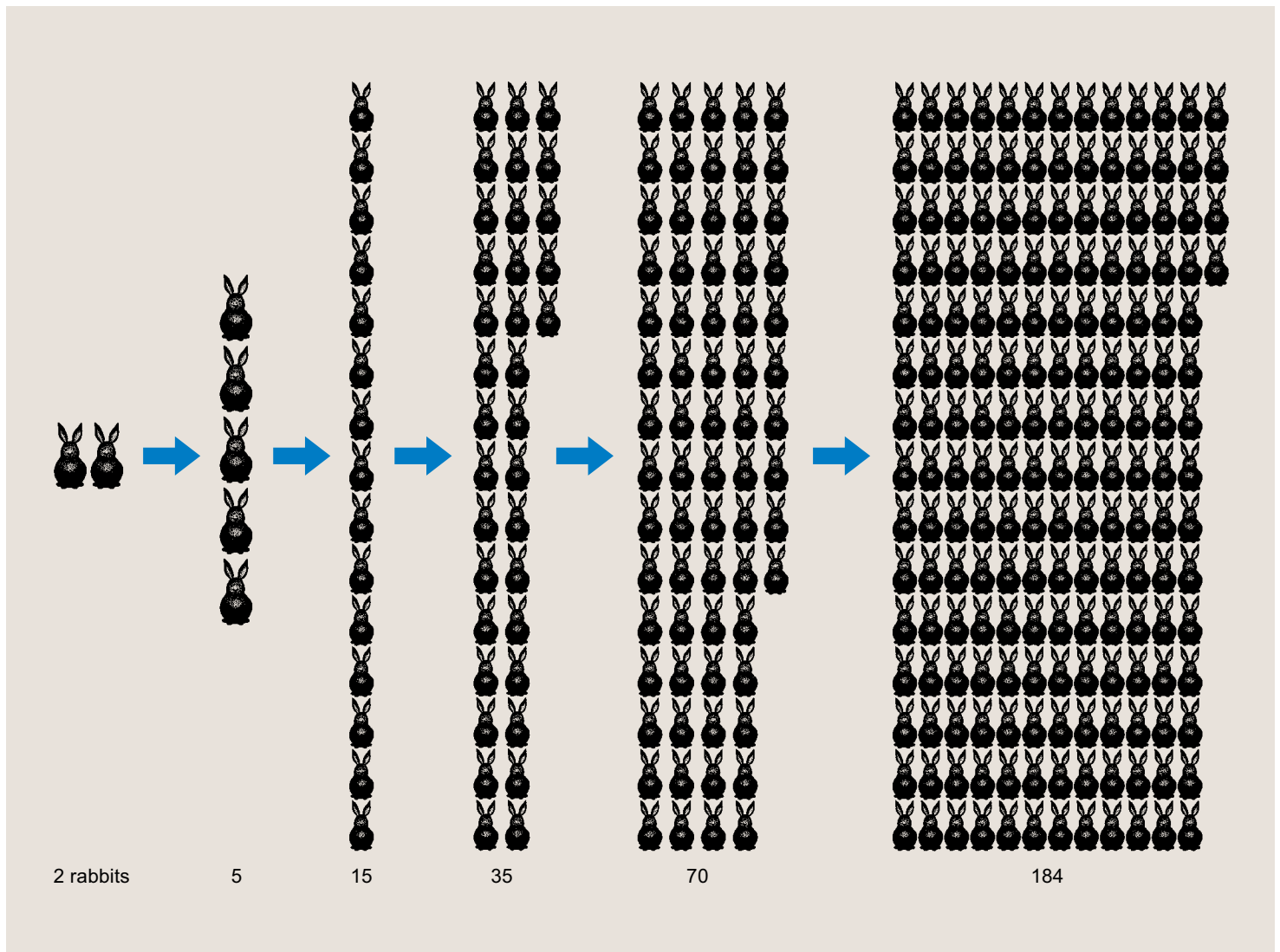
A doe can conceive immediately after giving birth, and males (bucks) wait at the entrances of breeding burrows to mate with does as they emerge. Ovulation is induced by mating. A female rabbit can be mated by many different dominant males (bucks). Pregnancy only lasts for one month, and a doe can potentially be pregnant for the entire time, from break of season until the grass dries up (in practice this

rarely happens for all rabbits in a population).

Litter size depends on a number of factors, including female (doe) age, the quantity and quality of vegetation, climate, space and the time of year. An average of 3-4 kittens are produced in litters at the beginning of the breeding season compared with seven or more at the end.

An increase in litter size is mainly due to the fact that most breeding doe's are maidens at the beginning of the year. Older rabbits produce larger rabbits and more young in their later years. An adult rabbit can produce 30-40 kittens per year under good seasonal conditions.

Two rabbits can increase to 184 in 18 months in an outside paddock without supplementary feed.



RABBIT BEHAVIOUR

Commonwealth Scientific Industrial Research Organization (CSIRO) researchers plotted the movement of individual rabbits and studied their interactions, in the 1960's. They discovered a system of dominance within each social group. Each group consisted of one dominant buck, a secondary buck and subdominant males including young that were accepted into the social group. The group structure offered protection to the young from other group members. In contrast, unmarked rabbits were attacked and driven away.

Rabbits define their territories by secretions from their anal glands which are located within the rectum. The secretions mark the faeces which are often deposited in buck heaps. The heaps are maintained with regular visits by bucks and to a lesser extent doe's.

Each social group forms its own closely guarded territory, marked out by the dominant animals using chin and anal gland secretions.

Rabbits may move outside of the territory to common feeding grounds and young may be rejected from the group as they approach maturity. The size of the territory depends on a number of factors, including availability of food and space. Rabbits may range more widely in summer when food is in short supply as opposed to the winter breeding period.

When there are few rabbits in an area, each social group will have a relatively large territory. With increasing numbers, more groups will live in the same area with correspondingly smaller territories for each group.

Rabbits have limited physiological adaptations to the hot dry conditions found in much of their range in Australia. Exposure to hot dry conditions can result in rabbits experiencing excessive water loss and ultimately death. They avoid such conditions by spending much of their time in the cool and moist warrens.

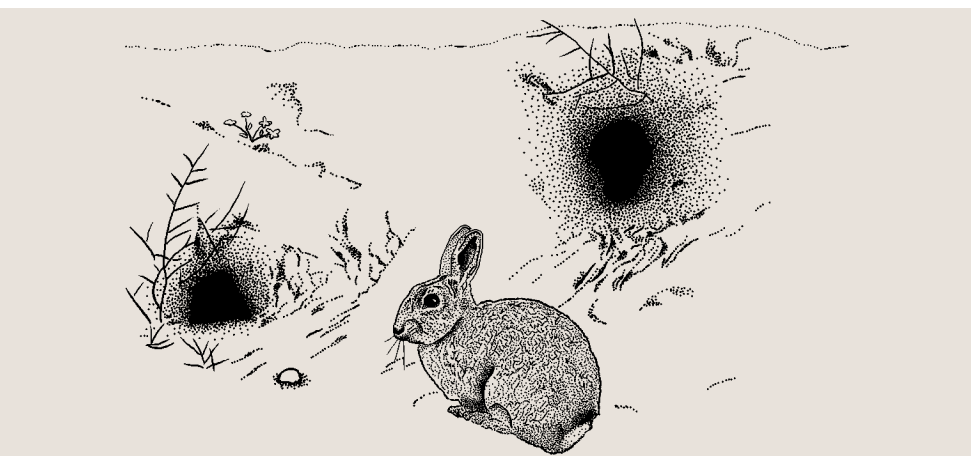
Warrens are very important for breeding. A warren is a labyrinth of burrows. A breeding stop can be extended into a warren as rabbits dig additional tunnels and new entrances. Dominant doe's will establish their breeding stops in separate runs within a warren. A breeding stop is a small dead-end tunnel leading from tunnels used by all rabbits within the warren. The first sign of breeding is usually fresh soil near burrow entrances. Females begin to clean out breeding stops two weeks after the first mating. Although this activity and the digging of new warrens are initiated by doe's the males join in the process.

The most dominant females get the best breeding locations within warrens which aids in protection from predators. Subdominant doe's may be forced to make their stops in isolated holes away from the main warren.

A week after selecting the breeding stop, the doe's belly fur slips and she uses the fur and dried grass to make a nest.



Buck heaps – marking social territories





Four weeks after mating she drops the litter and covers the entrance to the stop, only visiting it once every 24 hours. The kittens are born helpless and weigh approximately 40 grams, increasing by 7-8 grams/day. Their eyes open at 7 days of age and their ears open and fur grows at eight days of age. By the 19th day the kittens can survive by themselves although they do not usually emerge from the nest until 22 days of age.

The numbers of rabbits found in warrens and the ability of the warrens themselves to persist, depend greatly on the soil type and other conditions found in the area.

INTEGRATED LAND MANAGEMENT PLAN

An integrated rabbit control management plan is an extremely useful tool that land managers can use to assist in the control of rabbits. An integrated rabbit control management plan enables land managers to use a variety of methods to control rabbits during specific seasons and in different habitat types. An effective integrated rabbit control program should include poisoning, ripping and fumigation of warrens. Although none of these methods alone can completely control rabbit populations by themselves, the integrated use of these methods can be vital in the control of rabbits, particularly for flat or undulating country with low vegetation density.

Present day poisoning techniques are based on behavioural patterns of rabbits and are thus directed specifically at the target animal and not indiscriminately over the countryside as a whole. Fortunately, the bait “1080” is a poison which can be economical to use over large rural areas. 1080 blocks the metabolic pathway that cells use to get energy. Rabbits are more sensitive to “1080” than most Australian wildlife species so as long as the directions for use are followed, minimum off target damage will occur. However, domestic dogs are extremely sensitive to 1080 and all users should be aware that secondary poison can occur should dogs consume a rabbit that has died from eating “1080” treated oats.

Pindone is another poison that can be used in small acreage areas, (it is however more expensive than “1080”). Pindone is a multiple dose anti-coagulant S6 poison that can be purchased from most farm supply stores. Compared to 1080 treated oats, this product reduces the risk of secondary poisoning of dogs

and other scavengers due to its lower toxicity to these species. Also Vitamin K1 is an effective antidote.

Conservation of our native birds and other animals such as possums, kangaroos, wombats and insects depends so much on the survival of our native vegetation. Rabbit control methods, particularly the wise use of “1080” poison and warren destruction by ripping, are essential tools for native vegetation conservation programmes. Any disadvantages occasioned by rabbit control activities are offset by the direct benefits of removing the scourge of uncontrolled grazing by them.

As rabbits are a common food source for foxes, and the fact that foxes may prey more heavily on native animals if rabbits are in short supply, it is recommended that land managers incorporate fox control management strategies into their integrated management plans. Advice about fox control is available from your local Natural Resources Management Officer.



Warren destruction: backhoe minimum disturbance technique



Rabbit Control Summary & Checklist

DEVELOP AN INTEGRATED MANAGEMENT PLAN

Developing an Integrated Management Plan will ensure that the right methods are used for your particular landscape. Seek advice from an Authorised Officer.

TRAIN RABBITS TO EAT NON-POISONED OATS

Lay a narrow path of non-poisoned oats to form a trail and train the rabbits to eat the oats along the trail. Look for rabbit scratches to find the feeding areas. Lay the trail through all feeding areas near dung heaps and circle warrens with two or three loops of trail out to 100 metres. Note that some rabbits will only feed well away from the warren.

POISONING METHODS

Link baiting and poisoning and integrated management.

1080 is effective and quick acting and suitable for large scale baiting programs. Pindone can be used in peri-urban areas where there is a high risk to non-target animals from using 1080. Late summer or autumn is the best time to poison. Rabbit numbers are at their lowest as food is scarce and plant seeds are a major part of their diet, making oats ideal bait. In addition, rabbits generally do not breed during this period. They are less territorial and there are no juvenile rabbits that can be left behind after poisoning i.e. all rabbits can emerge to take the bait.

If using 1080, first remove any livestock from the paddock to be treated. Use a baitlayer or some other implement to create a shallow furrow in the soil. Lay plenty of oats on the trail. You will need approximately 24kms oat trail per 100ha of infested country. Use 4.2kg of oats per kilometre or 100 grains per metre of trail.

Free feeding is essential. Some rabbits are very shy feeders and they need to be trained to eat at the trail over a period of 12-16 days. The best results are obtained if three free feeds (oats with no poison) are laid with a three or four day interval between each feed. Wait another four days then lay poison oats (bait) at the rate of 2.8kg per kilometre. Cover the uneaten trail before returning stock to the paddock, especially if animals are being fed grain. Note that failure to do a free-feed will give a poor result and may after a period of time lead to a population of 'bait-shy' animals.

If using Pindone, simply sprinkle the bait along the trail where the rabbits are feeding.



Bait layer





For larger programs Pindone Oat bait can be applied using most conventional bait layers. Adequate quantities of oats should be laid so that a little (10-20%) remains in the trail on the morning after each feed.

Condition rabbits to eat the oats by offering two free feeds. Pindone treated oats should be administered to rabbits in a further three feeds about four days apart over a 10-12 day period. These three feeds are essential as Pindone is an accumulative poison that inhibits the rabbits from recycling their Vitamin K.

Poisoning to lower high rabbit numbers prior to ripping and removal of debris reduces cover for future rabbit establishment and makes warren destruction (present and future) easier.

WARREN DESTRUCTION

After poisoning, many people forget to destroy warrens. This is a mistake because it means that not every effort is taken to get rid of remaining rabbits and it leaves a perfect environment for those few rabbits to breed up again. Hence, it is very important to follow up baiting with warren ripping and fumigation of those burrows that reopen or are hard to reach with the tractor and ripping tine.

BE MORE PERSISTENT THAN THE RABBIT
REMEMBER, NO HOLES, NO RABBITS!
LETS WORK TOGETHER

Research shows that warren destruction is the most important part of lasting rabbit control. Remember to remove debris over warrens as this provides further shelter for rabbits.

Start warren destruction as soon as practical after poisoning. Begin ripping outside the furthest hole and rip a series of parallel lines, 18 or 40cm apart, right across the warren. Rip another series of parallel lines (at 90 degrees) across the first rip lines. Fumigation can be used to treat existing or reopened warrens. Dogs can be used to drive the rabbits underground to keep them contained. Aluminium phosphide tablets can be used as the fumigant. Ensure that all the entrances are treated to create a gas chamber effect. Always follow the directions on the label. Fumigants can also be used to treat small rabbit infestations where poisoning cannot be used or where ripping is not practical. The best time to fumigate is after the opening rains, when the soil is less porous. Steep banks, fence lines and warrens under trees are best treated by fumigation. Always check warrens after one month and treat any reopened holes.

Natural Resources Management Officers with appropriate training, accreditation and expertise are able to assist land managers with the use of explosives to collapse warrens on steep hills, creek banks and among heavy scrub areas and as a follow-up to ripping programs. Contact your local Natural Resources Management Officer for advice.

DEVELOP A NEIGHBOURHOOD OR COMMUNITY RABBIT CONTROL PROGRAM

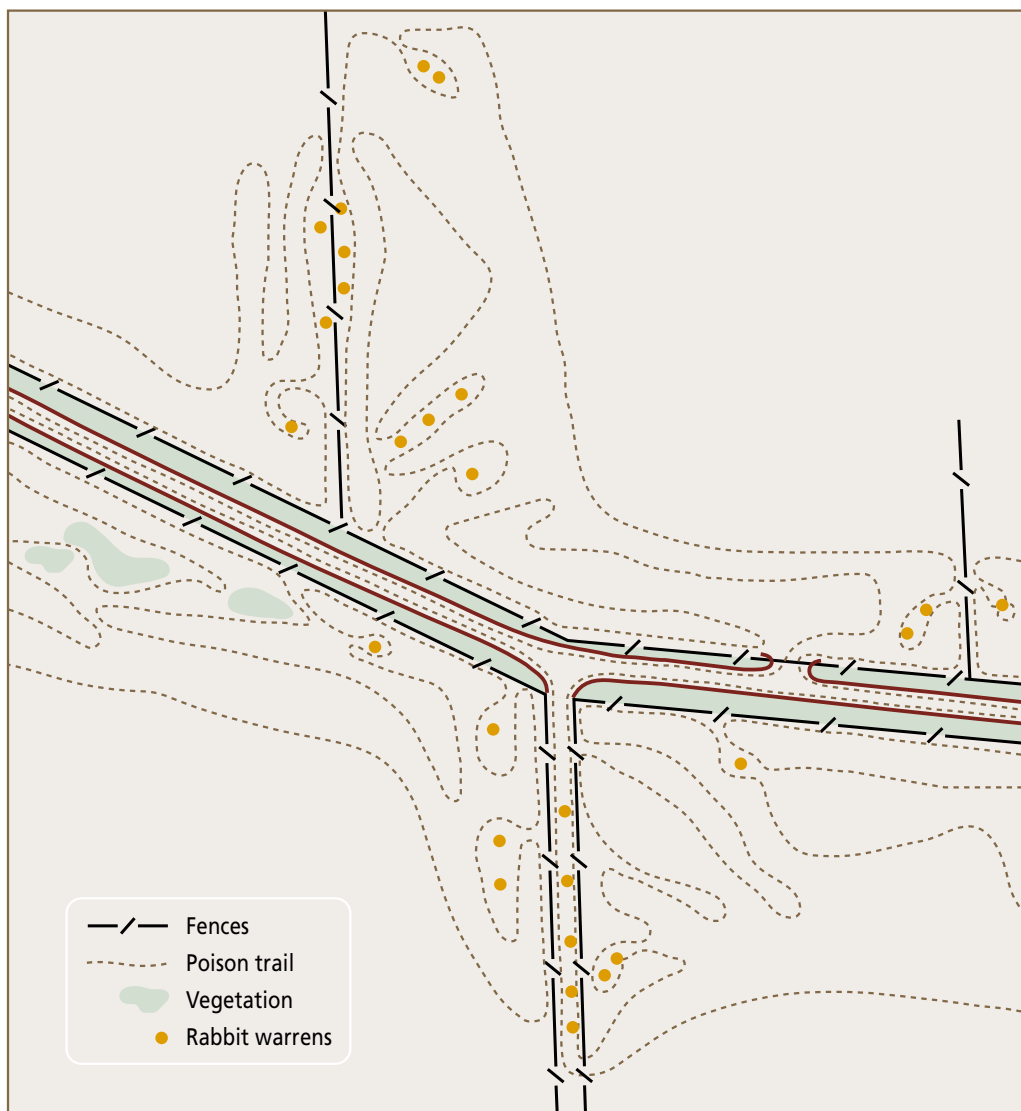
Developing a neighbourhood or community program to control rabbits over a large area at a specific time each year will help maximise rabbit control and make it difficult for new rabbits to colonise the area. Your local Natural Resources Management Officer can assist you in developing a community approach to rabbit control.

WE CAN GET AN EVEN BETTER RESULT IF NEIGHBOURING LANDOWNERS IN THE DISTRICT WORK TOGETHER AND AT A SIMILAR TIME WHEN DOING RABBIT WORK



TRAIL PLACEMENT

This is an example of trail placement needed to cater adequately for a rabbit-infested roadside. Trail must go through all areas where rabbits are active. Where rabbits have warrens in adjoining paddocks, 14 km of trails may be needed for each kilometre of road.



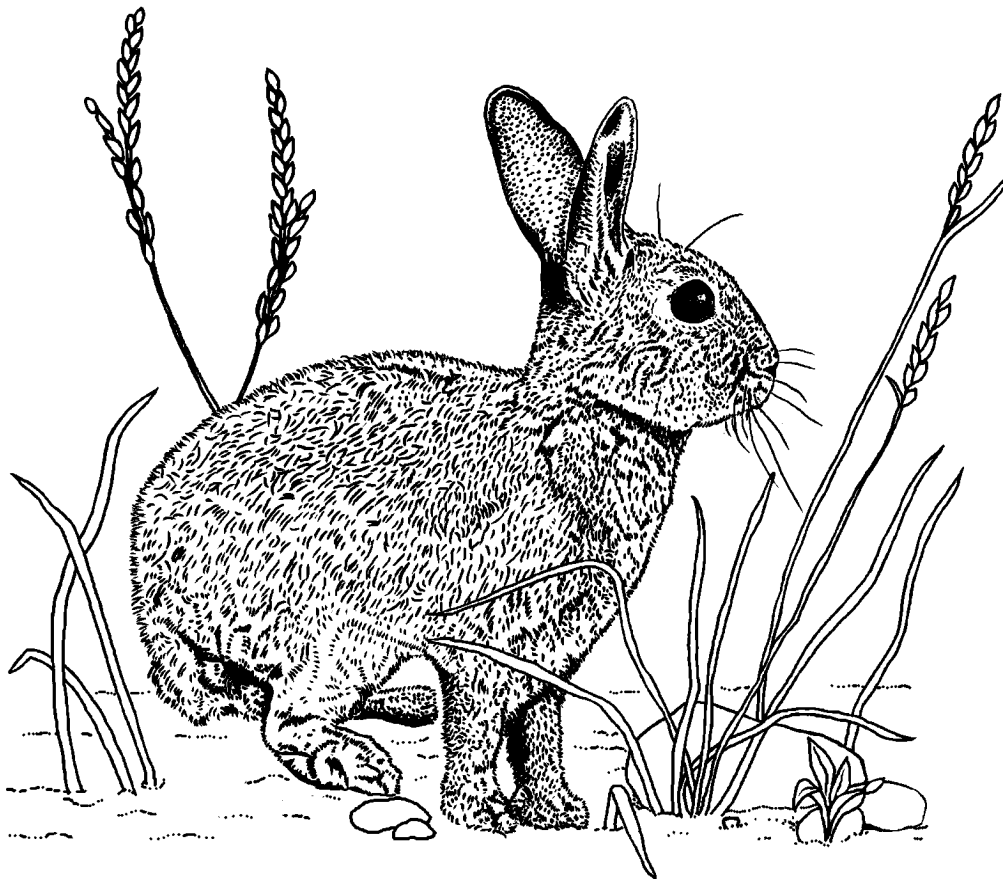
WILDLIFE & PET PROTECTION

All poisons should be used cautiously. Some native fauna such as the western grey kangaroo that originated in areas where 1080 naturally occurs in native plants have a high tolerance to the small amount of 1080 that will kill rabbits and foxes. However, not all native fauna have the same high tolerance. In addition, 1080 can be toxic to pets. Thus it is recommended that 1080 be used with caution and consideration be given to the potential uptake by wildlife and pets. Pindone can be used in peri-urban areas where there is a high risk to non-target animals from using 1080.

However, it is more expensive and is only cost effective for treating small areas.

Protect Native Vegetation: It is important to note that when destroying rabbit warrens due care must be taken to protect native vegetation. Section 192 of the NRM Act states clearly that a person taking measures for the control of animals or plants must take all reasonable steps to ensure “that native vegetation is not cleared except in accordance with guidelines prepared by the Native Vegetation Act 1991 and that damage to or destruction of other vegetation is kept to a minimum”.

It is important to remember that when removing any harbour to get to the warren, you do not cause more damage than the problem you are trying to eradicate. As an example, it is best to pull out the declared pest plants, such as the thorny African boxthorns, sometimes used by rabbits to establish their warrens underneath.



Rabbit Control Calendar

OCTOBER NOVEMBER DECEMBER

Time to Plan

- Draw a paddock map of warrens or locate with a GPS
- Spotlight count numbers
- Contact Local Regional Authorised Officer
- Organise oats
- Check equipment
- Remember there will be many young rabbits, rabbit numbers peak, crop damage will be most visible and some rabbits may be affected by RHD and the Myxo virus (these viruses are not reliable control methods)

JANUARY FEBRUARY MARCH APRIL

Poisoning

- Spotlight to count rabbits and check numbers
- Best time to poison
- Can cut rabbit numbers by 95%
- Rabbit territories undefended
- Rabbits hungry
- 3-4 day gap between non-poisoned feeds
- Three free feeds essential
- Wait 3-4 days then lay poisoned oat trail (for 1080 treated oats)
- Proceed to cross rip warrens as soon as practical after poisoning program.

MAY JUNE JULY AUGUST SEPTEMBER

Follow Up

- Remove debris to avoid future recolonisation by rabbits, to make present and future warren destruction easier
- Destroy now exposed warrens
- Use fumigation if warrens are not accessible
- **RECHECK WARRENS AND RE-RIP OR FUMIGATE**
- Spotlight again to check any remaining rabbits

WARREN DESTRUCTION ESSENTIAL

FUMIGATE TO KEEP WARRENS CLOSED

CONTACT

Contact your nearest South Australia Murray-Darling Basin Natural Resources Management Regional Authorised Officer for further assistance and advice. These officers are based at:

Office	Phone
Berri	8582 4477
Burra	8892 3033
Cambrai	8564 5154
Karoonda	8578 1493
Lameroo	8576 3400
Mt Barker	8391 7500
Murray Bridge	8532 1432
Tailem Bend	8572 3611





