Australian Government

Department of the Environment

DRAFT

Threat abatement plan for competition and land degradation by rabbits

2015

The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

This report should be attributed as '**Draft** Threat abatement plan for competition and land degradation by rabbits, Commonwealth of Australia 2015'.

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Introduction

This *Threat abatement plan for competition and land degradation by rabbits* establishes a national framework to guide and coordinate Australia's response to the impacts of European rabbits (*Oryctolagus cuniculus*) on biodiversity. It identifies the research, management and other actions needed to ensure the long-term survival of native species and ecological communities affected by competition and land degradation caused by rabbits. It replaces the previous threat abatement plan for rabbits published in 2008 (DEWHA 2008).

While this threat abatement plan aims primarily to abate the threat to key environmental assets (threatened species and ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and other matters of national environmental significance), it also recognises that rabbits have wider environmental impacts as well as social, cultural and economic impacts.

This plan should be read in conjunction with the publication *Background document for the threat abatement plan for competition and land degradation by rabbits* (Department of the Environment 2015a). The background document provides information on:

- rabbit characteristics, biology and distribution
- impacts on environmental, economic, social and cultural values, and
- current management practices and research.

Threat abatement plans

The EPBC Act provides for the identification and listing of key threatening processes. At the commencement of the EPBC Act in 1999, competition and land degradation by rabbits was listed as a key threatening process and a threat abatement plan was developed.

The Australian Government develops threat abatement plans with assistance from other government agencies, natural resource managers and scientific experts, and facilitates their implementation. To progress the main strategic actions within the threat abatement plan, the Department of the Environment relies on partnerships and co-investment with other government agencies, industry and other stakeholders. An important part of implementation of the threat abatement plan is ensuring that knowledge of improved abatement methods is disseminated to potential users.

Mitigating the threat of invasive species is a matter of developing, applying and integrating a number of control methods, not relying on one method. It also requires understanding and addressing social and economic factors; for example, through supporting the efforts of private landholders, leaseholders and volunteers to manage invasive species on their lands to achieve the desired outcomes for biodiversity conservation and primary production. In addition, research and development programs for managing pest species need to integrate the interests of both primary production and environmental conservation.

Regional natural resource management plans and site-based plans provide the best scale and context for developing operational plans to control invasive species. They allow primary production and environmental considerations to be jointly addressed and allow management to

be integrated across the local priority vertebrate pests within the scope of other natural resource management priorities.

Review of the 2008 TAP

The EPBC Act requires that a threat abatement plan be reviewed by the Minister at intervals of no longer than five years. The 2008 *Threat Abatement Plan for the competition and land degradation by rabbits* was reviewed by the Department of the Environment in 2013. The review assessed the progress and effectiveness of the threat abatement plan in: reducing the impacts of rabbits on biodiversity, specifically nationally listed threatened species and ecological communities; and preventing further species and communities from becoming threatened, through research, management and other actions. The review can be accessed at: http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits. In summary, the review found that:

- the issues and objectives outlined in the 2008 TAP were still valid and are likely to remain so into the future
- Rabbits have reached their ecological limit within Australia; threat abatement should therefore focus on minimising their impact rather than further spread
- There have been several successful eradications of rabbits on offshore islands in the last five years, most notably the eradication from Macquarie Island
- Exclosures have been useful in quantifying the impacts of rabbits on native flora and fauna
- Rabbits inhibit the regeneration of plants at densities as low as 0.5 rabbits per hectare
- Rabbit control programs have often been ad hoc, lacked strategic prioritisation, and have rarely been initiated in response to threatened species or ecological community recovery
- Information on the effects of rabbit abundance on pest predators, including prey switching, is limited
- Rabbit control research over the last five years has predominantly focussed on increasing the effectiveness of Rabbit Haemorrhagic Disease, with several new strains identified, and
- New approaches and educational tools e.g. online manuals, guidelines, factsheets and economic decision models, have been produced to assist land managers implement integrated control programs.

This TAP incorporates the knowledge gained since the 2008 TAP and has been modified to present priorities in line with the recommendations of the review.

Involvement of stakeholders

The successful implementation of this TAP will depend on a high level of cooperation between landholders, community groups, local government, state and territory conservation and pest management agencies, and the Australian Government. Success will depend on all participants allocating adequate resources to achieve effective on-ground control of rabbits at critical sites, improving the effectiveness of control programs, and measuring and assessing outcomes. Various programs in natural resource management, at national, state and regional levels, can make significant contributions to implementing the plan.

Threat abatement plan for rabbits

This section provides an overview of the threat and management of competition and land degradation by rabbits. The background document (Department of the Environment 2015a) should be referred to for further information.

The threat

The European rabbit (*Oryctolagus cuniculus*) was deliberately released onto the Australian mainland in the mid to late 1800s. Rabbits dominated two-thirds or 70% of the continent within 70 years (equivalent to approximately 5.3 million square kilometres) (Cox *et al.* 2013; Bengsen & Cox 2014). This is considered to be the fastest rate of any colonizing mammal anywhere in the world (cited in Williams *et al.* 1995; McLeod 2004) — with colonisation greatly aided by the use of warrens (which protect them against predators and climatic extremes), their high reproductive rates, and their ability to survive in a wide range of habitats (Williams *et al.* 1995). They are now one of the most widely distributed and abundant mammals in Australia (Williams *et al.* 1995); found in all states and territories and many offshore islands, with only the most northerly regions of the mainland thought to be rabbit free. Their exact abundance is unknown and cannot be readily quantified as population sizes frequently fluctuate through factors such as breeding events, mortality caused from biocontrol agents or drought, and availability of resources.

Rabbits inflict substantial damage upon both agricultural and environmental assets (e.g. native flora and fauna, vegetation communities, landforms, geomorphic processes and sensitive sites, and crops) and have been described as Australia's most costly vertebrate pest (Cooke *et al.* 2013). For agricultural commodities, this damage has been estimated at exceeding $200 million annually (Gong *et al.* 2009); for environmental commodities, the value of the damage has not been quantified. The introduction of rabbit biocontrol agents (myxoma and rabbit haemorrhagic disease virus) have helped to reduce both the economic and environmental impacts of rabbits in Australia, although even at lower densities (e.g. more than 0.5 rabbits per hectare), their impact still continues to be severe (Bird *et al.* 2012; Cooke *et al.* 2010; Cooke 2012b; cited in Cooke *et al.* 2013). Direct impacts of rabbits include:

- Competition with native wildlife for resources (food and shelter)
- Preventing plant regeneration
- Overgrazing and general damage to plant species
- Reversing the normal direction of plant succession

- Altering ecological communities and changing soil structure and nutrient cycling, leading to significant erosion, and
- Removal of critical habitat for arboreal mammals and birds, leading to increased predation and reduced reproduction.

Rabbits also have indirect impacts on native flora and fauna, including:

- Supporting populations of pest predators such as feral cats, foxes and wild dogs, and
- Promoting growth of introduced and unpalatable species such as weeds.

Rabbits impact over 300 EPBC Act listed threatened species and nine ecological communities. This includes 44 species of fauna (15 birds, 20 mammals, 6 reptiles, 1 invertebrate, 1 fish and 1 amphibian) and 260 listed plant species (Department of the Environment 2015b). A full list of these species is at Appendix A.

Managing the threat

As rabbits are so widely established and abundant in Australia, and given the current resources and techniques available, the focus of management is generally on abating their impacts rather than eradication. However, eradication may be achievable in isolated areas such as small reserves, exclosures, and offshore islands

Sustained control of rabbits is feasible and has been achieved in some large areas using well planned and timely integrated control measures, particularly after rabbits have been reduced by drought or disease (Cooke 1993; Cooke 2012a). Integrated control measures must seek to: use a range of control techniques (e.g. poisoning and warren destruction); target a range of pest species (e.g. rabbit control activities should also focus on the reduction in foxes, feral cats and weeds); and seek to control rabbits across neighbouring land tenures. For example, when integrated control measures were not undertaken on Macquarie Island, the removal of feral cats led to substantial increases to rabbit populations, resulting in landscape wide change and secondary impacts to breeding seabirds (Bergstrom *et al.* 2009). If integrated control measures had been applied, it may have saved considerable flow-on remedial management costs and previous control actions would not have been reversed.

In order to effectively manage rabbits and maximise control efforts, control efforts should be:

- targeted to protect sites where rabbits pose the greatest threat to biodiversity
- undertaken in a strategic manner to take advantage of the environmental conditions and other complementary activities, and
- monitored to ensure that objectives are met, and allow management options to be adapted to changing circumstances.

There are a range of control measures available for the management of rabbits. These include poison baiting, shooting, biological control agents (although this should not be relied upon as the only control measure), fencing and trapping. Research is continuing into improved biocontrol technology, particularly through three projects run by the Invasive Animals Cooperative Research Centre (Invasive Animals CRC) — the RHD Boost, RHD Accelerator and Bioprospecting projects (Cox *et al.* 2013). Further information on control measures and the

Invasive Animals CRC projects can be found in the supporting Background document (Department of the Environment 2015a).

Objectives and actions

The goal of this TAP is to minimise the impact of rabbit competition and land degradation on biodiversity in Australia and its territories by:

- Protecting affected threatened species and ecological communities, and
- Preventing further species and ecological communities from becoming threatened.

To achieve this goal, the plan has four main objectives:

1. Strategically manage rabbits at the landscape scale and suppress rabbit populations to densities below threshold levels in identified priority areas

2. Improve knowledge and understanding of the impact of rabbits and their interactions with other species and ecological processes

3. Improve the effectiveness of rabbit control programs, and

4. Increase engagement of, and awareness by, the community of the environmental impacts of rabbits and the need for integrated control.

Each objective is accompanied by a set of actions, which, when implemented, will help to achieve the goal of the plan. Performance indicators have been established for each objective. Progress will be assessed by determining the extent to which the performance indicators have been met.

The sections below provide background on each objective, followed by a table listing the actions required to meet the objective. Nineteen actions have been developed to meet the four objectives.

Priorities for each action are given in the tables below, categorised as 'very high', 'high' or 'medium'. Also, each action has been assigned a timeframe within which the outcome could be achieved once the action has commenced. Timeframes are categorised as short term (i.e. within three years), medium term (i.e. within three to five years) or long term (i.e. five years or beyond).

Objective 1 – Strategically manage rabbits at the landscape scale and suppress rabbit populations to densities below threshold levels in identified priority areas

As the eradication of rabbits from all of mainland Australia is not currently feasible, attention needs to be directed to the management and control of populations to reduce their impact on biodiversity. However, in order to efficiently and effectively manage rabbits, control programs need to be strategically designed and implemented. This includes the consideration of a number

of different factors which can influence the success or failure, effort required, and costs of control programs. This may include (among others):

- Identification of threatened species and habitats where rabbit control activities can provide the most benefit
- Wider, community-based coordination of actions, including on-ground control on private properties and in urban areas to provide control across wider areas to slow re-invasion
- Incorporation of economic decision-model analyses to maximise cost-benefit outcomes of control programs
- Identification of other land management activities such as pest control and weed management programs for integrated control and to reduce unintended consequences, and
- Environmental site conditions and their potential influence on control activities.

Control programs also need to take into account the number of rabbits per hectare. Several studies have found that if there are more than 0.5 rabbits per hectare, native species can be severely impacted (Mutze *et al.* 2008; Bird *et al.* 2012; Cooke 2012a). For example, when rabbit numbers are greater than 0.5 rabbits per hectare, the recruitment and regeneration of plants are inhibited, causing many of these species to become locally extinct (Mutze *et al.* 2008; Bird *et al.* 2012; Cooke 2012a).

The identification and consideration of threatened species and habitats is another critical consideration to ensure the survival of the species in that area. Removal of invasive species such as rabbits has been found to have significant benefits for native species such as reversing local population declines (Mutze *et al.* 2008; Bird *et al.* 2012). Management actions for invasive species should therefore focus on removing these threats to enable the persistence of threatened native species and to support well-functioning ecosystems. Species currently identified as being impacted by rabbits are outlined in Appendix A.

In addition to the above factors, prioritisation of control for pest species such as rabbits has been found to be more useful at regional scales e.g. catchment or national resource management levels. Planning at this level enables a more holistic view to rabbit management across regions, particularly in dividing and allocating resources (Murray *et al.* 2014). Regional areas are also likely to share the same or similar threatened species and ecological communities.

The actions under this objective therefore, seek to assist land managers with information to support strategic rabbit management programs and to focus abatement on priority areas. The actions are envisaged to not only lead to better environmental outcomes such as species and ecological community protection, but to a more efficient and effective use of limited resources.

Key actions for Objective 1 include identifying priority areas for rabbit control on a regional scale, implementing and supporting regional control programs, and promoting and maintaining control programs in areas adjacent to priority areas. In particular, actions will seek to support control of rabbits below threshold levels of 0.5 rabbits per hectare.

Action 1.1 seeks to determine regional priority areas for rabbit control by focussing effort on areas where rabbits have the greatest impact on threatened species and/or ecological communities. This includes identifying priority islands for eradication efforts in each state. It

also focuses on determining areas where the regeneration capacity of plants and the recovery of threatened species show the greatest potential. This will help obtain the greatest benefit for the amount of effort and resources put in. Economic decision models will be useful to help determine how these efforts can be prioritised and the best combination of control methods (see background document for further information on economic decision models (Department of the Environment 2015a)).

Action 1.2 follows on from action 1.1 by ensuring that control efforts are focused on a wider and more holistic landscape-scale, rather than on small patches of land and including all land tenures such as private land and urban areas. By focusing efforts in this way, control activities can be planned in a strategic manner to take advantage of environmental conditions and other complementary activities in the area.

Action 1.3 relates to action 1.2, by providing incentives for land managers to undertake more strategic and landscape-scale approaches to control programs. This should include coordination of control activities across neighbouring properties, including adjacent public and private land. Both action 1.3 and 1.2 help to maximise effectiveness and minimise costs by avoiding a piece-meal approach to rabbit control which facilitate immigration from adjoining or adjacent land where no control has been undertaken.

Action 1.4 focuses on assessing the implementation of regional and state and territory based control programs via regular and coordinated monitoring and reporting mechanisms. Monitoring rabbit control programs is critical to assist in determining whether a management program has been successful or not and what the failure points might be. This is particularly important at the regional and state/territory level where funding and effort are put into very similar activities and under similar environmental conditions, but by a range of different groups and individuals. By making program reports readily available, this will help ensure that any future control activities are as effective as possible by allowing management programs to be adapted and avoiding duplication or the implementation of actions that are unlikely to succeed. Where possible, a common and best practice approach to rabbit monitoring should be undertaken to enable comparisons to be made between control activities. Further information on monitoring approaches for rabbits can be found in the background document (Department of the Environment 2015a).

Action 1.5 focuses on targeted eradication efforts on high priority islands identified through action 1.1. Eradications of rabbits from islands may be feasible, particularly if the risk of new arrivals can be mitigated against. The use of integrated and well-thought out management plans will be critical in such eradication programs to avoid unexpected consequences and to ensure their success.

Performance indicators

- Regional priority areas for rabbit control are determined.
- Rabbits maintained at below threshold (0.5 rabbits per hectare) levels in identified priority areas.
- Landscape scale control programs are implemented and monitored at regional levels.
- Eradication of rabbits on islands is successful where this is attempted.

Action	Priority and timeframe	Outcome	Output	Responsibility
1.1. Prioritise areas on a regional scale (NRM, catchment level), for: a) their conservation value b) the potential for successful regeneration or rehabilitation of the species, and c) the degree of threat from rabbits. **Prioritisation should consider a range of factors (examples in the text above), including economic decision models.*	High priority, short term	Key species and ecological communities are prioritised for protection and management	Measurable reduction in the impact of rabbits on key species and ecological communities. Linkages to recovery plans (where available).	State governments, NRM and catchment groups
1.2. Continue to develop and implement cost effective and coordinated management programs across all land tenures, including urban areas.	High priority, medium term	Coordinated and targeted action by land managers.	Landscape scale management plans are adopted and implemented. Measurable recovery in threatened species and ecological communities. Rabbit numbers are reduced to less than 0.5 rabbits per hectare in priority areas.	State governments, NRM and catchment groups, land managers and friends groups
1.3. Create incentives for coordinated and strategic control across adjacent properties in all areas occupied by rabbits.	Medium priority, long term	Rabbit control is shared amongst adjoining land managers resulting in slower reinvasion and more effective control.	Strategic control is undertaken across all adjoining land tenures.	State/territory governments and local councils

Action	Priority and timeframe	Outcome	Output	Responsibility
1.4. Develop regular and coordinated reporting mechanisms at a regional and state scale to assess progress and apply adaptive management.	High priority, short term	Land managers are able to apply the most effective management actions to control rabbits.	Adaptive management practices are adopted and information is shared.	State governments, NRM and catchment groups, and land managers
1.5. Eradicate rabbits from identified islands	Very high priority, long term	Rabbits are eradicated or under sustained control on high priority islands.	Measurable recovery in threatened species and ecological communities.	State/territory governments and land managers

Objective 2 – Improve knowledge and understanding of the impact of rabbits and their interactions with other species and ecological processes

The biology and ecology of rabbits has been extensively studied throughout Australia, but a clear understanding of the interactions between rabbits and other fauna, as well as their contribution to a range of environmental processes is still not well understood. Many studies describe economic losses to agriculture, but for the environment, very little information on the value and extent of these losses has been readily quantified. Further, many land managers consider rabbits to be under control through the use of biocontrol agents, but there is little understanding of how even one rabbit can significantly impact native vegetation and how integrated control measures can enhance outcomes.

There is a paucity of research about the exact contribution of rabbits to the diet of native or introduced predators and the potential trophic-cascade effect that rabbit control, or even introduced predator control, may cause (e.g. increase in rabbit numbers, augmentation in resource competition with native herbivores, increase of predation on native prey species). For example, in semi-arid Australia, rabbits have been reported as a staple (and in some cases, primary) prey species for introduced species such as feral cats and foxes, and are thought to directly influence the abundance of these predators (Read & Bowen 2001; Holden & Mutze 2002; Glen & Dickman 2005). The abundance, survival and breeding of eagles, such as the wedge-tailed eagle (*Aquila audax*), has also been previously thought to be directly related to rabbit abundance, but some recent research is proving otherwise (see Olsen *et al.* 2014). It is therefore imperative that more conclusive information on potential impacts is garnered.

Key actions for Objective 2 focus on improving our understanding of the impacts of rabbits and the interaction of rabbits with other species, in order to use this information to optimise integrated rabbit control measures.

Action 2.1 seeks to further investigate the interaction between rabbits, feral cats, foxes and wild dogs to enable more effective integration of control activities for these species. Research is envisaged to focus on how predator abundance fluctuates in response to rabbit control, and the nature of the shift in predation to native species in response to rabbit control. This research is expected to help land managers to determine and anticipate any unexpected consequences (direct and/or indirect) of proposed control actions. Such assessments may save land managers considerable flow-on remedial management costs, and help to ensure the previous control actions have a positive outcome (Bergstrom *et al.* 2009).

Action 2.2 seeks to further investigate the correlation between rabbits and weed species and increase our understanding of the benefits of integrated management. Previous research has suggested that high levels of grazing and soil disturbance by rabbits around warrens is likely to promote the growth of introduced plant species, especially invasive weeds (Williams *et al.* 1995; Cooke 2012b). By understanding the correlation of rabbits and weeds, land managers should be able to respond more cost-effectively and efficiently to both invasive species.

Action 2.3 aims to continue research into whether or not rabbits sustain populations of native species (i.e. act as a main component of their diet), and whether rabbit control has any implications for the survival of these populations. In particular, research should aim to create a greater understanding of how native predators respond to a sudden and widespread reduction in rabbit numbers.

Performance indicators

- Control program planning demonstrates consideration of unexpected consequences of proposed actions.
- Control programs demonstrate use of integrated control measures for pest species that interact with rabbits and for weed species promoted by rabbits.
- Research papers are published that inform whether rabbit control is detrimental to the survival of native species.

Action	Priority and timeframe	Outcome	Output	Responsibility
2.1 Continue research into understanding the contribution of rabbits in maintaining feral cat, fox and wild dog numbers in different landscapes, and any potential effects of modifying pest predator populations (e.g. prey switching, decline in native species)	High priority, medium term	A clear and greater understanding of how management programs can influence rabbit and pest predator populations.	Research papers and reports on the interaction between rabbits and pest predators are published. Land managers are able to implement more integrated management	Researchers, Government and land managers

Action	Priority and timeframe	Outcome	Output	Responsibility
			programs for rabbits and other pest species without potential perverse environmental outcomes.	
2.2 Increase understanding of the correlation between rabbits and weed species and the benefits of integrating their management	Medium priority, medium term	A greater understanding of correlations between rabbit and weed control	Research papers and reports on correlations between rabbits and weeds are published. Land managers are able to implement more effective and targeted pest management.	Researchers, Government and land managers
2.3 Continue research into understanding the contribution of rabbits to the diet and abundance of native species.	High priority, medium term	A clear and greater understanding of whether rabbit management programs affect the abundance of native predators	Research papers and reports on the role or rabbits in maintaining populations of native predators are published. Land managers are able to implement more effective and targeted pest management.	Researchers, Government and land managers

Objective 3 – Improve the effectiveness of rabbit control programs

In order to reduce the impact of rabbits on native biodiversity and ecosystems, the use, improvement and development of control tools and programs is of high importance. However, as improving the effectiveness of control programs and control methods (particularly biocontrol agents) can take many years, it is imperative that strategic research and development of more effective and efficient techniques is begun now prior to any significant increases in rabbit numbers (Saunders *et al.* 2010; Cox *et al.* 2013).

In order to improve the effectiveness of rabbit control programs, we also need to understand the impact that control activities are having out in the field. As such, surveillance and monitoring of control activities and their effect on rabbits, including abundance, will be critical

in providing information to inform future management actions. This will include research into, and the development of additional control measures and use of new biocontrol agents.

Key actions for Objective 3 therefore include: improving conventional control options and tools for land managers; improving the coordination of monitoring and surveillance of rabbit control programs; continuing research into new biocontrol options; and increasing the adoption of standard control procedures.

Action 3.1 seeks to support ongoing research to ensure conventional management options are effective, target specific and humane. This includes supporting the development of more humane baits and conventional control methods — for example, the development of a humane carbon monoxide warren fumigator by the Invasive Animals Cooperative Research Centre. The development of further control tools is expected to enhance the effectiveness, efficiency and humaneness of control programs. It may also reduce potential impacts on both the environment and non-target species.

Actions 3.2 to 3.5 focus on maximising the effectiveness of rabbit biocontrol programs through understanding interactions and evolutions of the viruses, their optimal use, investigating the use of new viruses, and developing and registering new biocontrol agents/products. This includes increasing our understanding of how, and under what circumstances, the endemic RHD virus (RCV-A1) — which is found in cool and wet climates of Australia — interacts with the current RHDV strains and helps provide immunity. Given the effectiveness of biocontrol agents in reducing rabbit numbers and in helping to protect threatened species, these actions are considered of high priority and will require a long-term and ongoing commitment. Through developing a greater understanding of the viruses, including behaviours and evolutions, and increasing their effectiveness in the field, Australia will be better placed to respond to any future increases in rabbit numbers. It will also allow land managers to counteract any decrease in the effectiveness of existing strains by having new and effective biocontrol tools. Research being undertaken through Invasive Animals CRC programs such as the RHD Boost and Acceleration programs (see background document for further information on these programs (Department of the Environment 2015a)) will be of benefit to these actions.

Actions 3.6 focuses on ensuring there is adequate monitoring and surveillance throughout Australia to determine whether or not rabbit pathogens continue to be effective in reducing rabbit numbers. Monitoring and surveillance is also a critical element to understanding the prevalence, seasonal fluctuations and interactions with other biocontrol agents (Cox *et al.* 2013) and contributes to the outcomes of actions 3.3 to 3.5. Research under this action should include pre and post monitoring for any new release of a pathogen to track its performance and to better estimate the return on investment. This will help inform and define how successful future releases of biocontrol agents in the field might be and how they might complement or reduce the effects of existing measures (Saunders *et al.* 2010; Cox *et al.* 2013).

Action 3.7 aims to provide further tools for land managers to improve their ability to predict and forecast optimal rabbit control methods in order to effectively reduce the number of rabbits and their impact on various landscapes. At present, very few tools exist to estimate the various costs of using different control measures and how inaction may affect numbers of rabbits, impacts on the environment, and costs over time. In addition, the existing tools are limited to certain regions and habitat types and have not yet been extrapolated for use in all habitat types. By expanding the applicability of these tools, this would assist land managers to design more

effective control programs and gain a better understanding of the potential impact of their choice of control activities.

Action 3.8 follows on from action 3.7 by aiming to develop further economic assessment methods to determine the environmental benefits of rabbit control. At present, a model has been developed by Cooke *et al.* (2010) for the control of rabbits across south-eastern Australia with values assigned to native vegetation. Further native vegetation models need to be developed for use across all areas of Australia. Also of importance, values need to be assigned to the protection of native fauna, particularly those that are listed as threatened under the EPBC Act. Such values are likely to support management actions for native species, rather than only for agriculture where monetary values (and hence losses) can be more readily quantified.

Performance indicators

- Additional effective and humane control tools, including biological control agents, are developed. Research papers are published on the biology of rabbit viruses, including their behaviour, evolution and impediments.
- Monetary values are able to be assigned to the impact of rabbits on environmental assets.
- Pre and post monitoring is undertaken for the release of any new biocontrol agents.

Action	Priority and timeframe	Outcome	Output	Responsibility
3.1 Develop new methods for rabbit control that are effective, target specific and humane.	High priority, long term and ongoing	New humane and effective tools for control of rabbits are available to land managers	Measurable reduction in the number of rabbits. Reduced impacts on non-target species and the environment.	Researchers and product manufacturers
3.2 Continue research to maximise the effectiveness of existing biocontrol tools and investigate new biocontrol agents.	High priority, long term and ongoing	The use of biocontrol agents is maximised to reduce rabbit numbers.	Research papers and reports on biocontrols are published. Biocontrol agents made available.	Researchers
3.3 Develop and register new biocontrol agents and products.	High priority, long term and ongoing	Measurable and continued reduction in the number of rabbits through use of biocontrol agents.	Additional biocontrol agents are available to registered land managers.	Government and product manufacturers.
3.4 Increase understanding of	High	A clear	Research papers and	Researchers and

Action	Priority and timeframe	Outcome	Output	Responsibility
the seasonal patterns of RCV-A1 and its interaction with RHDV.	priority, long term	understanding of the interaction between RCV-A1 and RHDV.	reports on RCV-A1 and its interaction with RHDV are published. Future biocontrol research takes into account, and aims to reduce interactions of RCV-A1 with RHDV.	Government
3.5 Increase understanding of the long term effect of evolution and genetic resistance to biocontrol agents.	Medium priority, long term	A clear understanding of the virus' evolution and role in genetic resistance.	Research papers and reports on virus evolution and its role in genetic resistance are published. Future biocontrol programs are strengthened by taking account of the rate of evolution and development of genetic resistance.	Researchers
3.6 Conduct pre and post monitoring to determine success of biocontrol releases across a range of landscapes	High priority, medium term	Biocontrol agents continue to be effective in reducing rabbit numbers and their impact on the environment.	A clear understanding of the effectiveness, or otherwise, of each biocontrol agent release, and its environmental impacts.	Government, researchers and land managers
3.7 Further develop user-friendly models to predict and forecast the impact of changes in rabbit numbers and effectiveness of control methods in a range of different landscapes	Medium priority, medium term	Land managers are able to implement the most cost effective and optimal rabbit control activities.	Forecasting tools are developed for use by land managers.	Researchers and Government

Action	Priority and timeframe	Outcome	Output	Responsibility
3.8 Further develop economic assessment methods to determine the environmental benefits of rabbit control	Medium priority, medium term	Land managers are able to understand, and justify, the value of managing environmental assets.	Economic assessment tools are available to land managers	Researchers and Government

Objective 4 – Increase engagement of, and awareness by, the community of the impacts caused by rabbits, and the need for integrated control

The success of previous rabbit control, predominantly due to the effectiveness of biocontrol agents, has resulted in rabbits losing some of their public profile as a major pest species (Williams *et al.* 1995; Cox *et al.* 2013). This has reduced the general awareness of rabbits as a problem, which has often resulted in diminished public support for ongoing rabbit research and control (Williams *et al.* 1995; Cox *et al.* 2013).

As a step towards engaging stakeholders and raising their awareness of the impacts caused by rabbits, educational material (e.g. manuals on control techniques and monitoring) has been developed. However, communication of these materials and providing land managers with the skills necessary to recognise environmental impacts of rabbits (particularly at low levels) still needs further development and ongoing effort. In addition to this, different audiences will need to be engaged via different methods and emphasis will need to be placed on the benefits of individual and group contributions.

Williams *et al.* (1995) found that to successfully engage groups in the management of rabbit control, there needs to be:

- A high degree of local community understanding of the nature and extent of rabbit damage
- Group reinforcement through peer pressure and good communication
- Clear, identifiable and shared goals
- Synchronisation of control efforts, and
- Strong support from local and state pest management authorities.

Key actions for Objective 4 include ensuring better communication, engagement and awareness with land managers on the threat of rabbits to native species and other ecological processes, and how the use of integrated management methods can further reduce rabbit numbers.

Action 4.1 seeks to develop further training programs to help land managers (particularly supervisors and those planning local programs) to evaluate and adopt control methods

appropriate for local conditions, and determine in what circumstances and times they should be used. These training programs should provide land managers with the skills to recognise an increase in rabbit populations, prior to substantial damage being caused (see Cooke 2012a). Training should also focus on providing contractors with specialised skills to operate machinery to conduct control activities more cost-effectively over a range of properties. Train-the-trainer approaches may be useful and will allow knowledge and experience to be passed on to other land managers.

Action 4.2 focuses on engaging with the community, raising general awareness of the impact of rabbits, and garnering support for the use of control tools. This should include:

- raising awareness that more than 0.5 rabbit per hectare can significantly reduce the recruitment and regeneration ability of many native plants
- aiming to reduce community reliance on biocontrol agents as the only control tool for reducing rabbit numbers, and
- promoting the use of new biocontrol agents and humane control tools.

As part of action 4.2, specific communication campaigns will also need to be developed for any new biocontrol agents proposed for release, or other new control methods. By bringing the community onboard with proposed actions, there is a greater chance of achieving effective and coordinated rabbit control within these areas. It will also help reinforce how their contributions are valued and the benefit these actions can bring to their community and surrounding environment.

Action 4.3 seeks to promote the adoption of model codes of practice and standard operating procedures for the effective and humane management of rabbits (Sharp & Saunders 2012). This helps to ensure that rabbit management follows best practice and is undertaken humanely by land managers through adequate consideration of available control methods. In undertaking this action, it will be important for those promoting these codes of practice and standard operating procedures to acknowledge that relevant state and territory and occupational health and safety legislation must also be adhered to.

Action 4.4 aims to determine the barriers to uptake of conventional and integrated control methods by land managers and how best to increase uptake of best practice control methods. This will involve understanding a wide range of perceptions and motivations for rabbit control activities, including limiting factors which may need to be overcome. This action has linkages to action 4.2 and 4.1.

Performance indicators

- Land managers are able to recognise damage from an increasing number of rabbits and implement best-practice control methods at the most effective time.
- Contractors are skilled to operate specialised machinery and undertake rabbit control activities.
- The general community has an increased interest in the control of rabbits.
- There is an increased use of standard operating procedures and codes of practice for the effective and humane management of rabbits.

Action	Priority and timeframe	Outcome	Output	Responsibility
4.1 Develop further training programs to help land managers adopt locally appropriate monitoring and control methods.	Very high priority, long term - ongoing	Land managers are able to implement appropriate control programs and pass on knowledge and information to other land managers.	Land managers adopt the most effective monitoring and control measures. Further education/ training materials are developed and utilised.	Government, NRM groups and local councils
4.2 Promote and seek engagement by all people in the community in: • understanding the threat to biodiversity posed by rabbits • supporting rabbit management and the control actions used, including development of new control techniques • supporting the use of best practice, humane, cost-effective and integrated rabbit control methods.	High priority, long term - ongoing	Community support for the management of rabbits.	Further education materials developed and utilised.	Government, land managers, community groups, members of the general public
4.3 Continue to promote the adoption of the model codes of practice and standard operating procedures for effective and humane management of rabbits.	High priority, long term	Rabbits are not subjected to unacceptable suffering during control operations.	Rabbit control actions are humane and effective. Rabbit programs show a measurable reduction in the number of rabbits.	Government and land managers
4.4 Undertake research into the barriers to uptake of best practice control methods, and how this may be addressed.	High priority, short term.	An increase in land manager involvement in rabbit control.	Research papers on social and behavioural aspects of rabbit control are published.	Researchers and Government.

Duration and cost of the plan

This plan reflects the ongoing nature of the threat abatement process, given that there is no likelihood of national rabbit eradication in the near future. In general, most current rabbit control programs aim for long-term suppression of rabbit populations, and a reduction in damage to the environment and agricultural assets in the most cost-efficient manner.

This TAP provides a framework for undertaking targeted priority actions. Budgetary and other constraints may affect the achievement of the objectives of this plan, and as knowledge changes, proposed actions may be modified over the life of the plan. The Commonwealth is committed, via the EPBC Act, to *implement the threat abatement plan to the extent to which it applies in Commonwealth areas.* However, it should be noted that the Australian Government is unable to provide funding to cover all actions in this threat abatement plan across all of Australia and requires the financial and implementation support from stakeholders. Partnerships amongst and between governments, non-government organisations, community groups and individuals will be key to successfully delivering significant reductions in the threats posed by rabbits.

Investment in many of the TAP actions will be determined by the level of resources that stakeholders commit to management of the problem.

Given the extent of rabbits across Australia, an indicative estimate of the costs involved to undertake control actions outlined in this plan are provided below. It is important to note that the cost of controlling rabbits will continue to rise if rabbit populations are not continually managed and are allowed to increase due to favourable environment conditions and increasing resistance to RHD. The costs provided will also be highly variable depending on the location (including habitat and soil type), and availability of skilled contractors or persons able to assist with control activities. Anyone looking to implement an action is strongly recommended to undertake their own budget exercise for their particular circumstances and outcomes sought.

Action	Costs anticipated or known at the time of TAP development for action items	Estimated total cost across TAP
Poison baiting	$52 per hectare using 1080 oat baits (Cooke 2012a)	Annual cost of $780,000 at 500 sites of 30 hectares across Australia.
Ground shooting	$5,000–10,000 per week for ground shooting at a single site using professional shooters. Use of volunteer shooters (e.g. SSAA National) would cost considerably less than this.	Annual cost of $400,000 – $800,000 for 8 weeks of control at 10 sites across Australia. Less if volunteers are utilised.
Trapping	$3,000-4,000 per week for trapping at a single site.	Annual cost of $240,000 - $320,000 for 8 weeks over 10 sites across Australia.
Fumigation of warrens	$56 per hectare using aluminium phosphide tablets (Cooke 2012a)	Annual cost of $168,000 for fumigating 100 sites of 30 hectares across Australia.

Action	Costs anticipated or known at the time of TAP development for action items	Estimated total cost across TAP
Warren destruction	$40 per hectare where there is a moderate infestation of rabbits (Cooke 2012a); $69 per hectare using a bobcat backhoe at steep sand hills with dense scrub: (Cooke 2012a)	Annual cost of $600,000 - $1,035,000 at 500 sites of 30 hectares across Australia.
Exclusion fencing (using 30mm or smaller mesh)	$5,000 per kilometre to construct (Lowe *et al.* 2003). $10,000 per year for maintenance and monitoring.	$1,000,000 for construction of fences around 5 sites of 10 km^2 across Australia. $250,000 for ongoing maintenance of these 5 sites for 5 years.
Monitoring and surveillance activities.	Costs will be dependent on the type of monitoring used i.e. camera traps may be less expensive than physical monitoring. On average, $4000 per site	Monitoring repeated every 3 months at 50 sites $600,000.
Release of biocontrol agents	$52 per hectare using oat/carrot baits	Annual cost of $156,000 across 100 sites of 30 hectares in Australia.
Island eradications	$210 per hectare (based on using a combination of control methods). This does not involve integrated control for other pest species.	Dependent on size of island. Per island: $210,000 for smaller islands (approx. 1,000 hectares) to $2,730,000 for larger islands (approx. 13,000 hectares).
Research projects, including development of new control tools and models.	$250,000 annually per researcher Additional costs for registrations and production of the product/biological control agent. Note: these costs will be dependent on the complexity and number of registrations required, and costs to produce the product/agent.	To be determined for each project, model or control tool.
Social research into barriers for rabbit control.	$200,000 including community engagement.	$200,000.
Prioritisation of rabbit control areas	$100,000 for initial regional reviews of areas per state/territory	$800,000 plus additional funding for finer scale prioritisation.
Development of coordinated reporting mechanisms	$50,000 per state/territory	$300,000.

Action	Costs anticipated or known at the time of TAP development for action items	Estimated total cost across TAP
Development of management plans	$10,000 for each regional plan	$200,000 for 20 regions.
Community education	$200,000 per state/territory for general promotion per year. This amount may decline as material can be reused and education levels rise. Additional $200,000 per state/territory for releases of new biocontrol agents.	$1.2 million per state/territory over 5 years.
Training	$10,000 to $100,000 to develop different materials and programs. $2,000 to $100,000 for delivery.	$250,000 over 5 years. $300,000 over 5 years.

Implementing the plan

The Department of the Environment will work with other Australian Government agencies, state and territory governments and national and regional industry and community groups, to facilitate the implementation of the plan. Specific recovery plans for threatened species and other action plans will need to be taken into account when prioritising areas for management. There are also many different stakeholder interests and perspectives to take into account in managing rabbits and it will be important to consult and involve the range of stakeholders in implementing the actions in this plan. Greater integration between agricultural/pastoral and other control efforts will be encouraged.

The Australian Government will implement the plan as it applies to Commonwealth land.

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Appendix A

EPBC Act listed species and ecological communities affected by rabbits

All species in Appendix A were determined from profiles in the Australian Government's Species Profile and Threats Database (SPRAT) which identified rabbits as a threatening process. Note: the identification of these species as being affected by rabbits is based on a range of evidence, with some having solid scientific evidence to support the impact of rabbits on this species, where others may based on expert opinions. All species and ecological communities listed below are those which are listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. EPBC Act listing statuses are at September 2015.

Table A1: EPBC Act ecological communities identified as being affected by rabbits

Vegetation community	EPBC Act listing status
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered
Eastern Stirling Range Montane Heath and Thicket	Endangered
Perched Wetlands of the Wheatbelt region with extensive stands of living sheoak and paperbark across the lake floor (Toolibin Lake)	Endangered
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Endangered
Eastern Suburbs Banksia Scrub of the Sydney Region	Endangered
Shrublands and Woodlands of the eastern Swan Coastal Plain	Endangered
Silurian Limestone Pomaderris Shrubland of the South East Corner and Australian Alps Bioregions	Endangered
Temperate Highland Peat Swamps on Sandstone	Endangered
Upland Wetlands of the New England Tablelands and the Monaro Plateau	Endangered

Table A2: EPBC Act threatened flora identified as being affected by rabbits

Scientific name	Common name	EPBC Act listing status
Acacia araneosa	Spidery Wattle, Balcanoona Wattle	Vulnerable
Acacia ataxiphylla subsp. *magna*	Large-fruited Tammin Wattle	Endangered
Acacia auratiflora	Orange-flowered Wattle	Endangered
Acacia awestoniana	Stirling Range Wattle	Vulnerable
Acacia caerulescens	Limestone Blue Wattle, Buchan Blue, Buchan Blue Wattle	Vulnerable
Acacia carneorum	Needle Wattle, Dead Finish, Purple-wood Wattle	Vulnerable
Acacia cretacea	Chalky Wattle	Endangered
Acacia curranii	Curly-bark Wattle	Vulnerable
Acacia enterocarpa	Jumping-jack Wattle	Endangered
Acacia glandulicarpa	Hairy-pod Wattle	Vulnerable
Acacia insolita subsp. *recurva*	Yornaning Wattle	Endangered
Acacia latzii	Latz's Wattle	Vulnerable
Acacia lobulata	Chiddarcooping Wattle	Endangered
Acacia peuce	Waddy, Waddi, Waddy-wood, Birdsville Wattle	Vulnerable
Acacia phasmoides	Phantom Wattle	Vulnerable
Acacia pickardii	Birds Nest Wattle	Vulnerable
Acacia pinguifolia	Fat-leaved Wattle	Endangered
Acacia rhamphophylla	Kundip Wattle	Endangered
Acacia rhetinocarpa	Neat Wattle, Resin Wattle (SA)	Vulnerable
Acacia sciophanes	Wundowlin Wattle, Ghost Wattle	Endangered
Acacia subflexuosa subsp. *capillata*	Hairy-stemmed Zig-Zag Wattle	Endangered
Acacia terminalis subsp. *terminalis MS*	Sunshine Wattle	Endangered
Acacia vassalii	Vassal's Wattle	Endangered

Scientific name	Common name	EPBC Act listing status
Acacia volubilis	Tangled Wattle, Tangle Wattle	Endangered
Acanthocladium dockeri	Spiny Everlasting, Spiny Daisy	Critically Endangered
Adenanthos pungens subsp. *effusus*	Sprawling Spiky Adenanthos	Endangered
Allocasuarina robusta	Mount Compass Oak-bush	Endangered
Ammobium craspedioides	Yass Daisy	Vulnerable
Andersonia gracilis	Slender Andersonia	Endangered
Anigozanthos bicolor subsp. *minor*	Little Kangaroo Paw, Two-coloured Kangaroo Paw, Small Two-colour Kangaroo Paw	Endangered
Asterolasia nivea	Bindoon Starbush	Vulnerable
Atriplex infrequens		Vulnerable
Austrostipa metatoris		Vulnerable
Austrostipa wakoolica		Endangered
Azorella macquariensis	Macquarie Azorella, Macquarie Cushions	Critically Endangered
Ballantinia antipoda	Southern Shepherd's Purse	Endangered
Banksia cuneata	Matchstick Banksia, Quairading Banksia	Endangered
Banksia ionthocarpa	Kamballup Dryandra	Endangered
Banksia nivea subsp. *uliginosa*	Swamp Honeypot	Endangered
Banksia oligantha	Wagin Banksia	Endangered
Banksia serratuloides subsp. *serratuloides*	Southern Serrate Dryandra	Vulnerable
Barbarea australis	Native Wintercress, Riverbed Wintercress	Endangered
Beyeria lepidopetala	Small-petalled Beyeria, Short-petalled Beyeria	Endangered
Boronia capitata subsp. *capitata*	a shrub	Endangered
Borya mirabilis	Grampians Pincushion-lily	Endangered
Brachyscias verecundus	Ironstone Brachyscias	Critically Endangered
Brachyscome muelleri	Corunna Daisy	Endangered

Scientific name	Common name	EPBC Act listing status
Caladenia actensis	Canberra Spider Orchid	Critically Endangered
Caladenia amoena	Charming Spider-orchid	Endangered
Caladenia arenaria	Sand-hill Spider-orchid	Endangered
Caladenia argocalla	White-beauty Spider-orchid	Endangered
Caladenia audasii	McIvor Spider-orchid, Audas Spider-orchid	Endangered
Caladenia barbarella	Small Dragon Orchid, Common Dragon Orchid	Endangered
Caladenia behrii	Pink-lipped Spider-orchid	Endangered
Caladenia bryceana subsp. *bryceana*	Dwarf Spider-orchid	Endangered
Caladenia bryceana subsp. *cracens*	Northern Dwarf Spider-orchid	Vulnerable
Caladenia busselliana	Bussell's Spider-orchid	Endangered
Caladenia caesarea subsp. *maritima*	Cape Spider-orchid	Endangered
Caladenia calcicola	Limestone Spider-orchid	Vulnerable
Caladenia caudata	Tailed Spider-orchid	Vulnerable
Caladenia concolor	Crimson Spider-orchid, Maroon Spider-orchid	Vulnerable
Caladenia drakeoides	Hinged Dragon Orchid	Endangered
Caladenia elegans	Elegant Spider-orchid	Endangered
Caladenia formosa	Elegant Spider-orchid, Blood-red Spider-orchid	Vulnerable
Caladenia gladiolata	Bayonet Spider-orchid, Clubbed Spider-orchid	Endangered
Caladenia hastata	Melblom's Spider-orchid	Endangered
Caladenia hoffmanii	Hoffman's Spider-orchid	Endangered
Caladenia insularis	French Island Spider-orchid	Vulnerable
Caladenia intuta	Ghost Spider-orchid	Critically Endangered
Caladenia lowanensis	Wimmera Spider-orchid	Endangered
Caladenia macroclavia	Large-club Spider-orchid	Endangered

Scientific name	Common name	EPBC Act listing status
Caladenia melanema	Ballerina Orchid	Critically Endangered
Caladenia ornata	Ornate Pink Fingers	Vulnerable
Caladenia ovata	Kangaroo Island Spider-orchid	Vulnerable
Caladenia rigida	Stiff White Spider-orchid	Endangered
Caladenia robinsonii	Frankston Spider-orchid	Endangered
Caladenia rosella	Rosella Spider-orchid, Little Pink Spider-orchid	Endangered
Caladenia tensa	Greencomb Spider-orchid, Rigid Spider-orchid	Endangered
Caladenia tessellata	Thick-lipped Spider-orchid, Daddy Long-legs	Vulnerable
Caladenia thysanochila	Fringed Spider-orchid	Endangered
Caladenia versicolor	Candy Spider-orchid	Vulnerable
Caladenia viridescens	Dunsborough Spider-orchid	Endangered
Caladenia wanosa	Kalbarri Spider-orchid	Vulnerable
Caladenia woolcockiorum	Woolcock's Spider-orchid	Vulnerable
Caladenia xanthochila	Yellow-lip Spider-orchid	Endangered
Caladenia xantholeuca	White Rabbits, Flinders Ranges White Caladenia	Endangered
Calectasia pignattiana	Stilted Tinsel Lily	Vulnerable
Callistemon wimmerensis	Wimmera Bottlebrush	Critically Endangered
Callitriche cyclocarpa	Western Water-starwort	Vulnerable
Callitris oblonga	Pygmy Cypress-pine, Pigmy Cypress-pine, Dwarf Cypress-pine	Vulnerable
Calytrix breviseta subsp. *breviseta*	Swamp Starflower	Endangered
Carex paupera	Dwarf Sedge	Vulnerable
Cassinia tegulata	Avenue Cassinia	Critically Endangered
Centrolepis caespitosa		Endangered
Chamelaucium sp. Gingin (N.G.Marchant 6)	Gingin Wax	Endangered

Scientific name	Common name	EPBC Act listing status
Chorizema humile	Prostrate Flame Pea	Endangered
Codonocarpus pyramidalis	Slender Bell-fruit, Camel Poison	Vulnerable
Commersonia erythrogyna	Trigwell's Rulingia	Endangered
Commersonia prostrata	Dwarf Kerrawang	Endangered
Conospermum undulatum	Wavy-leaved Smokebush	Vulnerable
Conostylis dielsii subsp. *teres*	Irwin Conostylis	Endangered
Conostylis drummondii	Drummond's Conostylis	Endangered
Conostylis lepidospermoides	Sedge Conostylis	Endangered
Conostylis micrantha	Small-flowered Conostylis	Endangered
Conostylis misera	Grass Conostylis	Endangered
Conostylis rogeri	Kulin Conostylis, Single-flowered Conostylis	Vulnerable
Conostylis seorsiflora subsp. *trichophylla*	Hairy Mat Conostylis	Endangered
Conostylis setigera subsp. *dasys*	Boscabel Conostylis	Critically Endangered
Correa calycina		Vulnerable
Corybas dentatus	Toothed Helmet-orchid, Finniss Helmet-orchid	Vulnerable
Cynanchum elegans	White-flowered Wax Plant	Endangered
Darwinia apiculata	Scarp Darwinia	Endangered
Darwinia carnea	Mogumber Bell, Narrogin Bell	Endangered
Darwinia collina	Yellow Mountain Bell	Endangered
Darwinia foetida	Muchea Bell	Critically Endangered
Darwinia meeboldii	Cranbrook Bell	Vulnerable
Darwinia polychroma	Harlequin Bell	Endangered
Darwinia whicherensis	Abba Bell	Endangered
Daviesia bursarioides	Three Springs Daviesia	Endangered

Scientific name	Common name	EPBC Act listing status
Daviesia cunderdin	Cunderdin Daviesia	Endangered
Daviesia euphorbioides	Wongan Cactus	Endangered
Dichanthium setosum	bluegrass	Vulnerable
Diuris basaltica	Small Golden Moths Orchid, Early Golden Moths	Endangered
Dodonaea procumbens	Trailing Hop-bush	Vulnerable
Drakaea concolor	Kneeling Hammer-orchid	Vulnerable
Drakaea elastica	Glossy-leafed Hammer-orchid, Praying Virgin	Endangered
Eleocharis obicis	a spike rush	Vulnerable
Eremophila denticulata subsp. *denticulata*	Fitzgerald Eremophila	Vulnerable
Eremophila denticulata subsp. *trisulcata*	Cumquat Eremophila	Endangered
Eremophila nivea	Silky Eremophila	Endangered
Eremophila subteretifolia	Lake King Eremophila	Endangered
Eremophila viscida	Varnish Bush	Endangered
Eucalyptus cadens	Warby Range Swamp Gum	Vulnerable
Eucalyptus gunnii subsp. *divaricata*	Miena Cider Gum	Endangered
Eucalyptus leprophloia	Scaly Butt Mallee, Scaly-butt Mallee	Endangered
Eucalyptus mckieana	McKie's Stringybark	Vulnerable
Eucalyptus morrisbyi	Morrisbys Gum	Endangered
Eucalyptus rhodantha	Rose Mallee	Vulnerable
Euphrasia arguta		Critically Endangered
Euphrasia collina subsp. *muelleri*	Purple Eyebright, Mueller's Eyebright	Endangered
Frankenia conferta	Silky Frankenia	Endangered
Frankenia parvula	Short-leaved Frankenia	Endangered
Gastrolobium lehmannii	Cranbrook Pea	Vulnerable

Scientific name	Common name	EPBC Act listing status
Genoplesium littorale	Tuncurry Midge Orchid	Critically Endangered
Gentiana wissmannii	New England Gentian	Vulnerable
Glycine latrobeana	Clover Glycine, Purple Clover	Vulnerable
Goodenia integerrima	Gypsum Goodenia	Vulnerable
Grevillea althoferorum		Endangered
Grevillea curviloba subsp. *incurva*	Narrow curved-leaf Grevillea	Endangered
Grevillea dryandroides subsp. *hirsuta*	Hairy Phalanx Grevillea	Endangered
Grevillea elongata	Ironstone Grevillea	Vulnerable
Grevillea humifusa	Spreading Grevillea	Endangered
Grevillea kennedyana	Flame Spider-flower	Vulnerable
Grevillea maccutcheonii	McCutcheon's Grevillea	Endangered
Grevillea pythara	Pythara Grevillea	Endangered
Grevillea scapigera	Corrigin Grevillea	Endangered
Grevillea treueriana	Mt Finke Grevillea	Vulnerable
Gyrostemon reticulatus	Net-veined Gyrostemon	Critically Endangered
Hakea aculeata	Column Hakea	Vulnerable
Hakea maconochieana		Vulnerable
Hakea pulvinifera		Endangered
Hemiandra gardneri	Red Snakebush	Endangered
Hemiandra rutilans	Sargents Snakebush, Colourful Snakebush	Endangered
Hibbertia crispula	Ooldea Guinea-flower	Vulnerable
Hibbertia humifusa subsp. *erigens*	Euroa Guinea-flower	Vulnerable
Homoranthus darwinioides		Vulnerable
Ixodia achillaeoides subsp. *arenicola*	Sand Ixodia, Ixodia	Vulnerable

Scientific name	Common name	EPBC Act listing status
Jacksonia quairading	Quairading Jacksonia, Quairading Stinkwood	Endangered
Lambertia echinata subsp. *occidentalis*	Western Prickly Honeysuckle	Endangered
Lechenaultia chlorantha	Kalbarri Leschenaultia	Vulnerable
Lechenaultia laricina	Scarlet Leschenaultia	Endangered
Lepidium aschersonii	Spiny Pepper-cress	Vulnerable
Lepidium hyssopifolium	Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed	Endangered
Lepidium monoplocoides	Winged Pepper-cress	Endangered
Lepidium peregrinum	Wandering Pepper-cress	Endangered
Leucopogon gnaphalioides	Stirling Range Beard Heath	Endangered
Leucopogon marginatus	Thick-margined Leucopogon	Endangered
Macarthuria keigheryi	Keighery's Macarthuria	Endangered
Melaleuca kunzeoides		Vulnerable
Micromyrtus grandis		Endangered
Microtis angusii	Angus's Onion Orchid	Endangered
Minuria tridens	Minnie Daisy	Vulnerable
Myoporum cordifolium	Jerramungup Myoporum	Vulnerable
Myriophyllum lapidicola	Chiddarcooping myriophyllum	Endangered
Nematoceras dienemum	Windswept Helmet-orchid	Critically Endangered
Olearia astroloba	Marble Daisy-bush	Vulnerable
Ornduffia calthifolia	Mountain Villarsia	Endangered
Patersonia spirifolia	Spiral-leaved Patersonia	Endangered
Pelargonium sp. Striatellum (G.W.Carr 10345)	Omeo Stork's-bill	Endangered
Phebalium lowanense	Lowan Phebalium	Vulnerable
Philotheca basistyla	White-flowered Philotheca	Endangered

Scientific name	Common name	EPBC Act listing status
Pimelea curviflora var. *curviflora*		Vulnerable
Pimelea pagophila	Grampians Rice-flower	Vulnerable
Pimelea spinescens subsp. *spinescens*	Plains Rice-flower, Spiny Rice-flower, Prickly Pimelea	Critically Endangered
Pityrodia scabra	Wyalkatchem Foxglove	Endangered
Pomaderris subplicata	Concave Pomaderris	Vulnerable
Prasophyllum correctum	Gaping Leek-orchid	Endangered
Prasophyllum frenchii	Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid	Endangered
Prasophyllum goldsackii	Goldsack's Leek-orchid	Endangered
Prasophyllum murfetii	Fleurieu Leek Orchid	Critically Endangered
Prasophyllum pallidum	Pale Leek-orchid	Vulnerable
Prasophyllum petilum	Tarengo Leek Orchid	Endangered
Prasophyllum pruinosum	Plum Leek-orchid	Endangered
Prasophyllum spicatum	Dense Leek-orchid	Vulnerable
Prasophyllum subbisectum	Pomonal Leek-orchid	Endangered
Prasophyllum validum	Sturdy Leek-orchid	Vulnerable
Prostanthera calycina	West Coast Mintbush, Limestone Mintbush, Red Mintbush	Vulnerable
Prostanthera eurybioides	Monarto Mintbush	Endangered
Pterostylis arenicola	Sandhill Greenhood Orchid	Vulnerable
Pterostylis basaltica	Basalt Greenhood	Endangered
Pterostylis bryophila	Hindmarsh Valley Greenhood	Critically Endangered
Pterostylis cheraphila	Floodplain Rustyhood	Vulnerable
Pterostylis chlorogramma	Green-striped Greenhood	Vulnerable
Pterostylis cucullata	Leafy Greenhood	Vulnerable
Pterostylis despectans	Lowly Greenhood	Endangered

Scientific name	Common name	EPBC Act listing status
Pterostylis gibbosa	Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood	Endangered
Pterostylis lepida	Halbury Greenhood	Endangered
Pterostylis mirabilis	Nodding Rufoushood	Vulnerable
Pterostylis sinuata	Northampton Midget Greenhood	Endangered
Pterostylis sp. Hale (R.Bates 21725)	Hale Dwarf Greenhood	Endangered
Pterostylis xerophila	Desert Greenhood	Vulnerable
Ptilotus beckerianus	Ironstone Mulla Mulla	Vulnerable
Ptilotus fasciculatus	Fitzgerald's Mulla-mulla	Endangered
Ranunculus anemoneus	Anemone Buttercup	Vulnerable
Roycea pycnophylloides	Saltmat	Endangered
Rutidosis heterogama	Heath Wrinklewort	Vulnerable
Sclerolaena walkeri		Vulnerable
Senecio macrocarpus	Large-fruit Fireweed, Large-fruit Groundsel	Vulnerable
Senecio megaglossus	Superb Groundsel	Vulnerable
Solanum karsense	Menindee Nightshade	Vulnerable
Stachystemon nematophorus	Three-flowered Stachystemon	Vulnerable
Stylidium coroniforme	Wongan Hills Triggerplant, Wongan Triggerplant	Endangered
Swainsona murrayana	Slender Darling-pea, Slender Swainson, Murray Swainson-pea	Vulnerable
Swainsona pyrophila	Yellow Swainson-pea	Vulnerable
Symonanthus bancroftii	Bancrofts Symonanthus	Endangered
Synaphea quartzitica	Quartz-loving Synaphea	Endangered
Synaphea sp. Fairbridge Farm (D.Papenfus 696)	Selena's Synaphea	Critically Endangered
Synaphea sp. Pinjarra (R.Davis 6578)	Club-leafed Synaphea	Critically Endangered
Tetratheca deltoidea	Granite Tetratheca	Endangered

Scientific name	Common name	EPBC Act listing status
Tetratheca gunnii	Shy Susan	Critically Endangered
Thelymitra cyanapicata	Blue Top Sun-orchid, Dark-tipped Sun-orchid	Critically Endangered
Thelymitra epipactoides	Metallic Sun-orchid	Endangered
Thelymitra mackibbinii	Brilliant Sun-orchid	Vulnerable
Thelymitra matthewsii	Spiral Sun-orchid	Vulnerable
Thelymitra stellata	Star Sun-orchid	Endangered
Thesium australe	Austral Toadflax, Toadflax	Vulnerable
Thomasia glabripetala	Sandplain Thomasia	Vulnerable
Tribonanthes purpurea	Granite Pink	Vulnerable
Trichanthodium baracchianum	Dwarf Yellow-heads	Vulnerable
Verticordia densiflora var. *pedunculata*	Long-stalked Featherflower	Endangered
Verticordia fimbrilepis subsp. *fimbrilepis*	Shy Featherflower	Endangered
Verticordia hughanii	Hughan's Featherflower	Endangered
Verticordia plumosa var. *pleiobotrya*	Narrow-petalled Featherflower, Mundijong Featherflower	Endangered
Verticordia spicata subsp. *squamosa*	Scaly-leaved Featherflower	Endangered
Verticordia staminosa subsp. *staminosa*	Wongan Featherflower	Endangered
Verticordia staminosa var. *cylindracea*	Granite Featherflower	Endangered
Westringia crassifolia	Whipstick Westringia	Endangered
Wurmbea tubulosa	Long-flowered Nancy	Endangered
Xerothamnella parvifolia		Vulnerable
Zieria baeuerlenii	Bomaderry Zieria, Bomaderry Creek Zieria	Endangered

Table A3 outlines the threatened bird, reptile, amphibian and insect species which may be affected by rabbits.

Table A3: EPBC Act reptiles, amphibians, fish, birds and insects affected by rabbits

Species Type	Scientific name	Common name	EPBC Act listing status	IUCN listing status	Main impact by rabbits
Reptile	*Aprasia parapulchella*	Pink-tailed Worm-lizard, Pink-tailed Legless Lizard	Vulnerable	*Not listed*	Habitat degradation
	Christinus guentheri	Lord Howe Island Gecko, Lord Howe Island Southern Gecko	Vulnerable	Vulnerable	Habitat degradation
	Delma impar	Striped Legless Lizard	Vulnerable	Vulnerable	Habitat degradation
	Eulamprus tympanum marnieae	Corangamite Water Skink	Endangered	Endangered	Habitat degradation
	Ophidiocephalus taeniatus	Bronzeback Snake-lizard	Vulnerable	Vulnerable	Habitat degradation
	Tympanocryptis pinguicolla	Grassland Earless Dragon	Endangered	Vulnerable	Habitat degradation
Amphibian	*Philoria frosti*	Baw Baw Frog	Endangered	Critically endangered	Habitat degradation
Fish	*Maccullochella macquariensis*	Trout Cod	Endangered	Endangered	Habitat degradation
Bird	*Amytornis barbatus barbatus*	Grey Grasswren (Bulloo)	Endangered	Least concern[1]	Habitat degradation
	Amytornis modestus	Thick-billed Grasswren	Vulnerable	*Not listed*	Habitat degradation
	Anthochaera phrygia	Regent Honeyeater	Endangered	Critically endangered	Habitat degradation
	Cacatua pastinator pastinator	Muir's Corella (southern), Western Long-billed Corella (southern)	Vulnerable	Least concern[1]	Habitat degradation
	Calyptorhynchus lathami halmaturinus	Glossy Black-Cockatoo (Kangaroo Island), Glossy Black-Cockatoo (South Australian)	Endangered	Least concern[1]	Habitat degradation
	Cinclosoma punctatum anachoreta	Spotted Quail-thrush (Mt Lofty Ranges)	Critically Endangered	Least concern[1]	Habitat degradation; competition for resources
	Geophaps scripta scripta	Squatter Pigeon (southern)	Vulnerable	Least concern[1]	Habitat degradation
	Hylacola pyrrhopygia parkeri	Chestnut-rumped Heathwren (Mt Lofty Ranges)	Endangered	Least concern[1]	Habitat degradation; competition for resources
	Leipoa ocellata	Malleefowl	Vulnerable	Vulnerable	Habitat degradation

[1] IUCN Red List Status provides the status at species level and is taken to include the subspecies (a separate assessment at the subspecies level has not been completed at this stage).

Species Type	Scientific name	Common name	EPBC Act listing status	IUCN listing status	Main impact by rabbits
	Neophema chrysogaster	Orange-bellied Parrot	Critically Endangered, Marine	Critically endangered	Habitat degradation - removing food resources
	Pedionomus torquatus	Plains-wanderer	Vulnerable	Endangered	Habitat degradation
	Pezoporus occidentalis	Night Parrot	Endangered	Endangered	Habitat degradation
	Poephila cincta cincta	Black-throated Finch (southern)	Endangered	Least concern[1]	Habitat degradation
	Polytelis alexandrae	Princess Parrot, Alexandra's Parrot	Vulnerable	Near threatened	Habitat degradation
	Polytelis anthopeplus monarchoides	Regent Parrot (eastern)	Vulnerable	Least concern[1]	Poisoning by rabbit oat baits
Insect	*Synemon plana*	Golden Sun Moth	Critically Endangered	*Not listed*	Habitat degradation

Table A4 outlines the various statuses of mammals which may be affected by rabbits and the relative risk of rabbits on those species. These species were determined from *The Action Plan for Australian Mammals 2012* (Woinarski *et al.* 2014) and from profiles which identified rabbits as a threatening process in SPRAT. The overall threat rating considers both the severity and extent of habitat degradation by livestock and introduced herbivores and has been developed from *The Action Plan for Australian Mammals 2012* (Woinarski *et al.* 2014). For example, the threat is considered to be high risk where there may be a moderate consequence over the entire range, a severe consequence across a large extent of the range, or a catastrophic consequence across a moderate extent of the range (Woinarski *pers. comm*. March 2015). Note: the overall threat for habitat degradation is cumulative for both livestock and introduced herbivores (which rabbits are one of). Therefore this rating may not be solely representative of the impact of rabbits.

Table A4: EPBC Act threatened mammals affected by rabbits

Scientific name	Common name	EPBC Act listing status	IUCN listing status	Main impact by rabbits	Overall threat rating
Bettongia penicillata ogilbyi	Woylie	Endangered	Critically endangered[1]	Competition for resources; support predators	*Not assessed*
Burramys parvus	Mountain Pygmy-possum	Endangered	Critically endangered	Habitat degradation and resource depletion; support predators (cats)	*Not assessed*
Dasycercus cristicauda	Crest-tailed Mulgara	Vulnerable	Least Concern	Habitat degradation and resource depletion; support predators	High
Dasyuroides byrnei	Kowari, brushy-tailed marsupial rat, Byrne's crest- tailed marsupial rat	Vulnerable	Vulnerable	Habitat degradation and resource depletion, including reducing prey abundance; support predators	Moderate
Dasyurus geoffroii	Chuditch, Western Quoll	Vulnerable	Near threatened	Habitat degradation and resource depletion; support predators	*Not assessed*
Lagorchestes conspicillatus conspicillatus	Spectacled Hare-wallaby (Barrow Island)	Vulnerable	Least concern[1]	Habitat degradation; support predators	*Not assessed*
Lagorchestes hirsutus unnamed subsp.	Mala, Rufous Hare-Wallaby (central mainland form)	Endangered	Vulnerable[1]	Competition for resources; support predators	*Not assessed*
Lasiorhinus krefftii	Northern Hairy-nosed Wombat, Yaminon	Endangered	Critically endangered	Competition for resources; habitat degradation	Minor
Macrotis lagotis	Greater Bilby	Vulnerable	Vulnerable	Habitat degradation; competition for resources; support predators	Minor
Notomys fuscus	Dusky Hopping-mouse, Wilkiniti	Vulnerable	Vulnerable	Habitat degradation; support predators	High - very high
Onychogalea fraenata	Bridled Nail-tail Wallaby	Endangered	Endangered	Habitat degradation; competition for resources; support of predators	Very high
Perameles gunnii unnamed subsp.	Eastern Barred Bandicoot (Mainland)	Endangered	Near threatened[1]	Habitat degradation; competition for shelter; support predators	Minor
Petrogale lateralis MacDonnell Ranges race	Warru, Black-footed Rock-wallaby (MacDonnell Ranges race)	Vulnerable	Near threatened[1]	Competition for resources; support predators	Moderate

Scientific name	Common name	EPBC Act listing status	IUCN listing status	Main impact by rabbits	Overall threat rating
Petrogale lateralis lateralis	Black-flanked Rock-wallaby	Vulnerable	Near threatened[1]	Competition for resources; support predators	Minor
Petrogale penicillata	Brush-tailed Rock-wallaby	Vulnerable	Near threatened	Competition for resources; support predators	High
Petrogale xanthopus xanthopus	Yellow-footed Rock-wallaby (SA and NSW)	Vulnerable	Near threatened[1]	Competition for resources; support predators	High
Pseudomys australis	Plains Rat, Palyoora	Vulnerable	Vulnerable	Habitat degradation; support predators	High
Pseudomys fieldi	Shark Bay Mouse, Djoongari, Alice Springs Mouse	Vulnerable	Vulnerable	Habitat degradation; support predators	*Not assessed*
Pseudomys fumeus	Konoom, Smoky Mouse	Endangered	Endangered	Habitat degradation; support predators	*Not assessed*
Pseudomys oralis	Hastings River Mouse, Koontoo	Endangered	Vulnerable	Habitat degradation; support predators	Minor