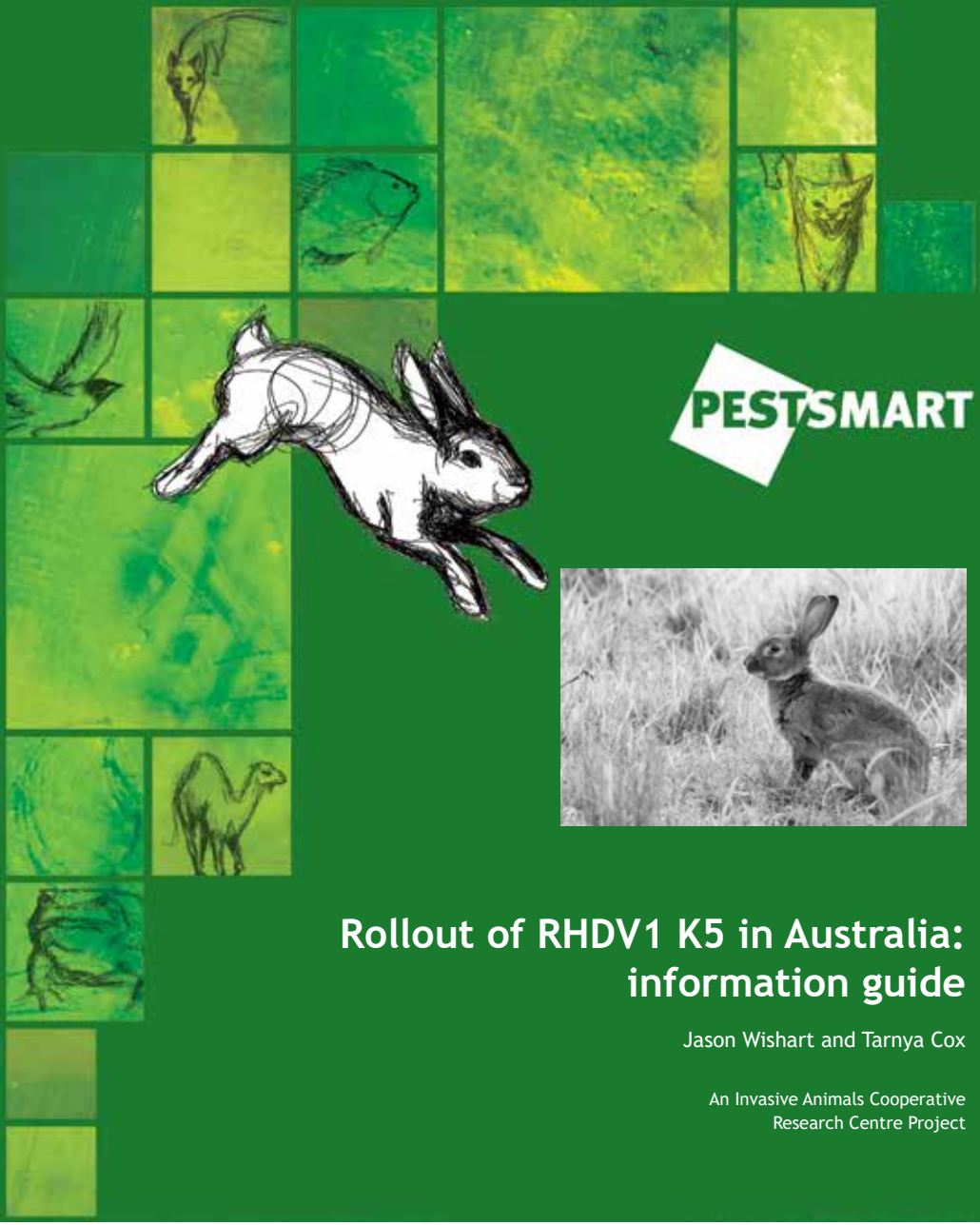


PESTSMART

Rollout of RHDV1 K5 in Australia: information guide

Jason Wishart and Tarnya Cox

An Invasive Animals Cooperative Research Centre Project

Invasive Animals CRC

Australian Government
Department of Agriculture and Water Resources

NSW Government
Department of Primary Industries

CSIRO

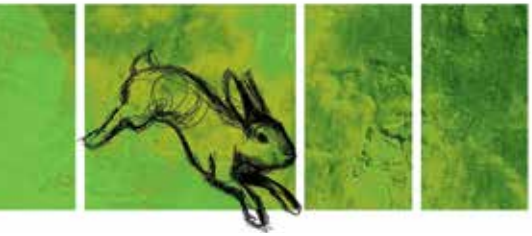
awi Australian Wool Innovation Limited

mla MEAT & LIVESTOCK AUSTRALIA

RFA

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme



PestSmart Connect

RabbitScan

Website: www.pestsmart.org.au/

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Cover image: Rebecca Zanker.

Rollout of RHDV1 K5 in Australia: Information guide

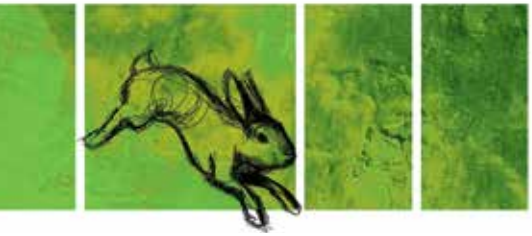
Jason Wishart and Tarnya Cox

An Invasive Animals Cooperative
Research Centre Project

The 'RHD Boost' research initiative has been delivered through the Invasive Animals CRC, with major financial and in kind resources provided by the Australian government, State governments, and industry and non-government organisations. The partners in this national collaborative project include:

- Australian Government Department of Agriculture and Water Resources
- NSW Department of Primary Industries
- Victoria Department of Economic Development, Jobs, Transport and Resources
- Department of Primary Industries and Regions South Australia
- Australian Wool Innovation
- Meat and Livestock Australia
- Foundation for Rabbit Free Australia
- Department of Agriculture and Food Western Australia
- University of Adelaide
- Department of Agriculture and Food Queensland
- ACT Government Environment and Planning
- ACT Government Territory and Municipal Services
- Parks Victoria
- CSIRO

For more information please visit:
www.pestsmart.org.au/boosting-rabbit-biocontrol-rhdv-k5-national-release/



Contents

1. Rabbits in Australia

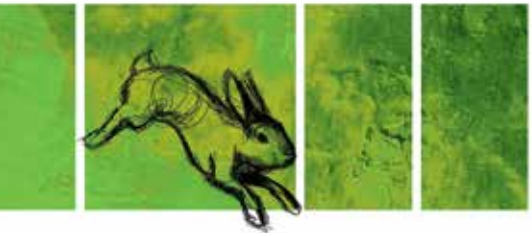
Domestic rabbits were brought to Australia on the first fleet. The first wild populations were recorded in Tasmania, where they were numbered in the thousands on some estates by 1827. In 1859, Thomas Austin released 24 wild rabbits on his mainland property, near Geelong Victoria, for hunting purposes. By the 1920s rabbits had spread to all states and territories and their population was thought to be as high 10 billion.

The rate of spread of rabbits in Australia is believed to be the fastest of any colonising mammal anywhere in the world. Rabbits were able to rapidly colonise Australia for numerous reasons, but the use of a warren (protection from elements and predators), their ability to survive in a wide range of habitats and their high reproductive potential were impacting factors. Another reason rabbits were so successful was because there were few parasites and diseases to keep their numbers in check.

Rabbits are estimated to cause over $200 million dollars in damage to Australian agriculture every year, and they are recognised as a potential threat to at least 304 native threatened species. As a consequence of the damage they cause, rabbits are managed wherever they occur. Historically, this was achieved using exclusion fencing and conventional methods such as warren destruction, fumigation and poison baiting. However, broad-scale population level control was not possible until the introduction of two biocontrol agents — myxoma virus (MYXV) and rabbit haemorrhagic disease virus (RHDV).

Rabbits around a water trough, South Australia 1938. Image: M W Mules

The Invasive Animals CRC and its predecessor organisations have been successfully leading rabbit biocontrol research in collaboration with government and research agencies and industry partners since the early 1990s.



2. History of rabbit biocontrol in Australia

MYXV	**Myxoma virus**
RHDV1	**Rabbit haemorrhagic disease virus**
RHDV1 v351	**Czech variant of RHDV1 used in Australia since 1995**
RHDV1 K5	**Korean variant of RHDV1**

Myxoma Virus (MYXV)

The first field trials of MYXV were undertaken in South Australia's arid zone between 1938 and 1942. The virus killed many rabbits during this time, but it did not spread far. In 1950, the virus was released near Albury NSW, and was more successful. It spread rapidly and by 1954 was present throughout most of Australia's rabbit population, resulting in population declines in excess of 90%. Fleas and mosquitoes are known to be key contributors to its rate of spread the second time.

Within a few years rabbits began to develop resistance to MYXV and their populations began to recover. Today it is estimated that MYXV affects 20 – 40% of the rabbit population and MYXV is still considered to be an important part of integrated rabbit management programs.

Rabbit Haemorrhagic Disease Virus (RHDV1)

RHDV1 was imported to Australia in 1991 to determine its suitability as an additional biocontrol agent for rabbits. RHDV1 causes rabbit haemorrhagic disease (RHD), which is an acute and highly contagious disease that affects only wild and domestic European rabbits (*Oryctolagus cuniculus*). There is no cure for RHD, but there is a vaccine.

There are several strains and variants of RHDV1, but the one first used to control rabbits in Australia was the Czech 351 strain (RHDV1 v351). In 1995, quarantine trials of RHDV1 v351 began on Wardang Island, South Australia. The virus escaped from the island, likely by flies, and quickly spread across mainland Australia. RHDV1 v351 was officially released the following year and it drastically reduced rabbit populations, although it was

less effective in cooler, higher rainfall climates.

Initially, RHDV1 v351 was a suspension formulation that was injected into wild rabbits. In 2006, the use was extended for application on carrots and oats, and in 2015 a new lyophilised formulation (freeze dried) was registered for injection and bait use.

In the 13 years after its release, RHDV1 v351 resulted in nearly $6 billion of savings associated with reduced rabbit populations and impacts to agriculture. Despite this, rabbit numbers are now increasing due to increasing resistance to RHDV1 v351.

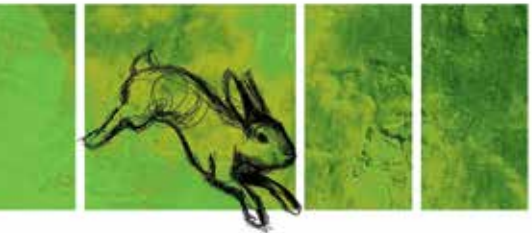
RHDV1 vial
Image: John Kovaliski

Benign Caliciviruses

Benign or non-disease causing caliciviruses have been present in Australia since the introduction of the first wild rabbits 150 years ago. The benign Rabbit Calicivirus Australia 1 (RCV-A1) was isolated from wild rabbits in Australia in 2009. Varying levels of antibodies to benign caliciviruses have been found in Australian rabbits, although higher levels of antibodies are found in rabbits in higher rainfall areas.

Tests reveal that infection with RCV-A1 reduces the likelihood of death from RHDV1 v351. This explains why RHDV1 v351 was less effective in higher rainfall areas. Scientists are currently investigating the geographic distribution and genetic diversity of this benign strain, and have developed antibody tests to identify its presence in the field.

The cumulative economic benefits for agriculture alone from MYXV and RHDV over 60 years are estimated at $70 billion.



3. Invasive Animals CRC rabbit biocontrol program

The Invasive Animals CRC (IA CRC) rabbit biocontrol program (2005-2017) is a strategic partnership between the Australian, state and territory governments (particularly NSW and SA), CSIRO, industry through Australian Wool Innovation and Meat and Livestock Australia, University of Adelaide, University of Canberra, University of Queensland, and Rabbit Free Australia. It aims to:

1. Discover why RHDV has variable performance in cooler, wetter parts of Australia
2. Evaluate, produce and select new RHDV strains to improve rabbit biocontrol effectiveness
3. Develop more efficient RHDV delivery systems
4. Improve understanding of rabbit genetic resistance and its implications for rabbit biocontrol
5. Assess the benefits of additional potential rabbit biocontrol agents.

More information at:
www.invasiveanimals.com/publications/corporate

Rabbit warrens. Image: Colin Somerset

HISTORY OF IA CRC RABBIT BIOCONTROL PROGRAM

RHDV1 K5

The proposed national release of RHDV1 K5 to take place to boost rabbit bio-control in Australia

2016/17

FREEZE-DRIED RHDV

New freeze-dried version of RHDV v351 made available for injection and bait use

2015

2015

RHD BOOST

Global search for a new strain of RHDV with superior performance in wetter and cooler regions to overcome problems with RCV-A1. 38 strains considered and a selection tested in Australian quaran-tine facilities. RHDV1 K5 was selected

2015

2014

2012

KNOWLEDGE

Co-evolution of rabbit resistance and RHDV evolution knowledge improved

2010

2009

RHDV1 v351

The original RHDV variant released in the mid-1990s, RHDV v351, has new suspension approved for use on carrot and oat baits.

2006

NEW BIOCONTROL AGENTS

Assessment of new potential rabbit biocontrol agents finished and business case released recommending evaluation of a rabbit parasite (*Eimeria*) and RHDV2 as two new potential rabbit biocontrol agents

RHD ACCELERATOR

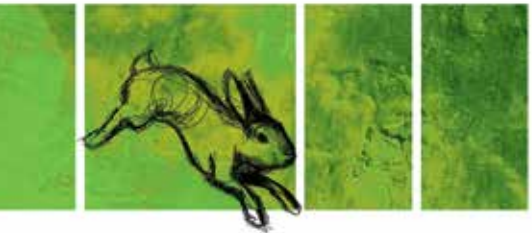
RHD Accelerator project demonstrates proof of principle in accelerated evolution of RHDV virus variants, with the aim of producing a continuous supply of virulent RHDV strains

GENETIC RESISTANCE

Genetic resistance by rabbits to RHDV v351 demonstrated

RCV-A1

Native benign rabbit calicivirus that impedes effectiveness of RHDV1 v351 in wetter, cooler regions isolated and named RCV-A1. Level of cross protection of RCV-A1 shown to vary nationally, but can be up to 40%



4. The RHD Boost project

Observations of growing resistance to RHDV1 v351 resulted in the Invasive Animals Cooperative Research Centre (IA CRC) commissioning the RHD Boost project. The objective of the project was for Australian Governments and industry to work together to find a RHDV1 strain to improve rabbit biocontrol effectiveness in Australia. The search and evaluation led to a naturally occurring RHDV1 variant from Korea (RHDV1 K5) being selected for further testing.

Image: Brian Cooke

RHDV1 K5

RHDV1 K5 is not a new virus; it is a Korean variant of RHDV1 and specific to the European rabbit (*Oryctolagus cuniculus*). The RHD Boost project also found that RHDV1 K5 is likely to work better than RHDV v351 in cool-wet regions of Australia.

Similar to RHDV v351, RHDV1 K5 is a lyophilised formulation that must be reconstituted in distilled water prior to use, and it will be used to either inject live rabbits, or be prepared as carrot or oat bait and fed to live rabbits. Infected rabbits will spread RHDV1 K5 to other rabbits by direct contact or indirectly through faeces and vectors such as insects.

It is unlikely that RHDV1 K5 will achieve the population reductions that RHDV v351 initially did, as it is not being released into a naïve population. Knockdowns are expected to be improved by anywhere from 0- 40%. It is important that RHDV1 K5 is used as part of an integrated multi-technique rabbit management program.

The intended use patterns of RHDV1 K5 are the same as those used for the existing product containing RHDV v351 (see *RAB001 Inoculation of rabbits with RHDV* and *RAB010 Bait delivery of RHDV* for details). In addition, RHDV1 K5 will be a Restricted Chemical Product (RCP) so its supply will be restricted in accordance with State and Territory legislation (see *Persons authorised to access RHDV1 K5 within each state and territory* on page 13).

RHDV1 Vaccine

Because RHDV1 K5 and RHDV1 v351 are variants of the same virus (RHDV1), the same vaccine (Cylap®) can be used to protect rabbits from both strains. To further demonstrate this, the NSW Department of Primary Industries implemented a pilot study through the Invasive Animals CRC to determine the suitability of Cylap® to protect domestic and production rabbits from RHDV1 K5.

The experiment compared the mortality of a small number of vaccinated and unvaccinated rabbits that were infected with a high dose of RHDV1 K5. All of the rabbits that were vaccinated with Cylap® survived the infection and none of the unvaccinated rabbits survived. Hence, the experiment indicates that the currently registered vaccine will protect pet rabbits against disease from RHDV1 K5.

The Australian Veterinary Association recommends vaccinating rabbits against RHDV1 K5 and RHDV1 v351 at 10-12 weeks of age, followed by an annual booster and health check. Occasionally, in the face of an outbreak, rabbits may be vaccinated earlier than 10 weeks of age in which case a booster is recommended 4 weeks later.

The vaccine to protect pet and farmed rabbits is available from your local veterinarian.

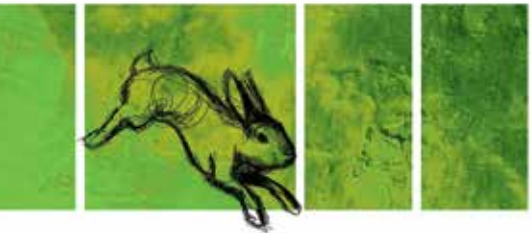
Pet rabbit

Discovery of RHDV2 in Australia

Recently, a new virus has been found in wild rabbits in NSW, ACT, VIC and SA. This virus is referred to as RHDV2 because while the mode of death is the same as RHDV1 (RHDV1 K5 and RHDV v351), they are two separate viruses. RHDV2 can cause death in young kittens (3-4 weeks) and the currently available vaccine (Cylap®) is not fully protective against disease from RHDV2.

RHDV2 has also been reported to infect certain sub-species of hares, but not the European brown hare (the only species of hare found in Australia).

If the RHDV2 present in Australia is highly virulent, it could benefit rabbit control as it may overcome immunity to field strains of RHDV1 v351. However, if it out-competes the existing strains and replaces them but has lower virulence, leading to increased survival of rabbits



during virus outbreaks, it could lessen the impact of current and future biocontrol initiatives using RHDV1 in Australia.

The ability to overcome immunity to field strains also means that RHDV2 may be able to overcome vaccination. Preliminary studies from Europe show that the commercially available vaccine at least partially protects against RHDV2, and protection is increased if regular boosters are applied. A revised vaccination protocol to improve protection of rabbits against RHDV2 is available from your veterinarian.

Notwithstanding, it is recommended that the proposed release of RDHV K5 should go ahead and the sampling program around its release should be taken as an opportunity to determine the distribution and potential impact of RHDV2.

Regulatory approval process for RHDV1 K5 and timeline

The registration and release of RHDV1 K5 requires both national, state and territory approvals. Below is the current state of affairs as of April 2016:

- Commonwealth Quarantine Act 1908 – Release from Quarantine was approved in July 2014 by the Commonwealth Department of Agriculture and Water Resources.
- Commonwealth Biological Control Act 1984 – In March 2016, Amendments were passed to the Act to clarify the definition of an organism to be consistent with the original intent of the Act.
- Commonwealth The Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act) – Application was submitted in July 2015 and is currently under consideration by the Commonwealth Department of the Environment.
- Commonwealth Agricultural and Veterinary Chemicals Act 1994 and other associated Acts – In April 2016, the proposed registration of RHDV1 K5 as a Restricted Chemical Product (subject to the favourable review of additional information – APVMA s159 and public consultation).

Once all these approval processes are signed off, the release, when it occurs, will be coordinated by operational leads in each state and territory with oversight by the Invasive Plants and Animals Committee.

To keep up to date on the progress of these approval processes please sign up to our monthly RHD Boost update at: *www.pestsmart.org.au/subscribe/*. Be sure to click on RHD Boost updates when signing up online.

5. Get involved

The Invasive Animals CRC and partners are urging landholders, farmers, community groups and councils across the country to express their interest to participate in the final stages of the research to support the release of RHDV1 K5. If you would like to be involved as a monitoring site, then please follow these steps:

Contact your neighbours

The project team is looking for groups of landholders to be involved in the release, therefore if you want to be involved you should contact you neighbours to confirm they would like to be involved too. You can use existing groups for this such as your local Landcare group or other Natural Resource Management group.

It is important to note that different states and territories may have different regulations around the handling and release of the virus; you will need to make sure your group contains the appropriate authorised person (see *Persons authorised to access RHDV1 K5 within each state and territory*, page 11).

Identify a group coordinator

Identify someone in the group that will be the point of call within the project team and who will be responsible for collating group data and samples.

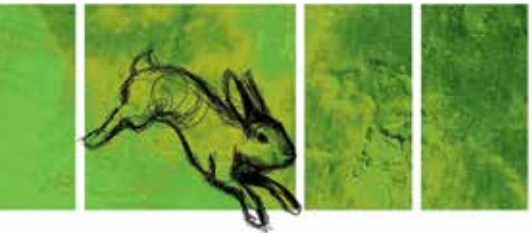
Determine what type of site you want to be

There are two types of sites: **Release sites** and **Broad-scale sites**.

Broad-scale sites: undertake a three-night spotlight count with a vehicle using standard methods. The transect must be a minimum of 1km and cover at least 25% of the site where the release is to take place (such as the paddock). Samples also need to be taken from 20 shot rabbits prior to release. Information on what and how to collect will provided after sites are selected.

Release sites: must undertake some form of assessment of their rabbit population prior to release (eg spotlight count or dung count). Shot samples are not required and there are no minimum site requirements.

Rabbit dung heap.
Image: Keryn Lapidge



Contact the project team

Once your group has been confirmed and the site types determined, the group coordinator should register your interest with the project team by completing the online expression of interest form at:

www.pestsmart.org.au/get-involved-as-a-monitoring-site/

Expressions of interest close May 31st 2016

The selection process

Sites will be selected strategically in consultation with rabbit experts from each state. Due to a cap on the number of free vials that are available, priority will be given to sites that are known to be rabbit prone, are not within 50km of another release site and are placed to ensure maximum coverage of areas where rabbits are distributed. Ideally, monitoring sites will be selected from various rabbit affected locations around Australia to enhance spatial replication and ensure its effectiveness in various habitats and climates. Sites will be selected mid 2016 and the project team will be in contact with all EOI applicants to advise them of the outcome in July 2016.

So far, the team has received expressions of interest from numerous locations around Australia (Fig.1). If you are located in a rabbit prone area, especially where we have received limited expressions of interest; please feel free to get involved via the aforementioned processes.

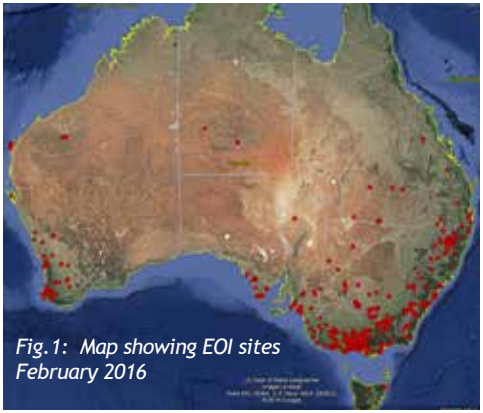


Fig.1: Map showing EOI sites February 2016

Manufacture and distribution

RHDV1 K5 will be manufactured at the Elizabeth Macarthur Agricultural Institute (EMAI), which is the NSW Department of Primary Industries (NSW DPI) Centre of Excellence for Animal and Plant Health.

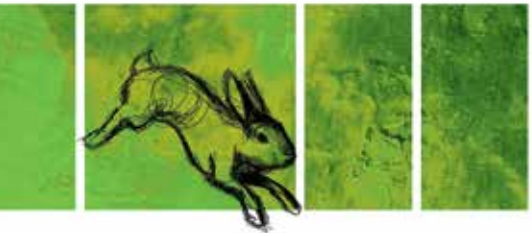
RHDV1 K5 will be delivered to the authorized officers, in each state where monitoring sites are established, after the registration and release of RHDV1 K5 has been approved by the APVMA and a release date has been confirmed. Further information on distribution and release will be provided through the RHD-Boost newsletter and on the PestSmart site:

www.pestsmart.org.au/boosting-rabbit-biocontrol-rhdv-k5-national-release/

Persons authorised to access RHDV1 K5 within each state & territory

For the purposes of supply and use of product RHDV1 K5, an 'authorised person' is defined as follows for each State/Territory:

New South Wales	Persons who have undergone appropriate training and been approved as Authorised Control Officers (ACO's) by the Department of Primary Industries.
Queensland	Authorised officers of the Department of Agriculture and fisheries and Local Government.
Victoria	In fee-for-service situations, authorised users include those holding a Commercial Operators Licence with vermin destroyers endorsement or Pest Control Licences authorising the use of pesticides formulated for the control of pest animals. Authorised users for aerial application are those holding a Pilot (Chemical Rating) Licence. In other situations, the use of RHDV is not restricted, meaning it may be used and supplied to any person within Victoria.
South Australia	Authorised officers under the *Natural Resource Management Act (2004)* who: 1. Have successfully completed the Vertebrate Pest Management Course, 2. Are suitable qualified officers of the Department of Environment, Water and Natural Resources or Biosecurity SA.
Tasmania	Officers of the Department of Primary Industries, Water and Environment, and persons who hold an Agricultural Spraying Permit issued under the Tasmanian *Agricultural and Veterinary Chemicals (Control of Use) Act 1995*.
Western Australia	Persons, Licenced Pest Management Technicians, officers of the Department of Agriculture and Food and Department of Parks and Wildlife who have undergone appropriate training offered by the Department of Agriculture and Food and are licenced by Department of Health under the Health Pesticides Regulations.
Northern Territory	An authorised person appointed by the NT Chemical Coordinator under the *Agricultural and Veterinary Chemicals (Control of Use) Act*.
Australian Capital Territory	Authorised ACT Government Officers who have completed appropriate training as determined by the ACT Environment Protection Authority.



State and territory coordinators for RHDV1 K5 project

State / Territory	Name	Organisation	Email
NSW	Quentin Hart	NSW DPI	quentin.hart@dpi.nsw.gov.au
QLD	Peter Elsworth	QLD DAF	Peter.Elsworth@daf.qld.gov.au
Victoria	John Matthews	DEDJTR	john.matthews@ecodev.vic.gov.au
SA	Greg Mutze	PIRSA	Greg.Mutze@sa.gov.au
Tasmania	Michael Askey-Doran	DPIPWE	michael.askey-doran@dpipwe.tas.gov.au
WA	Susan Campbell	DAF	susan.campbell@agric.wa.gov.au
NT	Peter Saville	DPIF	Peter.Saville@nt.gov.au
ACT	Oliver Orgill	ACT TMS	oliver.orgill@act.gov.au

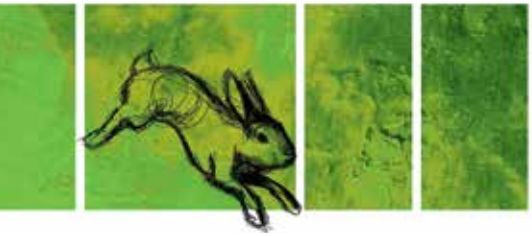
Image: Tarnya Cox

6. Get involved with monitoring using *RabbitScan*

You can get involved in monitoring rabbit activity using *RabbitScan*, a web-mapping program and App for landholders to record rabbit activity in their local area. This can be used to help decide where to do control, and coordinate control with neighbours. Rabbit counts can be mapped in *RabbitScan* before and after the release of RHDV1 K5, and the program will also soon display a rabbit disease outbreak map to show where rabbit biocontrol viruses are active.

- Record sightings, warrens, dung heaps, impacts, and control activities (such as baiting or warren ripping).
- Join or create a landholder group online to keep your members informed about current rabbit problems, and work together.
- Receive updates about rabbit activity and local control programs.
- Use data recorded in your region to help decide where to undertake rabbit control. *RabbitScan* also contains many resources and links to many groups.
- You can also download the Apps onto your smartphone or tablet and use offline when no data connection is available.

Visit www.rabbitscan.org.au to download the FeralScan Pest Mapping Mobile App for iOS or Android



7. Key take-home messages

1. Rabbits are estimated to cost over $200 million in lost agricultural production every year. They compete with grazing stock for food, contribute to soil erosion and destabilise the structural integrity of the land potentially leading to injury of livestock.

2. Rabbits are linked to the decline of native animals and plant species throughout their range. It is suggested that rabbits impact on 304 threatened species in Australia.

3. RHDV1 K5 is a variant of rabbit haemorrhagic disease virus (RHDV1) that causes a fatal haemorrhagic disease in the European rabbit (*Oryctolagus cuniculus*). Importantly, it is specific to the European rabbit.

4. RHDV1 K5 is spread by insect vectors, such as bushflies and blowflies. Direct contact between a rabbit and a rabbit carcass with RHDV1 K5 is also an avenue of spread. Animals that prey on rabbit carcasses such as foxes, dogs and cats may also excrete the virus in their faeces.

5. No variant of RHDV1 (including RHDV1 K5) has ever been found to cause infection in any other animal except the European rabbit (*Oryctolagus cuniculus*). Even predatory animals that eat rabbits that have died from RHDV1 do not develop an infection.

Image: Rebecca Zanker

6. RHDV1 K5 is expected to work in all areas, but the greatest benefits are expected to occur in the cool-wet regions where RHDV1 v351 was less effective. An endemic benign calicivirus occurs in these locations and temporarily protects rabbits from RHDV1 v351.

7. While it's difficult to predict exact knockdown figures, we expect that there will be improved knockdown in areas where RHDV1 v351 is less effective. Knockdowns could be improved anywhere from 0-40% depending on the location of the rabbit population and the number of susceptible animals within the population.

8. RHDV is one of the more humane methods of controlling wild rabbits. Rabbits basically end up with 'cold-like' symptoms. Post-infection, there may be a rise in body temperature

after 24 hours and the animal may exhibit signs of lethargy. In the majority of animals, no symptoms are observed. After the onset of fever, death occurs within 6-12 hours in 70-90% of cases. (see *Humaneness assessment: bait delivery of RHDV*). The overall welfare impact prior to death has been assessed as low using the relative humaneness model developed under the Australian Animal Welfare Strategy.

9. There is a vaccine that has been shown to be effective against disease from RHDV1 K5.

10. Community assistance with the spread of RHDV1 K5 will help ensure that the virus reaches as many rabbit populations as possible and that the best possible knockdown is achieved.

11. RHDV1 K5 is not a silver bullet so the community must take advantage of its knockdowns by following up with conventional control tools to achieve sustainable long-term control.

12. Consider *RabbitScan* for your local area to map rabbit problem areas, and to help coordinate control after RHDV1 K5 to maximise the long-term benefits of the virus release.

Rabbit warren. Image: John Borg

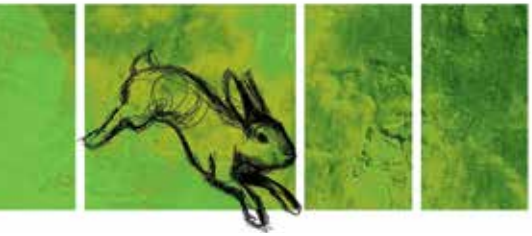


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Image: Neil Schultz

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