# Rabbit Hemorrhagic Disease

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## Introduction

The etiologic agents of rabbit hemorrhagic disease (RHD) are rabbit hemorrhagic disease viruses (RHDVs). These highly contagious viruses are members of the viral family Caliciviridae, genus *Lagovirus* (Schoch et al. 2020) and negatively affect various lagomorph species, often causing high mortality rates in select taxa. While other lagomorph-associated caliciviruses exist, we focus on RHDV (also known as classical RHDV including subtype RHDVa) and RHDV2 (also know as subtype RHDVb and RHDV serotype 2) within this chapter, with a major emphasis on recent outbreaks of RHDV2 in wildlife in North America. Although the bulk of the research associated with environmental persistence, viral shedding, and transmission has been directed towards classical RHDV, RHDV2 is thought to have similar traits (USDA 2020*a*). As will be evident in this chapter, the environmental stability of RHDVs can be so long that the epidemiology of these viruses in wild populations can be quite complicated. This disease is a classic example of the dangers associated with the introduction and establishment of a foreign animal pathogen transmitted from domestic animals into wildlife (Tom Gidlewski, personal observation).


Rabbits, hares, and pika represent the major lagomorph taxa found throughout much of the world. Illustration by Laura Donohue.

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## Emergence of RHDV and RHDV2

An outbreak of a viral-induced disease in adult rabbits imported from Germany was reported in Jiangsu province of the People's Republic of China during early 1984 (Liu et al. 1984, Chasey 1994). This observation presumably represents the first documented case cluster of RHD in farmed rabbits. Likely based on the importation mentioned above, it has been suggested that RHDV emerged in Europe during the 1970s or 1980s (CFSPH 2020). The European rabbit (*Oryctolagus cuniculus*) is the source of dozens of breeds of commercial and pet rabbits, and RHDV initially caused disease in only this species. During the 1980s, the virus spread to other parts of Asia, Europe, North Africa, and to the New World (Abrantes et al. 2012).

While it did not become established at all locations where it was introduced, RHDV eventually affected countries in a nearly worldwide distribution (Abrantes et al. 2012) (Figure 15.1). Prior to the emergence of RHDV2, RHDV was thought to have been responsible for the mortality of nearly 250 million free-range European rabbits and domestic rabbits (McIntosh et al. 2007). This estimate from 2007 is now undoubtedly low. Other studies have indicated that between 1987 and 1990, RHDV was responsible for the death of millions of rabbits in Italy alone (Capucci and Lavazza 1998).

During the summer of 2010, a new serotype of RHDV emerged in France (Le Gall-Reculé et al. 2011), now known as RHDV2. Following the initial detection, the virus spread throughout Europe and reached Australia by 2015 (Mahar et al. 2018). The first detection of RHDV2 in North America occurred in Quebec, Canada, during 2016 in domestic rabbits associated with small farms (USDA 2019, Ambagala et al. 2021). In 2018, RHDV2 was confirmed in feral domestic rabbits in British Columbia, Canada (USDA 2018, Ambagala et al. 2021). That same year, a virus closely related to the 2018 Canadian virus was detected in a pet rabbit in Ohio, USA (USDA 2019). The following year, RHDV2 was detected in domestic and feral rabbits on Orcas Island, Washington,

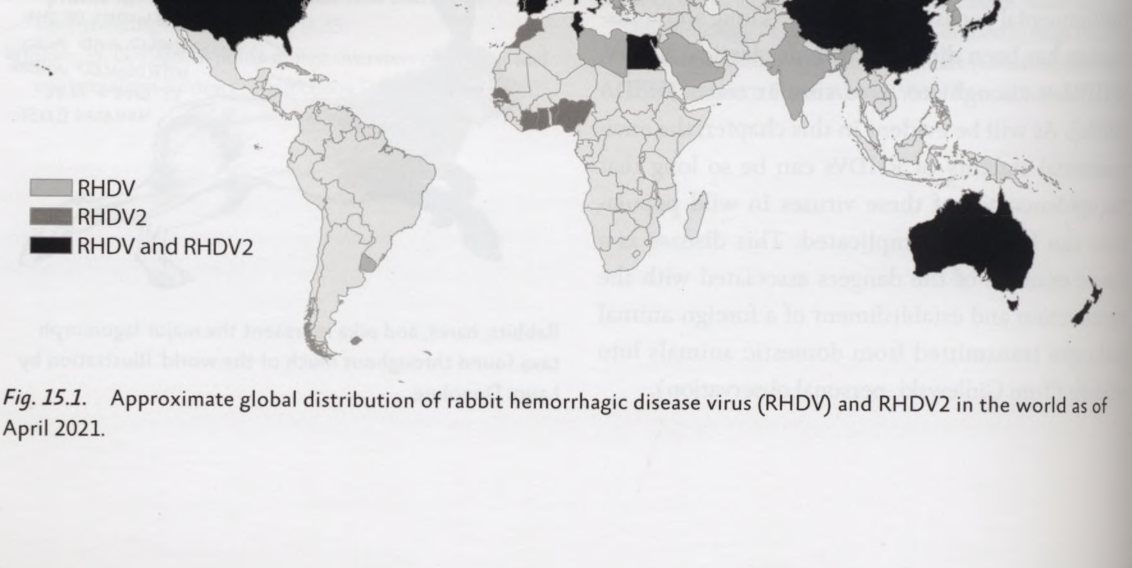


*Fig. 15.1.* Approximate global distribution of rabbit hemorrhagic disease virus (RHDV) and RHDV2 in the world as of April 2021.

USA (USDA 2019). During early 2020, RHDV2 was confirmed in a domestic rabbit in New York, USA. Subsequently, a major outbreak of RHDV2 in domestic rabbits and native North American lagomorphs, primarily including jackrabbits (*Lepus* spp.) and cottontails (*Sylvilagus* spp.), was reported from the southwestern United States and Mexico during the spring of 2020 (Figure 15.2). The initial detections in the United States were reported from New Mexico, USA. At the time of this writing, RHDV2 has been confirmed in more than 10 US states, as far east as Florida and as far north as Montana. Thus, it appears RHDV2 may still be expanding its distribution throughout North America (Duff et al. 2020), as susceptible wild and domestic hosts are widely distributed. RHDV2 may have a competitive advantage over RHDV in areas where RHDV has been previously established because RHDV2 has a broader host range, the capacity to infect young animals, and the ability to infect and cause mortality in rabbits that have antibodies to classical RHDV (Peacock et al. 2017, Taggart et al. 2022).

## Rabbit Hemorrhagic Disease Virus Introductions

Precisely how RHDV and RHDV2 were introduced into new countries located significant distances from endemic countries is poorly understood, including the recent introduction of RHDV2 into North America. However, importation of rabbit meat from the People's Republic of China is believed to be one source (Gregg et al. 1991, McIntosh et al. 2007). Some introductions of RHDV have been accidental, such as from field trials on an island spilling over to the mainland (i.e., Australia); others have been illegal introductions (i.e., New Zealand) (O'Hara 2006, Effler 2015). It has been suggested that the rapid spread of RHDV2 to many countries would not have been possible without human assistance (Rouco et al. 2019). As outlined

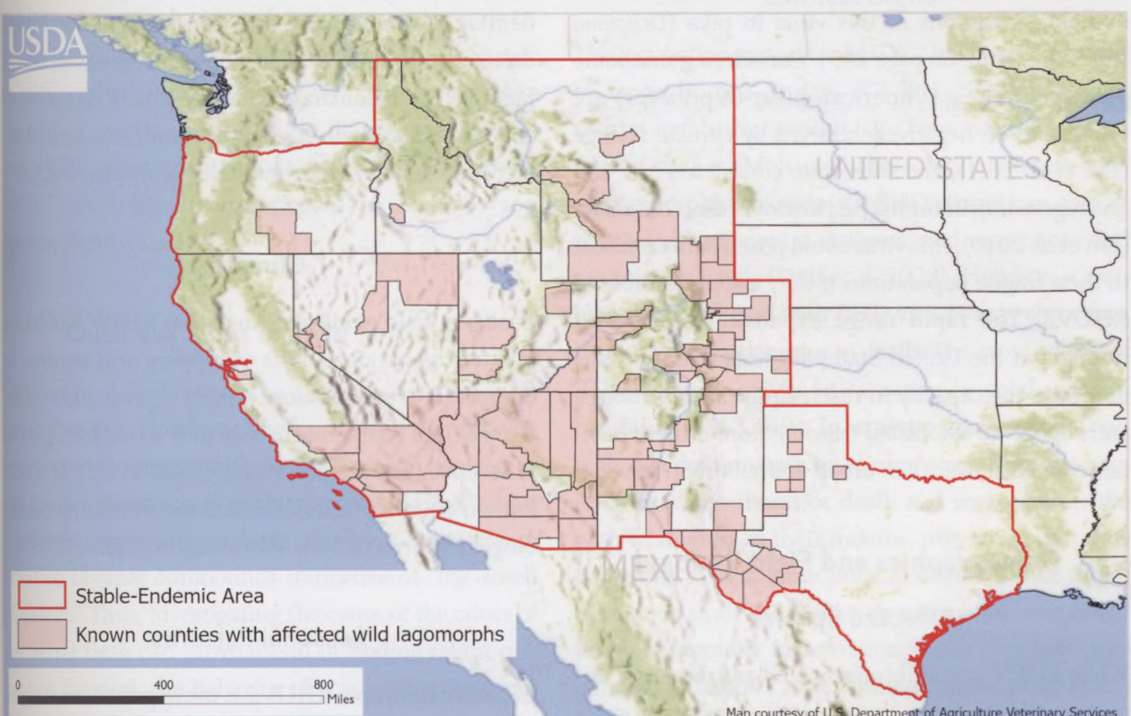


*Fig. 15.2.* Distribution of rabbit hemorrhagic disease virus 2 in wild lagomorphs in the continental United States as of 8 July 2021.

below, there are many anthropogenic and natural factors that could result in the dispersal of RHD viruses.

## Etiology

While RHDV infections in wild lagomorph species are largely limited (e.g., primarily wild European rabbits), RHDV2 has a broader host range. For example, while RHDV did not cause disease in select experimentally infected North American lagomorphs (Lavazza et al. 2015, Mohamed et al. 2022), RHDV2 does cause mortality in many naturally infected North American lagomorph species including cottontails (*Sylvilagus* spp.) and jackrabbits (*Lepus* spp.). An additional major distinction between the two viral serotypes is that young rabbits (<6–8 weeks) tend to be resistant or subclinical in regards to RHDV but are susceptible to RHDV2 (2–3 weeks and older) (OIE 2019).

While multiple rabbit and hare species are susceptible to RHDV2, we are unaware of any experimental or field evaluations of this virus in pika (*Ochotona* spp.; see picture on page 259). Considering that some pika species (e.g., American pika; *O. princeps*) are thought to be negatively affected by climate change (Erb et al. 2011), and others are considered rare and endangered lagomorphs (e.g., Kozlov's pika, *O. koslowi*) (Lin et al. 2010), this virus could pose a serious threat to their fragile populations if they are susceptible to RHDV2. The rapid range expansion of RHDV2 throughout the United States suggests that the virus may have the capacity to reach alpine sites, although anthropogenic-associated transmission to these habitats could be lower than urban and suburban areas.

## Demographics and Field Biology

### Affected Species

While RHDV primarily affects wild and domestic European rabbits (note that a small number of cases have been reported in Iberian hares, *Lepus granatensis*; Lopes et al. 2014), RHDV2 has a broader host range and has had negative impacts on rabbits and hares in both the Old and New Worlds. Some examples of species affected by RHDV2 include domestic and feral European rabbits, desert cottontails (*Sylvilagus audubonii*), mountain cottontails (*S. nuttallii*), eastern cottontails (*S. floridanus*), brush rabbits (*S. bachmani*), riparian brush rabbits (*S. bachmani riparius*), black-tailed jackrabbits (*Lepus californicus*), antelope jackrabbits (*L. alleni*), and pygmy rabbits (*Brachylagus idahoensis*) in the New World (USDA 2020*b*, Mohamed et al. 2022) and wild, feral, and domestic European rabbits, brown hares (*Lepus europaeus*), Italian hares (*L. corsicanus*), Iberian hares, and cape hares (*L. capensis*) in the Old World (Puggioni et al. 2013, Camarda et al. 2014, Hall et al. 2017, Velarde et al. 2021) (Table 15.1). The fact that the viral host changed over time demonstrates the need to be ever vigilant to the adaptable nature of viruses (Tom Gidlewski, personal observation).

There have been reports of RHD viruses in species outside of the order Lagomorpha (e.g., mammalian orders Artiodactyla, Carnivora, Eulipotyphla, and Rodentia) (Calvete et al. 2019, Bao et al. 2020, Abade dos Santos et al. 2022). In some of these cases, it was possible to demonstrate RHD virus or RHD nucleic acid associated with lesions; however, cause and effect has not been experimentally demonstrated.

### Climate

Based on field studies in Australia, RHDV has had a greater impact on rabbits occupying arid regions as compared to cooler, more humid regions; therefore, climate and temperature may play a role in regional differences in infection rates (Cooke 2002). It is unknown whether RHDV2 will show similar epidemiologic patterns in New World lagomorphs.

### Seasonal Patterns

In parts of Europe, RHDV2 is more prevalent in late spring, while previous observations of RHDV cases (prior to its apparent replacement by RHDV2) were more common during the fall (Duff et al.

*Table 15.1.* Examples of lagomorph species that have been negatively affected by rabbit hemorrhagic disease virus 2 as of July 2021 (see page 262 for more examples.)

| Common name | Scientific name | Status | Reference |
|---|---|---|---|
| European rabbit | *Oryctolagus cuniculus* | Wild, domestic, feral | Camarda et al. 2014, USDA 2020*b* |
| Desert cottontail | *Sylvilagus audubonii* | Wild | USDA 2020*b* |
| Mountain cottontail | *Sylvilagus nuttallii* | Wild | USDA 2020*b* |
| Eastern cottontail | *Sylvilagus floridanus* | Wild, experimental | USDA 2020*b*, Mohamed et al. 2022 |
| Western brush rabbit | *Sylvilagus bachmani* | Wild | USDA 2021 |
| Black-tailed jackrabbit | *Lepus californicus* | Wild | USDA 2020*b* |
| Antelope jackrabbit | *Lepus alleni* | Wild | USDA 2020*b* |
| Brown hare | *Lepus europaeus* | Wild | Hall et al. 2017, Velarde et al. 2017 |
| Italian hare | *Lepus corsicanus* | Wild | Camarda et al. 2014 |
| Cape hare | *Lepus capensis* | Wild | Puggioni et al. 2013 |
| Iberian hare | *Lepus granatensis* | Wild | Velarde et al. 2021 |

2020). Surveillance of wildlife for RHDV2 infections in the United States has been based largely upon mortality events during 2020–2021. Currently, unless a new wild lagomorph species presents with a probable RHDV2 infection, cases in wildlife are generally not confirmed in counties that have already had positive wild lagomorphs or domestic rabbits. As a result, identifying temporal trends in cases in wildlife populations in the United States is difficult at present. However, domestic rabbit mortality events in the United States from February 2020 to June 2021 peaked in the spring, similar to what has been reported in Europe (see above; Figure 15.3).

## Outbreak Signs in Field Settings

Outbreaks of RHD viruses may go unnoticed in rural environments. However, when enhanced surveillance is warranted, some simple techniques can be used to aid in the detection of rabbit carcasses. First, rabbit carcasses, especially in large numbers, will release volatile organic compounds indicative of "the smell of death." Thus, investigating the cause of the odors of decaying flesh can prove useful in finding rabbit carcasses. Second, the behavior of scavenging birds can also aid in finding lagomorph mortalities, especially when animals have recently expired. Similarly, observations of increased numbers of mammalian scavengers could aid in the detection of rabbit carcasses, but they may not be as visible as scavenging birds. Depending on how quickly carcasses are consumed, scavenging animals can also hinder searches for deceased lagomorphs in field settings.

## Clinical Signs

The incubation period for RHDV2 has been estimated to range from 3–5 days (CFSPH 2020), although shorter incubation periods have been noted in experimental studies (Mohamed et al. 2022). Clinical signs of lagomorphs infected with RHD viruses can consist of ataxia, inappetence, dullness, and respiratory and neurological signs (Duff et al. 2020). Highly susceptible rabbits infected with RHD viruses may show few, if any, clinical signs prior to death. The rapid course of RHD typically results in carcasses in good physical condition (OIE 2019). In experimental settings, animals can demonstrate no clinical signs until they are discovered moribund or dead, and some rabbits die with fresh grass in their mouths, suggesting that they had eaten a short time prior to death (Cooke 2002, Mohamed et al. 2022). Bloody nares have been noted in experimentally infected cottontails that have succumbed to RHDV2 infection (Mohamed et al. 2022) and have been suggested as an indicator of RHDV in various species (Cooke 2002). Because of this striking sign, bloody discharge from the nose or mouth may be

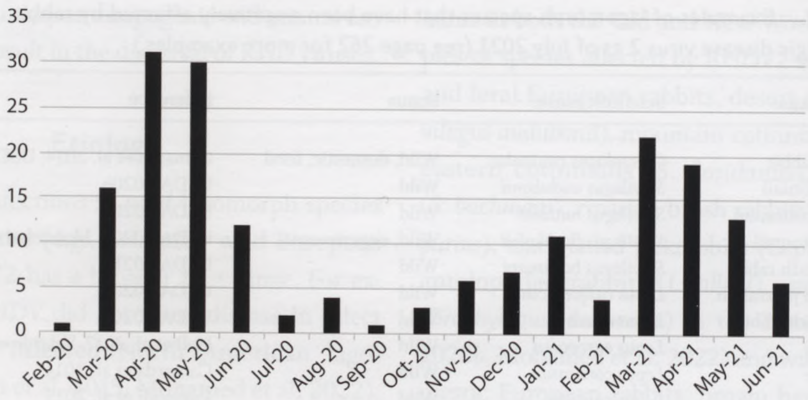


*Fig. 15.3.* Approximate monthly rabbit hemorrhagic disease virus 2 (RHDV2) domestic rabbit mortality events reported in the United States from February 2020 to June 2021. This timeframe represents the initial detections and the expansion of the RHDV2 outbreak that was first documented in the southwestern United States. This figure is based upon the mortality start dates of mortality events reported to the US Department of Agriculture, Animal and Plant Health Inspection Service.

*Fig. 15.4.* Bloody discharge (i.e., epistaxis) associated with the nares of rabbits that succumbed to rabbit hemorrhagic disease. Images by Fawzi Mohamed.

a useful field indicator when no apparent signs of trauma are noted (Figure 15.4).

## Pathogenesis and Pathology

The primary RHD lesions in rabbits are acute necrotizing hepatitis (Abrantes et al. 2012), splenic enlargement, and hemorrhages caused by disseminated intravascular coagulation (Henning et al. 2005, OIE 2019). Concurrent experimental infections of New Zealand white rabbits and eastern cottontails with RHDV2 demonstrated very similar lesions in both species (Mohamed et al. 2022). The onset of clinical signs and death appeared 24–36 hours sooner in New Zealand white rabbits inoculated with RHDV2 compared to eastern cottontail rabbits (Mohamed et al. 2022).

## Diagnosis

The definitive diagnostic tests for RHD infection in US lagomorphs are the antigen enzyme-linked immunosorbent assay (AG-ELISA) and reverse transcription-polymerase chain reaction (RT-PCR).

Some specific AG-ELISAs can distinguish which RHD virus may be present. The RT-PCR assay distinguishes between RHDV and RHDV2 (OIE 2021*b*). Electron microscopy, hemagglutination testing, immunostaining, western blot, and rabbit inoculation can also be used to identify virus. Diagnostic assays are limited, as neither RHDV nor RHDV2 can be grown in cell culture (CFSPH 2020); the virus can only be propagated by animal inoculation.

The highest titers of virus are found in the livers of infected animals during acute or peracute disease. Virus can also be detected in spleen, serum, and various bodily excretions (OIE 2019). Liver is usually considered the best diagnostic tissue for collection from intact rabbit and hare carcasses to diagnose RHD.

## Outcome and Treatment

There is no practical treatment for RHD at this time; however, the potential use of small-molecule inhibitors as a treatment has been reported (Perera et al. 2022). Nonetheless, not all animals infected with these viruses succumb to their infections. For example, survival in both field and experimental infection studies have been reported for RHDV (Cooke 2002). In addition, 2 of 5 (40%) eastern cottontails (*Sylvilagus floridanus*) experimentally infected with RHDV2 survived infection (Mohamed et al. 2022). Among animals that survive, it is unknown how long those animals maintain infectious virus (OIE 2019). Based upon a highly sensitive PCR assay, however, viral RNA persistence (which does not always indicate the presence of live virus) has been documented for up to two months for rabbits that have recovered from RHD (OIE 2019). It would be of interest to know if New World lagomorphs that recover from RHDV2 infections have similar survival probabilities as compared to naïve animals (Figure 15.5). If New World lagomorph survival following RHDV-2 infection is confirmed in multiple species, serosurveys coupled with survival analyses could be used to help address the long-term impacts of this virus on wild lagomorph populations.

## Management

The management of RHD viruses in wild lagomorph populations poses many challenges. The populations of certain lagomorphs (e.g., rabbits and hares) can be very large, animals within these populations can have overlapping home ranges, and the perimeter of a population is not readily definable unlike other wild mammalian disease systems (e.g., prairie dogs, *Cynomys* spp., and *Yersinia pestis*). The management of RHD viruses is complicated by the stability of the virus in rabbit carcasses and meat. This suggests mechanical vectoring by humans (e.g., movement of the virus on

*Fig. 15.5.* A pair of desert cottontails (*Sylvilagus audubonii*) foraging within close proximity to each other. As rabbit hemorrhagic disease virus 2 (RHDV2) is highly contagious and environmentally stable for long periods of time, close contact and/or environmental contamination may facilitate transmission. Experimental infections suggest that some *Sylvilagus* spp. exposed to RHDV2 may survive their infections (Mohamed et al. 2022).

clothes, shoes, and equipment) and by predators and scavengers, as well as mechanical transmission from insects may all contribute to virus spread and new outbreaks (Chasey 1994, Asgari et al. 1998, Cooke 2002, McColl et al. 2002, OIE 2019) (Figure 15.6). In many ways, foreign animal disease introduction and establishment in wildlife is a worst-case scenario. Our management options are severely limited, and we very well may have an established reservoir forever (Thomas Gidlewski, personal observation).

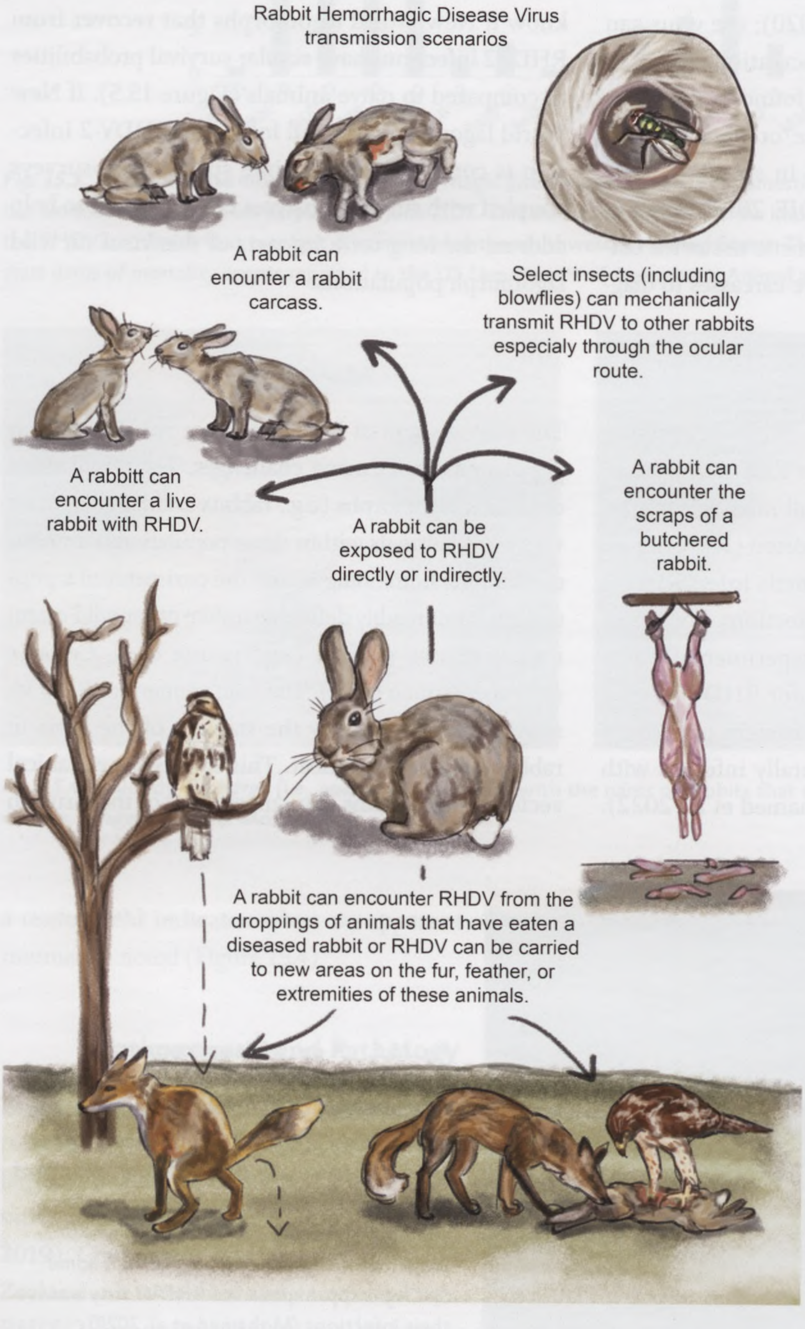


*Fig. 15.6.* Several transmission scenarios have been proposed and are possible for rabbit hemorrhagic disease viruses (RHDVs). Illustration by Laura Donohue.

## Environmental Stability

The environmental stability of RHD viruses presents a major challenge to management. Homogenized liver supernatant from samples collected from rabbit carcasses at 20 days post-mortem contained sufficient live virus to kill naïve rabbits (McColl et al. 2002). Laboratory experiments conducted at cool temperatures (4°C) have indicated that the virus can survive for at least 225 days in organ suspensions; survival times of at least 2 days were noted for organ suspensions and virus placed in a dry state when temperatures were increased to 60°C (Šmíd et al. 1991). An additional study reported that RHDV can remain viable in animal tissues for at least three months in field settings, but dried excreted virus remained viable for a shorter period (e.g., <1 month) (Henning et al. 2005). Overall, these studies suggest that the long-term survival of RHDV in carcasses and tissues may help to maintain RHDV in lagomorph populations, even in the absence of active infections (Henning et al. 2005). Indeed, assuming optimal conditions for virus survival, it is conceivable that a wild population could become reinfected months after an epizootic has ended.

## Virus Dispersion by Non-lagomorph Species

While they are not thought to have the capacity to replicate the virus (but see recent information on this topic in the affected species subsection above), predators and scavengers can excrete RHDV in fecal material following the consumption of infected rabbits (OIE 2019). It has been suggested that RHDV may survive on feet, claws, and regurgitated materials of scavenging birds (Chasey 1994). Thus, it is reasonable to assume that the same scenario may be possible for RHDV2. Depending on the mobility of the animal species in question, this represents a possible mechanism for the moderate to reasonably long-distance movement of the virus. While the chance of this type of transmission event may be small (Chasey 1994), raptors predating or scavenging on RHD infected rabbits or carcasses and subsequently moving the virus significant distances could help explain the "jumps" in the distribution of known RHDV2 cases in the United States during early 2020 to 2021. While natural transmission pathways have certainly expanded the distribution of RHDV2, anthropogenic pathways likely played a significant role in spread in the United States.

## Mechanical Transmission from Insects

Insects (e.g., mechanical vectors), as well as the microclimates and vegetative characteristics that influence their density, have been suggested to be involved in small-scale patterns of spread of RHDV (Henning and Davies 2005). For example, various insects were suggested as potential mechanical vectors for the movement of RHDV out of a quarantine enclosure on Wardang Island, Australia (Cooke 2002). Furthermore, oral and anal excretions from flies have been suggested as a potential transmission mechanism to rabbits via the oral or conjunctival routes (Asgari et al. 1998). Overall, many insect species and taxonomic groups can be contaminated with RHDV (Cooke 2002).

## Citizen Science

Considering that moribund rabbits and rabbit carcasses can be quickly removed from the landscape by predators and scavengers and that many rabbits may die underground (Duff et al. 2020), outbreaks of RHD could go unnoticed in some situations. This provides an excellent opportunity for citizen science to play a significant role in wildlife management, as few agencies have the staff needed to survey the vast habitat of native rabbit species. Outreach to encourage the general public to report dead and moribund rabbits could be a high priority for any region with lagomorphs that may become infected. Citizen science in the form of organized hikers, hunters, and other types of outdoor enthusiasts with a prearranged on-line reporting system could be extremely valuable for the early detection of case clusters. Notably, citizen science efforts from rabbit hunting events in New Zealand proved to be a useful and inexpensive method to obtain large quantities of data from a vast geographic region regarding potential RHDV effects in rabbit populations (Rouco et al. 2014).

### Field Biosecurity

When working with wild lagomorphs, it is important to consider the potential for people and their equipment to spread RHD viruses. At a minimum, equipment should be decontaminated, and clothing should be sanitized whenever the location of study sites changes. RHDV can be inactivated with a household bleach solution diluted with water with appropriate contact time (USDA 2020*a*). See additional guidance on this topic (e.g., disinfectants, dilutions, contact time, and personal protective equipment) from the US Department of Agriculture (USDA 2020*a*).

During the US RHDV2 outbreak, field necropsies of rabbit carcasses have been discouraged to avoid the unintentional spread of the virus; rather, it has been recommended that carcasses be contained in at least two layers and transferred to a qualified laboratory with appropriate biocontainment for necropsy (USGS 2020). Considering that not every carcass discovered during a large mortality event will be submitted for diagnostic evaluation as well as the fact that RHD viruses can survive in carcasses for long periods (Henning et al. 2005), managing a large number of carcasses in an outbreak situation may become an issue. Some suggestions for dealing with carcasses include incineration or burial sufficient in depth to inhibit access by scavengers (USGS 2020). Caution should be exercised in dealing with carcass removal, packaging, or disposal, as rabbits are frequently infected with other pathogens, some of which are zoonotic (e.g., *Francisella tularensis* and other pathogens). Rabbit ectoparasites that can spread pathogens will leave to find a new host when a carcass begins to cool.

### Alternative Surveillance Systems

There may be value in utilizing carnivore sera as a means to assess the previous presence of RHD in rabbit populations following a rabbit population decline or when rabbits are not available to sample. Red fox (*Vulpes vulpes*) given oral doses of homogenized liver from rabbits that succumbed to RHD developed antibody responses that lasted for at least six months in some individuals (Leighton et al. 1995). Thus, assuming availability of appropriate serological assays, this surveillance method could be used to assess previous RHD activity at locations where lagomorph populations have experienced die-offs for unknown reasons. Serological pathogen surveillance programs in wild canids (e.g., coyotes, *Canis latrans*) have previously been used in the United States to estimate the prevalence of *Yersinia pestis* in various ecosystems (USDA 2010). Assuming the continued surveillance of coyotes for multiple pathogens and that they develop an antibody response, adding RHDV2 to the list of pathogens monitored could be a cost-effective means for large-scale surveillance.

### Vaccination

No licensed RHDV vaccines currently exist in the United States, but two killed vaccines (Filavac VHD K C+V and Eravac RHDV-2) from the European Union may be imported for use under special permit (USDA 2020*c*). However, as of the fall of 2021, a US vaccine manufacturer has received emergency use authorization for an experimental RHDV2 vaccine from the USDA. Injectable vaccines may have utility for protecting species or populations of concern to a limited extent (e.g., populations in enclosures, islands, or small populations). Strategic use of one of the European vaccines to protect listed and sensitive cottontail populations like riparian brush rabbits

(*Sylvilagus bachmani riparius*) began in 2021. In the absence of vaccines adapted for oral vaccination through a baiting program, the widespread use of vaccination to control RHD viruses in wildlife populations will remain limited.

## Financial, Legal, and Political Factors

### Financial

In Europe, RHDV2 has been responsible for significant economic losses to commercial rabbit production and to geographic regions where rabbit hunting has a large influence on the local economy (Rouco et al. 2019). While the rabbit industry in the United States is smaller in size than in some other countries, it is estimated to be worth over $2 billion (USD), the bulk of which is associated with pet rabbits and associated supplies (USDA 2020*b*) (Figure 15.7).

### Legal

At present, rabbit hemorrhagic disease is listed as a notifiable terrestrial animal disease by the World Organization for Animal Health (OIE 2021*a*). Within the United States, state and federal agricultural authorities should be informed of RHDV cases without delay (CFSPH 2020). Because RHDV2 affects both domestic and wild lagomorphs, state, tribal, and federal wildlife officials should be informed of any suspected or confirmed cases immediately.

In addition to the health of lagomorph populations, decimated populations of these species could negatively affect other trophic levels, especially predators that rely on rabbits and hares as a major food source. In Mediterranean Spain, the reduction in European rabbit populations (for which RHD viruses were thought to be at least partially responsible) has been implicated as a major threat to endangered predators that specialize on rabbits as a food source in this region (Moreno et al. 2004). Similarly, drastic declines in lagomorph populations in key regions in the United States could negatively affect select predators, potentially leading to changes in legal status under state and federal laws. For example, a preferred food of lynx (*Lynx canadensis*) is often snowshoe hares (*Lepus americanus*) (O'Donoghue et al. 1998).


*Fig. 15.7.* Domestic rabbits are popular pets in many countries. In situations where domestic rabbits are housed outdoors, wild and domestic rabbits could interact and spread pathogens to each other. Illustration by Laura Donohue.

### Political

Political factors associated with RHD viruses are more prevalent in countries or regions where the virus has been accidently, intentionally, or illegally introduced. Prior to 2020, RHDV2 was considered a foreign animal disease in the United States. However, now that it has become established in wildlife populations, RHDV2 is considered to be endemic and stable in certain US locations. Without the intervention of large-scale oral vaccination or other control programs, native lagomorph populations will continue to be at risk. Importantly, the United States has multiple lagomorph species that are of conservation concern. If RHDV2 were to severely affect these fragile populations, they could be at risk of extinction, a situation likely to provoke political action. A few potential impacts on policy and public resource use could involve restriction of public access and changes in hunting seasons and bag limits.

## Summary

With RHDV2 now established in the United States and spreading among and within wild rabbit and hare populations, population and ecosystem level impacts (including conservation issues involving rare and sensitive subspecies) may be realized. Currently, the only practical management tools available are vaccines, and as yet there is no broad scale ability to utilize them, because capture–vaccinate–release of individual animals is the only option at this time. It remains to be seen whether surviving lagomorph populations will develop tolerance or natural immunity.

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