Scottish Squirrel Health

Summary report of an expert workshop about health and disease in Scottish squirrels.

2026
JUN

Royal (Dick) School of Veterinary Studies, University of Edinburgh

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Executive Summary

The red squirrel, *Sciurus vulgaris*, is an iconic Scottish species of conservation concern and a key indicator of native woodland biodiversity.

Red squirrel populations are impacted by the viral disease squirrelpox, which is transmitted from the introduced invasive grey squirrel, *Sciurus carolinensis*, and they are also susceptible to leprosy and other disease conditions.

The ecology, extent and impact of diseases in both red and grey squirrels are deserving of greater research focus, to inform development of a wider, more refined set of species conservation and management tools.

This workshop was convened by the Royal (Dick) School of Veterinary Studies (R(D)SVS), University of Edinburgh, with the aims of reviewing current squirrel health monitoring and research activities in Scotland, identifying key health surveillance and broader research needs, and generating ideas for future collaborative monitoring and research. It was also anticipated that it would help inform a parallel review of Scotland's red squirrel conservation strategy, led by NatureScot.

Twenty experts in squirrel monitoring and research in Scotland attended the workshop, including representatives of the R(DSVS and the Roslin Institute, University of Edinburgh, Saving Scotland's Red Squirrels (SSRS) and the Scottish Wildlife Trust (the Trust), NatureScot, the Moredun Research Institute (MRI), Heriot-Watt University, National Museums Scotland (NMS), Forest Research and the University of Liverpool.

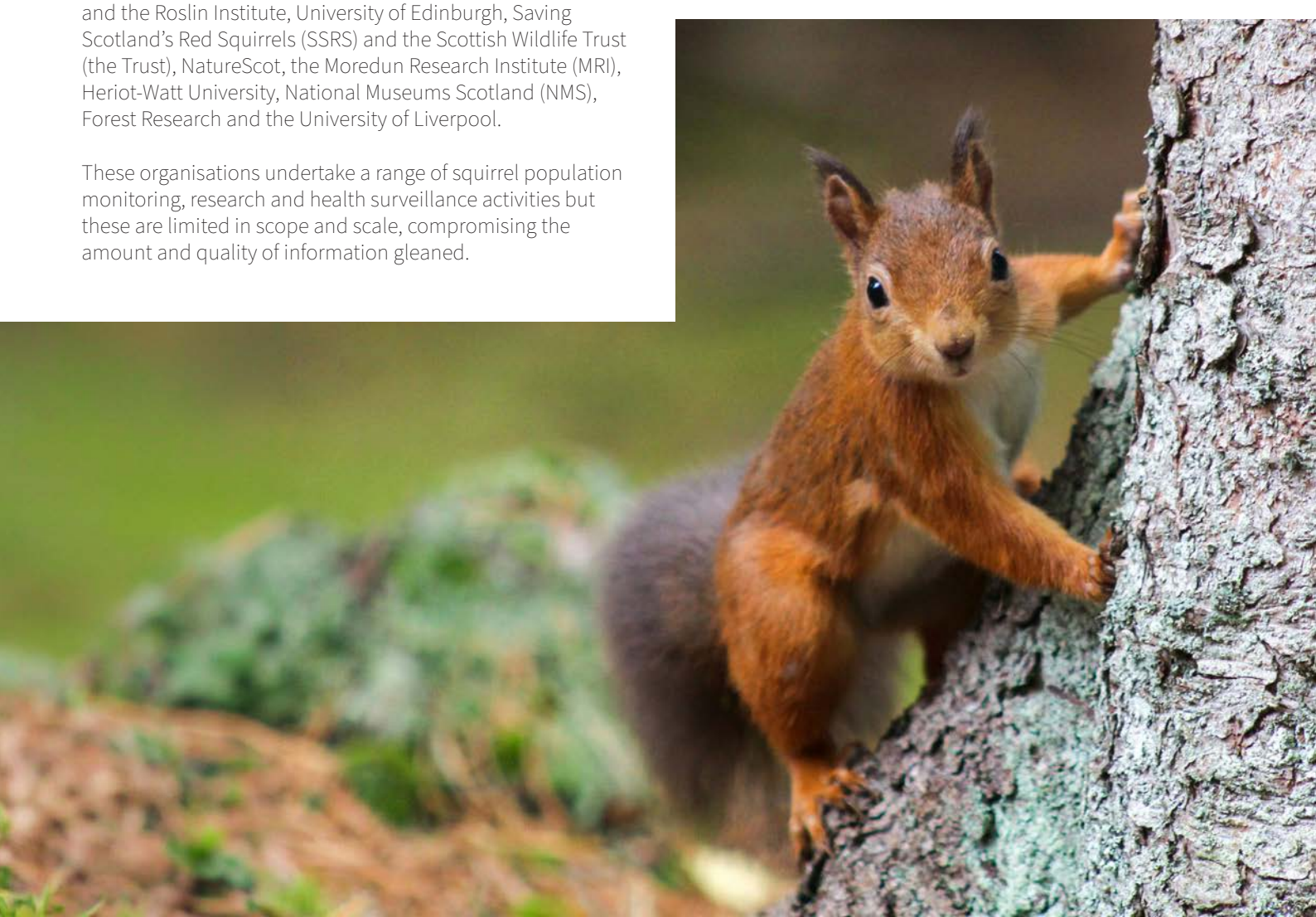
These organisations undertake a range of squirrel population monitoring, research and health surveillance activities but these are limited in scope and scale, compromising the amount and quality of information gleaned.

The expert group identified five key needs for enhanced monitoring and research into squirrel health and disease in Scotland:

1. Formation of a squirrel conservation research network
2. Creation of a centralised information hub
3. Enhanced population, genomic and disease monitoring, and sample acquisition
4. Enhanced interdisciplinary collaboration, and
5. Additional funding and manpower.

Health and disease concerns, and genetic diversity, must receive attention as part of red squirrel and wider ecosystem recovery efforts, since disease and low genetic diversity threaten the species' persistence.

Even with relatively low-level funding, notable progress could be made in forming an expert group, a hub and in enhancing interdisciplinary monitoring and research, but consistent financial support is needed for these to become a reality.



Background

There is huge potential for nature restoration in Scotland, embodied in the Scottish Government's target for Scotland to become Nature Positive by 2030.

This target includes recovery of 'vulnerable and important species and habitats'. One such species deserving of conservation focus is the red squirrel, *Sciurus vulgaris*.

This is an iconic species and key indicator of native woodland biodiversity; Scotland has become an important stronghold for the species as a consequence of marked declines elsewhere in the UK.

However, in recent decades the introduced invasive grey squirrel, *Sciurus carolinensis*, has colonised an increasingly large area of southern and central Scotland, leading to the complete loss of red squirrels from some areas through ecological competition and transmission of the disease squirrelpox, which is caused by squirrelpox virus.

The red squirrel is one of multiple Scottish species for which disease has become an increasingly important conservation threat. Added to disease, recent research has shown that Scottish red squirrels have extremely low genetic diversity which may be further compromising their ability to cope with this and other threats.

Squirrelpox was first diagnosed as a cause of mortality in red squirrels in southern Scotland in 2007, but has gradually moved northwards in association with grey squirrel population expansion.

Red squirrels are also susceptible to other disease conditions, including leprosy, pneumonia and other infectious diseases, and non-infectious conditions such as traumatic injury.

Disease is evidently a concern for red squirrel conservation, and some of these disease conditions, such as leprosy and tick-borne diseases, are of interest given that humans are also susceptible to them.

However, the ecology, geographical extent and population impact of many disease conditions in both red and grey squirrels remain poorly understood.

By furthering our understanding in these areas, we will potentially be able to develop a wider and more refined range of tools to conserve and manage squirrels, which would in turn have benefits for native woodland ecosystems.

Multiple organisations in Scotland, including the R(D)SVS, the MRI and the Trust have been monitoring, and researching issues relating to, squirrel health for decades. However, many of these activities are currently being conducted pro bono.

There is a need to both maintain and expand existing squirrel health monitoring and research. This in-person workshop was therefore intended as a means to:

- Review current squirrel health monitoring and research activities in Scotland
- Identify key surveillance and research needs
- Create a foundation for renewed and new collaborations in this field, and
- Generate ideas for future collaborative monitoring and research initiatives.

Furthermore, it was anticipated that the workshop outputs would help to inform a parallel process led by NatureScot of reviewing the Scottish Strategy for Red Squirrel Conservation.

Twenty experts with experience of squirrel health/population monitoring and research in Scotland attended the workshop. They included representatives of the R(D)SVS and the Roslin Institute, University of Edinburgh, SSRS and the Trust, NatureScot, the MRI, Heriot-Watt University, NMS, Forest Research and the University of Liverpool.

The participants had a wide range of expertise spanning the social sciences, ecology, zoology, animal health, conservation practice, invasive species management, mathematical modelling, and genomics.

Current activities, limitations and knowledge gaps

Information was collated on current activities the expert participants are undertaking relating to red squirrel health and disease, including through a number of presentations, and on the limitations of these activities and remaining knowledge gaps.

Current activities include those listed in Table 1 (below):

Table 1. Current activities undertaken by workshop participants and collaborators in relation to squirrel health and disease in Scotland

Activity	Organisation(s)[1]
Red squirrel conservation planning and oversight	NatureScot and SSRS
Population monitoring of red and grey squirrels	SSRS
Disease monitoring and diagnosis in red and grey squirrels	SSRS, R(D)SVS, MRI, APHA, UoL and others
Post-mortem examinations of red squirrels	R(D)SVS
Sample biobanking	R(D)SVS, NMS and others
Mathematical modelling of squirrel population interactions and disease epidemiology	Heriot-Watt University
Genomic, anatomical and ecological studies of squirrels	R(D)SVS, Roslin Institute, NMS and others
Grey squirrel control	SSRS and others
Early research into potential biotechnical tools for grey squirrel control	Roslin Institute
Research on public attitudes and perspectives on squirrel management and conservation	Forest Research

[1]SSRS – Saving Scotland's Red Squirrels; R(D)SVS – Royal (Dick) School of Veterinary Studies; MRI – Moredun Research Institute; APHA – Animal and Plant Health Agency; UoL – University of Liverpool; NMS – National Museums Scotland.

There are existing, longstanding collaborations between some of these organisations and with other bodies such as Forestry and Land Scotland, the Forestry Commission and other research institutes in the UK and overseas. The SSRS and others are also in frequent communication with volunteer squirrel groups and members of the public across Scotland.

However, current activities are limited in their scope and scale. For example, most current population and disease monitoring of both red and grey squirrels is ad hoc, which limits the information gleaned.

Current key surveillance activities and diagnostic testing have largely been carried out pro bono to date, including post-mortem examinations at the R(D)SVS and squirrelpox diagnostics at the MRI.

Consequently, squirrel carcasses received for post-mortem examination at the R(D)SVS are typically frozen on receipt, which reduces the likelihood of detecting novel or emerging disease conditions and compromises the quality of samples collected for further research.

There is also no formal network for communication between experts involved in squirrel health monitoring and research. Many important knowledge gaps remain, even regarding basic squirrel biology, that need to be understood to enable development of biotechnical and other management tools.

Other questions concern how disease-causing agents are able to persist in grey squirrel populations; squirrel-to-human and human-to-squirrel infectious disease transmission; associations between landscape management and disease risks; and the role of genetic diversity in the red squirrel's disease susceptibility.

Key needs

The expert group identified five main needs and ideas for enhancing collaboration, monitoring and research into squirrel health and disease in Scotland:

1. A squirrel conservation research network

A squirrel conservation research network should be formed to facilitate improved communication and coordination between squirrel experts in Scotland.

The group could help to identify and prioritise monitoring and research needs, and would promote more interdisciplinary collaboration. It should also link with the UK Squirrel Accord, which helps to coordinate squirrel-related activities between the four nations of the UK.

2. A centralised information hub

An information hub should be created as a focal resource for provision and sharing of information. It could include a list of experts working with squirrels and serve as a platform for sharing samples and data.

The expert group and hub should start with a Scotland focus but could be expanded in time to include other UK-wide stakeholders. Standardised sampling protocols and training resources could be developed by the expert group and be made available through the hub. As above, there are opportunities for collaboration with the UK Squirrel Accord.

3. Enhanced monitoring and sample acquisition

Enhanced population, genomic and disease monitoring is needed in both red and grey squirrels. This includes improved coordination between these activities, for example, to better understand the population-level impacts of disease.

Increased numbers of red squirrel carcass submissions from a wider geographical area in Scotland are also needed to achieve more comprehensive disease monitoring and to improve the likelihood of detecting novel disease threats to red squirrels; a higher submission rate could likely be achieved by expanding SSRS's current public engagement work.

Post-mortem examinations should be also done at the point of carcass receipt, to maximise the information and samples obtained, and the range of pathogens screened for should be expanded through development of more cost-effective, reliable and adaptable diagnostic tests.

4. Enhanced interdisciplinary collaboration

Interdisciplinary working is key to monitoring, researching and improving squirrel health and disease management, and would be facilitated by the interdisciplinary expert group and information hub.

5. Additional funding and manpower

Funding for squirrel health monitoring is currently extremely limited, with much work being conducted pro bono. Enhanced funding of key organisations and projects, and in turn increased humanpower, is essential if the above needs are to be achieved. It is important to stress that notable progress could be made even with relatively low-level funding, but this funding would need to be sustained in the long term to maintain an expert group, hub, and enhanced health monitoring activities.

Next steps

Through its Scottish Biodiversity Strategy, the Scottish Government has committed to 'protect[ing] and support[ing] the recovery of vulnerable and important species and habitats'. Health and disease concerns in vulnerable native species must receive attention as part of these recovery efforts, not least in the red squirrel, where disease is one of the key threats to population persistence.

It is likely that NatureScot's updated Scottish Strategy for Red Squirrel Conservation will also emphasise the importance of an enhanced focus on squirrel health and disease, and provide a framework for translating these needs into action points.

Maintaining and expanding long-term squirrel health monitoring and managing wild populations towards greater health will depend on reliable long-term funding being available.

This workshop was made possible through a grant from the University of Edinburgh's Moray Endowment Fund

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June 2026