



**Red Squirrel Conservation
Strategy for Northern
Ireland 2022 – 2032**



**Ulster
Wildlife**

Acknowledgements

This Strategy has been developed by Ulster Wildlife, Katy Bell, Michael Stinson, Dr Joshua Twining, Dr Caroline Finlay, David Everest (APHA), Jennifer Fulton and Dr Annika Clements, in collaboration with the Northern Ireland Environment Agency, the Northern Ireland Squirrel Forum members and the UK Squirrel Accord. This has been developed through funding from the NIEA Environment Fund, the NIEA Challenge Fund and the Garfield Weston Foundation.



Foreword

Kay Haw – UK Squirrel Accord

Red squirrels are among Northern Ireland's most iconic and well-loved mammals. Charismatic and colourful, they brighten the country's woodlands, parks and gardens. They are also ecologically important, supporting natural habitat regeneration where their forgotten nut and seed stashes germinate in the soil.

Following the introduction of grey squirrels from North America, the red squirrel suffered significant declines in population and range during the 20th century, which resulted in it becoming a UK protected and priority species. Thankfully, time and energy dedicated to safeguarding and restoring this native species is contributing to reversing the once dire situation across the island of Ireland. This new red squirrel strategy will further advance red squirrel conservation in Northern Ireland and bring extra focus on activities to protect this wonderful mammal.

The overarching aims of the Northern Ireland strategy are reflected in ongoing work to ensure the red squirrel has a future in all parts of the UK. Collaboration is vital to conserve species that only understand physical rather than political borders. With the situation in Northern Ireland being somewhat different to the rest of the UK, the focus in this strategy on All-Ireland cooperation is vital to ensure success.

Protecting and restoring the world's biodiversity from anthropogenic impacts, such as habitat destruction and the introduction of invasive species, is challenging but not impossible.

As we gain better understandings of the natural world and its systems, and new technologies are developed, it is possible to repair imbalances and rectify mistakes when we dedicate the resources to do so.

The UK Squirrel Accord partnership's research to develop a grey squirrel oral contraceptive and species-specific delivery mechanism will hopefully contribute to the significant gains in red squirrel recovery already taking place across Northern Ireland.

Thanks to the valuable work of organisations such as Ulster Wildlife, agencies such as the Northern Ireland Environment Agency and the key roles community groups and volunteers play, the red squirrel now has a much brighter future. The UK Squirrel Accord will continue to support these outstanding efforts and commends all those involved.



Jon Lees

NIEA and NI Squirrel Forum

The red squirrel in Northern Ireland is possibly in the strongest position it has been for three generations, as the data collated in this report indicates very healthy sighting figures in the south west which appear to be pushing eastward at a steady and observable rate.

The undeniable impact associated with recovery of the pine marten across the island of Ireland is clearly a very powerful factor. However, the reason that so many pockets of red squirrels have hung on across the Province is certainly linked to the hard work and dedication of the volunteers in the community red squirrel groups, and those landowners who undertake or encourage grey squirrel control across their properties.

Now is not the time to become complacent, urban grey squirrels are numerous and adaptive and our town and city environments are not likely to rapidly become the preferred habitat of the pine marten. Although urban pine marten may in the future become as common place as foxes and badgers, these spaces will be secondary to the quieter rural woodland fringes.

Two paradoxical strategies will need to be played out; breaking down the

pathways and corridors utilised by the grey squirrels to spread from their strongholds especially during strong breeding years, primarily by targeting pinch points on these routes and concentrating resources in those areas. While on the other hand trying to link the pockets of red squirrels which remain in fragmented forest pockets to permit the repopulation of extant areas and help diversify the gene pool. Planting must be as diverse as possible but of those tree species recognised to be less favourable to grey squirrels; so tree choice and location must be considered if you are bridging red populations but not encouraging greys to move.



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1. Executive Summary

This strategy has been developed to aid the conservation and continued recovery of red squirrels in Northern Ireland. It has set out clear aims, and actions to achieve those aims, which will need to be taken on board by a range of organisations in order to effectively implement this strategy.

AIMS:

1. Maintain populations of red squirrels across their current range.
2. Continue to support red squirrel recovery across their former range.
3. Seek removal of grey squirrels by; human control, and by the support of pine marten recovery.
4. Support appropriate habitat management to aid red squirrel conservation.

ACTIONS TO ACHIEVE AIMS:

- Grey squirrels:
 - o Anthropogenic grey squirrel management
 - o Pine marten as an agent of grey squirrel control
- Monitoring/ surveys
- Public support/ awareness
- Disease control
- Releases and translocations
- Future Policy and Research
- Nature Recovery Networks

Katy Bell,
Senior Conservation Officer,
Ulster Wildlife



2. Introduction

This Strategy has been developed by Ulster Wildlife on behalf of the Northern Ireland Environment Agency. It was produced in collaboration with the Northern Ireland Squirrel Forum including volunteer red squirrel groups, eNGO's, Forest Service and the Animal and Plant Health Agency (APHA).

The actions proposed are a statement of intent and can be taken on by any organisation that has the resources to carry them out. This document outlines the key aims to aid red squirrel conservation in NI, while also recognising the importance of grey squirrel control. The Strategy aims to have a 10-year lifespan but maps and records may change over time, requiring flexibility and responsiveness in the strategy's longer-term implementation. We recognise the contribution of individuals and communities and believe ongoing support and co-ordination is required for effective implementation of this strategy. This strategy is for conservation work in Northern Ireland but will require collaboration on an All-Ireland basis as well as across the UK.

2.1 Red squirrels in Northern Ireland

The Eurasian red squirrel (*Sciurus vulgaris*) is a Northern Ireland Priority Species (www.habitas.org.uk/priority/species.asp?item=5108) and is the only native species of squirrel found on the island of Ireland. It is a well-loved and familiar species in many woodlands across all six local counties. However, the species has been displaced from considerable areas of suitable habitat across NI by the invasive non-native Eastern grey squirrel (*Sciurus carolinensis*). Introduced to Co. Longford in 1911, the presence of this North American species potentially threatens the long-term viability of Irish red squirrel populations through disease and competition. Grey squirrels can outcompete red squirrels for food and they can adapt to a variety of habitats; they can also carry the squirrelpox virus which can be fatal when passed to reds, but causes grey squirrels no harm. Small fragmented populations of red squirrels can be completely wiped out by squirrelpox.

The red squirrel has been the focus of considerable conservation efforts in recent years with several local volunteer groups, the Northern Ireland Environment Agency, Ulster Wildlife, Belfast Zoo, and others, seeking to halt the further range contraction of the species and encourage recolonisation of formerly occupied areas of suitable habitat. A series of recent camera trap surveys undertaken by Ulster Wildlife (see **Figure 1**), QUB and the 2019 All-Ireland Squirrel and Pine Marten Survey have demonstrated that red squirrel recovery is taking place across much of NI and the wider island of Ireland, but the picture is uneven and they remain absent from many areas of suitable habitat, particularly in the more urbanised eastern counties (see ANNEX 1).

The situation in Northern Ireland, and the island of Ireland as a whole, differs from the situation in England, Scotland and Wales (<https://squirrelaccord.uk/>) as the spread and densities of red squirrels, grey squirrels and pine martens differ in each country. It is useful to have a co-ordinated

approach and Ulster Wildlife are members of the UK Squirrel Accord; however, it is equally important to consider the unique circumstances we face for red squirrel recovery on the island of Ireland.

The Northern Ireland Squirrel Forum (NISF) is a body which brings together a wide range of interested parties, both statutory and non-statutory, to seek to share best practice, disseminate new research, and create a more effective suite of actions to conserve red squirrels locally. Additionally, from 2016-2019 Ulster Wildlife was the lead local partner of the Red Squirrels United (RSU) project, which

was the largest red squirrel conservation project ever undertaken. The RSU project targeted four main areas of red squirrel populations locally (Fermanagh/ West Tyrone, Mournes, North West and north-mid Antrim), although red squirrels are also found widely outside of these zones, at the start of the RSU project these areas were considered the main strongholds for the species. An independent economic appraisal of the impact of the RSU project quantified the value of the programme as amounting to £11.5 million of benefits for red squirrel conservation based on social, ecological and environmental factors (ERS, 2019).

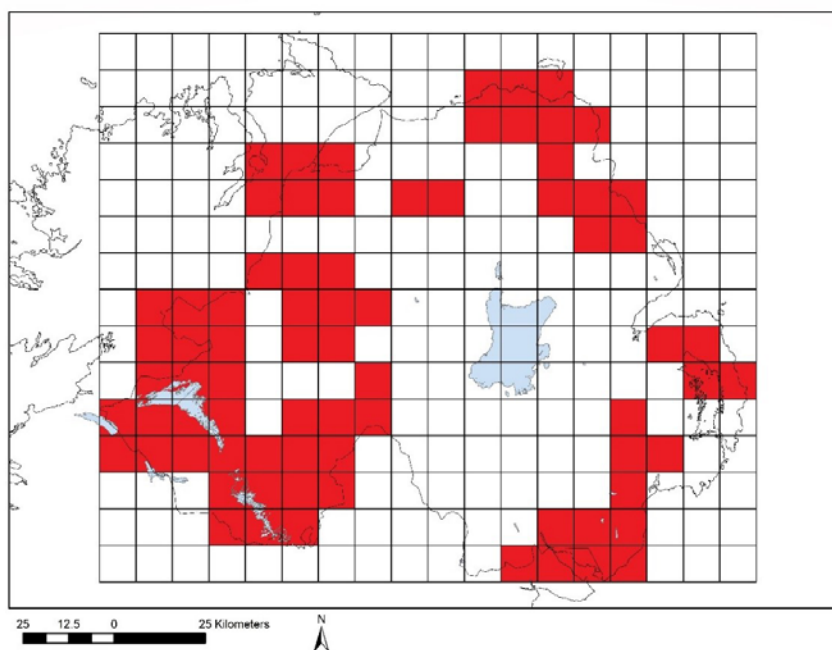


Figure 1: The 10km² squares in which red squirrels have occurred during Ulster Wildlife led camera trapping surveys 2017-20.

To achieve the maximum impact from a range of conservation activities to benefit red squirrels (such as grey squirrel management and habitat creation), it is essential to have an overarching strategic view of the most appropriate measure for a particular area and where (geographically) that action would have the greatest impact. A significant motivation for the development of a NI Red Squirrel Strategy relates to the need to ensure a strategic approach more

broadly, recognising that most volunteer groups are only able to operate in limited local contexts. It is also vital to extend this work to the border counties of Northern Ireland and take an all-Ireland approach to red squirrel conservation. The need to consolidate the conservation efforts to date, and ensure that the recovery of red squirrel range currently underway is continued, adds further relevance to the prompt production of this strategy.



3. AIMS

1. Maintain populations of red squirrels across their current (2021) range. Emphasis on maintaining the key strongholds including the Glens of Antrim, Northwest, West Tyrone, South Tyrone, Fermanagh, South Armagh and the Mournes.
2. Continue to support red squirrel recovery across their former range particularly (but not exclusively) in Ards, mid/ east Tyrone, the Northwest and mid and south Down.
3. Seek removal of grey squirrels in areas identified above to limit the risk of disease transmission and/ or competitive displacement by two primary means:
 - i. Supporting pine marten recovery as a key driver of red squirrel conservation locally, whilst recognising that pine marten related conflict issues can arise (wildlife and human) and seek acceptable solutions to such issues.
 - ii. Support strategic, best practice, grey squirrel management (both professional and voluntary) as a key tool in red squirrel conservation locally – focus of effort on sites/ areas likely to have the maximum impact on grey squirrels to the benefit of red squirrels.
4. Support appropriate woodland management and creation to support red squirrel conservation, whilst recognising woodland creation is not desirable in every context.

4. Actions to Achieve AIMS



Grey squirrel © Gillian Day

4.1 Grey squirrels

We recognise that to secure the long-term future of red squirrels in NI, in terms of the risks emanating from grey squirrels, nothing short of the eradication of grey squirrels from the island of Ireland will eliminate these threats.

Recent range contraction of grey squirrels across the island is welcome, with the All-Ireland Squirrel and Pine Marten Survey 2019 highlighting; “grey squirrel records however had decreased in number, and the range covered by the species had dropped considerably, with 37.8% fewer hectads (10 km x 10 km squares) occupied than in 2012” (Lawton *et al.* 2020). However, the species remains present in substantial numbers

in five out of six NI counties (see **Figure 2**) and was recorded in 21 out of 32 counties island-wide. It is worth noting that in some counties very small numbers of grey squirrels now seem to be present, such as Monaghan, Offaly, and Kilkenny, and the counties with the greatest numbers are predominately on the eastern seaboard.

Future developments regarding pine marten recovery and the possible use of new innovative anthropogenic control methods, such as the development of a contraceptive or gene editing, are likely to be key to any future eradication of grey squirrel, alongside traditional control methods. These methods will be vital in urban areas with large source populations of grey squirrels.

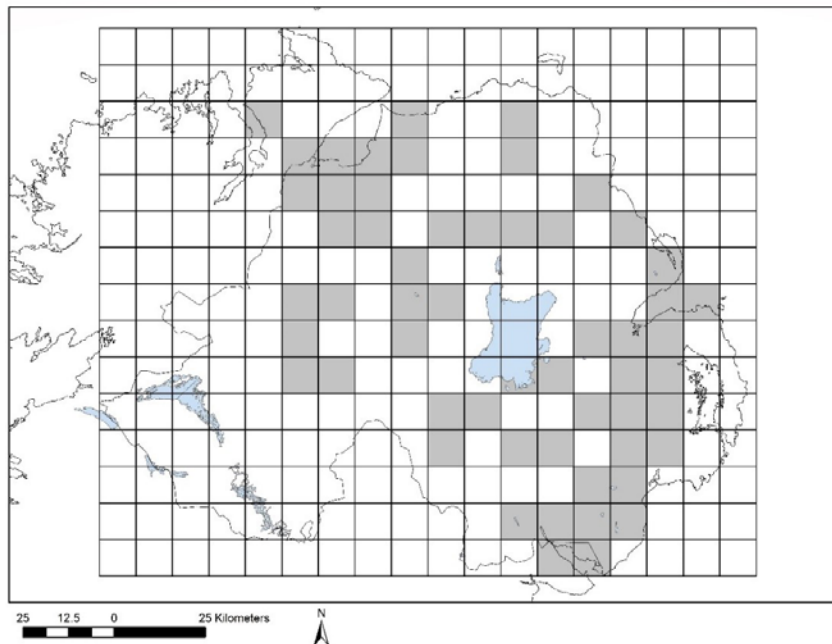


Figure 2: The 10km² squares in which grey squirrels have occurred during Ulster Wildlife led camera trapping surveys 2017-20.

4.1.1 Anthropogenic grey squirrel management

Human led grey squirrel management using traditional methodologies (trapping and shooting) is necessary in some areas of NI. This is vital in order to protect small, fragmented populations of red squirrels across the country. Locally, the majority of grey squirrel management is undertaken by volunteers. Many of these volunteers have often been involved in grey squirrel management for many years and have devoted considerable personal effort to the activity. Professional grey squirrel management has been more limited in NI, but it can be extremely useful alongside and/ or by coordinating volunteer activities - making the overall effort much more effective.

To maximise the impact of grey squirrel management, all control should have clearly defined parameters and should

take a strategic approach. All grey squirrel control to benefit red squirrels should have a defined strategy regarding its desired local impact, and potentially how the work fits into the wider context. Coordination of control efforts between adjacent areas is highly desirable (without spreading effort too thinly). **Figure 3** shows the key control zones which have been identified across Northern Ireland. **Priority 1** shows areas which require immediate action in order to protect localised populations of red squirrels; and **Priority 2** shows larger source populations which need large-scale co-ordinated control (see ANNEX 2 for full size map). The larger urban areas could be candidates in the future for the use of a grey squirrel contraceptive.

This map has been produced with the data available at the time so is subject to change. Red squirrel strongholds and grey squirrel control priorities may change over time.

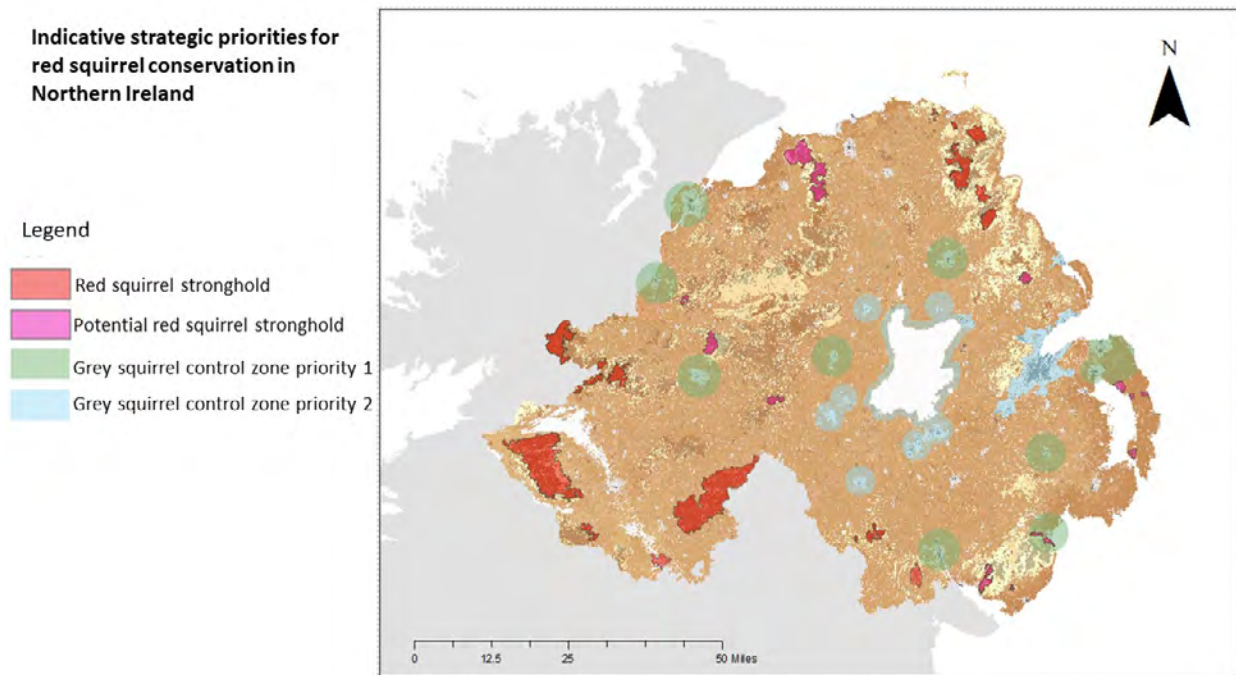


Figure 3: Indicative strategic priorities for red squirrel conservation in NI (2021).

4.1.2 Pine marten as an agent of grey squirrel control

The recent recovery of pine marten across much of their former range locally is a conservation success story in its own right and has potentially significant implications for the future of red squirrel conservation across the island of Ireland.

A host of recent work across Ireland and Scotland (Sheehy, E. & Lawton, C. 2014; Twining *et al.* 2020a, b, c; Sheehy *et al.* 2018 & Twining *et al.* 2021) has demonstrated that pine marten recovery has negatively impacted grey squirrel populations at a landscape scale (likely responsible for their disappearance from entire counties including Co. Fermanagh), with red squirrels



Pine marten © Ronald Sugenor

rapidly recolonising the habitat vacated by the collapsing grey squirrel populations.

Red squirrels have recolonised numerous areas (at a landscape scale) across the island of Ireland without any human assistance, such as translocations or release of captive bred individuals (Flaherty, M. & Lawton, C., 2019). Surveying for Ulster Wildlife, the Red Squirrels United project, and the All-Ireland Squirrel and Pine Marten Survey demonstrated that grey squirrel collapse is continuing, at present, across huge areas of the island of Ireland, with entire counties which formerly had large grey squirrel populations reporting not a single sighting.

Fascinatingly in Co. Longford, the location of the original release, no grey squirrels were recorded in 2019. Nor indeed, in the surrounding counties of Leitrim or Westmeath – all three counties had grey squirrel present in 2007 (Carey *et al.* 2007) and 2012 (Lawton *et al.* 2015). Similarly, functional grey squirrel populations have disappeared from Co. Fermanagh since 2012, without a single record during 2017-20 surveying. It is vital to note the almost complete disappearance of grey squirrels in these areas

has been achieved without any coordinated anthropogenic grey squirrel control. Pine marten recovery has demonstrated effective landscape scale level impact on grey squirrel populations in those areas where they have achieved sufficiently high densities to impact grey squirrel. However grey squirrel control is still essential in areas across NI.

Given that pine marten recovery is continuing apace across NI (confirmed records from all 6 counties – see **Figure 4**), it is likely that pine marten mediated collapse of grey squirrel will occur in other areas in the coming years (Twining *et al.* 2020b, c). Recent research has shown the importance of habitat in the relationship between pine martens and red and grey squirrels (Twining *et al.* 2021). However, it is possible that in urban areas, pine marten may not reach sufficient densities to cause collapse of grey squirrel populations and other approaches will be required (Twining *et al.* 2020c). It is also important to note that grey squirrel control is required in the short-term to eliminate the risk of the loss of isolated red squirrel populations.

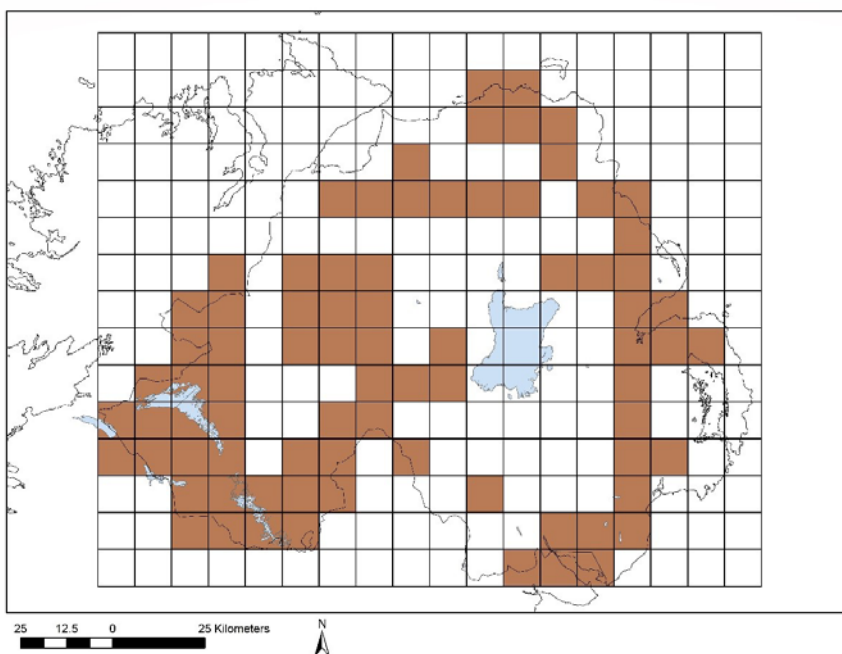


Figure 4: The 10km² squares in which pine marten have occurred during Ulster Wildlife led camera trapping surveys 2017-20.

4.2 Monitoring/surveys

Regular monitoring of the distribution of both squirrel species and pine marten is critical to the effective implementation of red squirrel conservation measures and the evaluation of their success. Monitoring can occur at a number of different spatial and temporal scales depending on context. For example, regular (or near constant) monitoring of key red squirrel sites in areas with large grey squirrel populations in the vicinity is likely to be essential, whereas in areas of red squirrel dominance at considerable distance from large grey squirrel populations such as in Fermanagh, annual or biannual monitoring of a selection of sites could be more appropriate. Ulster Wildlife will be carrying out a presence/absence survey across Northern Ireland every other year; continuing the survey work that started in 2014.

Monitoring can be directed towards localised goals such as identification of the incursion of individual grey squirrels into a key red squirrel site, through to regional or island-wide aims such as identification of changes in distribution over a longer timeframe. Volunteer red squirrel groups play an important part in monitoring.

Monitoring is an excellent opportunity for volunteers to take part in vital conservation work and can often lead to greater involvement in red squirrel conservation or engagement with wider ecological issues. Ulster Wildlife are committed to the long-term monitoring of these three species in Northern Ireland. See ANNEX 1 for further details.



4.3 Public support/ awareness

The red squirrel is a well-known and much-loved species by many in the general public. They are a charismatic species that are easily recognisable and an important part of our local biodiversity. Red squirrels can play an important part in raising awareness of woodland biodiversity and to aid in the conservation of lesser known woodland species. It is important to raise awareness at a local level to a wide variety of groups; from education in schools, to local councils, the general public, and a variety of stakeholders.

Local groups are often best placed to undertake awareness raising in their localities – highlighting the threat to a red squirrel population in a particular woodland or asking for sightings of squirrel species at a particular site.

Recent research led by Forest Research, through the Red Squirrel United Project, highlighted that exposure to grey squirrel management and public outreach are potentially more important than the local presence of red squirrel, to ensure high levels of public support for grey squirrel management (<http://www.redsquirrelsunited.org.uk/news/publications/>).

Across Ireland, pine marten related grey squirrel control is highly likely to be the key driver of grey squirrel removal at a landscape scale in the coming decades, thus outreach

pertaining to amelioration and prevention of pine marten conflict will be essential (www.pinemarten.ie).



Heart of Down Red Squirrel Group

4.4 Disease monitoring

Ongoing disease monitoring and surveillance and reporting is essential throughout Northern Ireland. Through the Red Squirrels United (RSU) Project research was undertaken by Animal and Plant Health Agency (APHA) regarding the prevalence of squirrelpox and adenovirus in local grey squirrel populations. David Everest (who led the research) has provided an overview of the results of this work below. This analysis was confined to a particular area in Northern Ireland and to understand the situation across the country further monitoring of squirrelpox and adenovirus prevalence is needed.



North West Red Squirrel Group

Viral surveillance of grey squirrels from Northern Ireland

The following article describes the work undertaken to investigate virus infection presence within grey squirrels from Northern Ireland, work undertaken as part of the Red Squirrels United (RSU), EULife and National Lottery Heritage Funded project. The project investigated both squirrelpox virus (SQPV) and adenovirus (ADV) in grey squirrels from four separate landscape areas of the UK, namely Northern Ireland, north Wales (Gwynedd), Lancashire (Formby) and northern England (Kielder Complex).

The Northern Ireland grey squirrels were collected from the Mourne Mountains area between 2016 and 2019 by Ulster Wildlife. They were submitted to the Animal and Plant Health Agency (APHA) laboratory at Weybridge in Surrey, who were contracted by the project board and partners to provide the scientific support analyses. The analyses were undertaken using polymerase chain reaction (PCR) assays, to detect amplified viral DNA from the samples. PCRs were used as both SQPV and ADV appear as asymptomatic infections in the grey squirrel, meaning that on examination, there are no signs of infection presence, so it is very unlikely that any virus particles would be detected if using electron microscopy when looking for a possible pathogenic infection presence. In fact, no cases of visible virus particle detection by electron microscopy for ADV have ever been detected in the grey squirrel and only one case of SQPV in 1994 in an animal from Surrey. The red squirrel, however, produces symptomatic, pathogenic cases of both

viruses on a regular basis and electron microscopy detection is widely used, with PCR as a support assay when requested.

For the RSU project, the original aim was to collect 300 animals from each of the four study areas, so giving 1200 animals in total for analysis, with PCRs for both viruses being undertaken, using spleen for ADV and lip tissue for SQPV. However, sampling difficulties meant that not all the required animals could be collected from each area and a decision was made to revise the sampling plan. As a compromise hair samples were incorporated to complement the tissue assays to give a matched animal sample where possible. In addition, further samples would be utilised from areas with extra ('spare') samples, to make up any shortfall in planned numbers. As a result, instead of separate tissue assays, a combined spleen and lip tissue sample was analysed along with separate hair assays. In total, samples from 1506 grey squirrels were submitted to APHA for analysis, with samples from 1405 ultimately selected for PCR analysis. From these, 1378 tissue (spleen and lip) and 1031 hair (tail hair or whisker) samples in total were analysed, with Ulster Wildlife's contribution amounting to 472 tissue and 276 hair samples analysed, from the 473 animals sampled out of the 486 animals submitted. When all the assay results were completed, it showed that the samples supplied by Ulster Wildlife from NI compared favourably with the overall results and these and the results from the other areas and may be seen in Table 1.

Table 1. Nested qPCR assay results on samples submitted by Ulster Wildlife

Sample	ADV	SQPV	Both viruses
Tissue	46% (216/472)	11% (50/472)	5% (22/472)
Hair	14% (39/276)	5% (13/276)	0.4% (1/276)

Overall, 43% of tissue samples (598/1378) were ADV positive, 10% (136/1,378) were SQPV positive and a further 5% (66/1,378) were positive for both viruses. For hair samples, 11% (113/1,031) were ADV positive, with 10% (106/1,031) SQPV positive and

another 2% (15/1,031) positive for both viruses. When both sample sets are combined, results are again comparable between NI and the overall sample population analysed. These can be seen in Table 2.

Table 2. Nested qPCR assay results on combined samples submitted by Ulster Wildlife

Area	ADV	SQPV	Both viruses
Northern Ireland	34% (255/748)	8% (63/748)	3% (23/748)
Overall	29% (711/2,409)	10% (242/2,409)	3% (81/2,409)

For the 1405 individual animals, 54% (762/1405) were positive for ADV, SQPV, or both viruses, with 70% (536/762) ADV positive, another 11% (111/762) SQPV positive and a further 15% (115/762) for both viruses. Ulster Wildlife's animals revealed 56% (266/473) positive for one or more viruses,

43% (204/473) positive for ADV, another 6% (30/473) SQPV positive and a further 7% (32/473) for both viruses. Of the positive animals, 85% (651/762) were ADV and 30% (226/762) SQPV positive, revealing ADV rather than SQPV as the most prevalent virus by far.

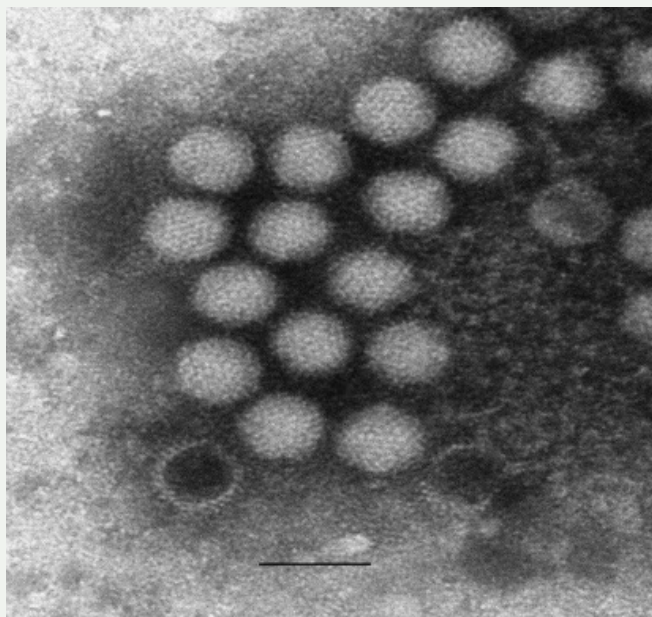


Figure 1. An SQPV particle detected by TEM in a grey squirrel from England in 1994, the only case of squirrelpox disease in the species (Bar=200nm.) © APHA Labs

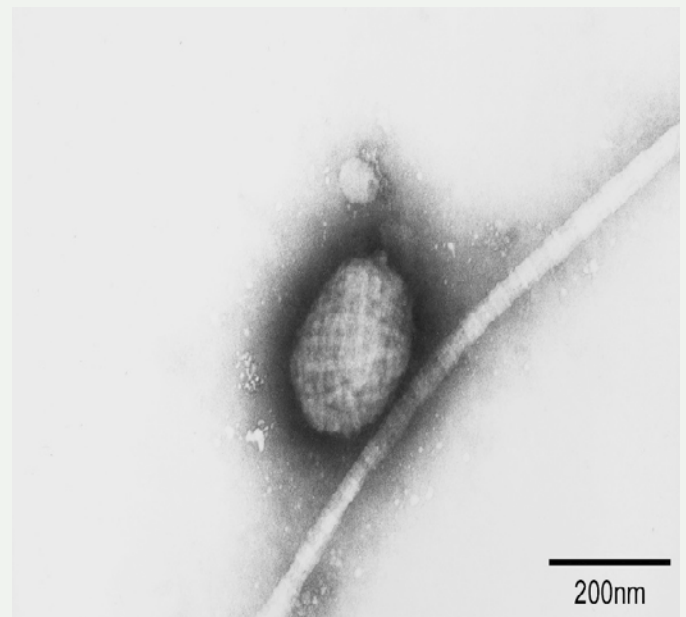


Figure 2. ADV particles detected by TEM in red squirrel intestinal content (Bar=100nm). © APHA Labs

The above micrographs depict both virus particle types and give an idea of their appearance using electron microscopy. Both infections in grey squirrels are normally asymptomatic with no pathology or particle detection. In red squirrel, both viruses can be asymptomatic, SQPV rarely so, or pathogenic. Both have been detected in red squirrels from the Tollymore Forest area as

pathogenic infections, SQPV first detected in 2011, along with a couple of cases from the Glenarm area of the country. An ADV case was also detected in Tollymore Forest in 2011.

David Everest
APHA Weybridge



Red squirrel © Adam Gerrard



4.5 Captive breeding releases and translocations

Captive bred releases have been undertaken in NI in recent years using red squirrels from Belfast Zoo's breeding programme. Red squirrels from this source have been released into various sites in Co. Antrim and Co. Down. Additionally, translocation of wild red squirrels from Co. Fermanagh has also occurred in recent years. These have been carried out to supplement existing populations and establish red squirrel populations in areas where they once were. Separately there have also been red squirrel reintroductions in the Republic of Ireland in Counties Mayo and Galway (Waters, C. & Lawton, C. 2011).

As noted in the *Scottish Strategy for Red Squirrel Conservation* (2015), such releases and translocations should be "regarded as a lower priority than defending extant red squirrel populations that are currently under threat." This analysis is also applicable in an NI context, especially as there is evidence that natural recolonisation is underway in many areas and that natural recovery is the preferable option to achieve the best chance of a sustainable outcome.

Releases have inherent risks such as lack of wild fitness traits amongst released animals, possibility of disease spread (including adenovirus and squirrelpox) and possible genetic issues; both arising from the genetic diversity of the released animals and the risk of deleterious genetic impacts of the introduced animals on the receiving population of red squirrels.

If releases are planned in the future careful adherence to the International Union for the Conservation of Nature (IUCN) Guidelines should be adopted with a range of factors in the rationale for any release considered (IUCN/SSC, 2013). Such criteria should include whether the release is necessary for the overall wellbeing of the species (what is the overarching aim of the programme), the adoption of a long-term, scientifically robust, monitoring plan post release, and clear delineation of the exit strategy – the point at which it is agreed that no future releases will occur, as the original project goals have been achieved. This list of criteria is not exhaustive and assessment based on the full IUCN Guidelines should be made prior to any proposed future releases or translocations.

4.6 Future Policy and Research

Red squirrel conservation should be considered as part of the future planning of local agri-environment schemes, particularly how landowners could be encouraged to achieve effective grey squirrel management on their holdings. Provision of professional control personnel funded through agri-environment schemes (working across a significant number of farms/ landholdings) is a model which may have useful application in a NI context.

In recent years, considerable academic research has been devoted to red squirrel, grey squirrel, and pine marten on the island of Ireland. Institutions including the National University of Ireland Galway (Sheehy, E. & Lawton, C. 2014), Queen's University Belfast (Twining *et al.* 2020a, b, c & 2021) and Waterford Institute of Technology (O'Meara, D.B. 2018), have all produced important contributions to further our collective knowledge regarding these species in Ireland. When further research questions are being formulated and research undertaken, collaboration between these institutions and the wider red squirrel conservation community (statutory and non-statutory) will be essential.

Pertinent research questions that have been suggested during the consultation for the development of this strategy included monitoring of post-release red squirrels, abundance of red squirrels in Ireland, pine marten interaction with both red and grey squirrels, grey squirrel contraception trials and how to reduce pine marten/ human conflict.

As part of the implementation of this strategy it is vital that the strategy is updated to reflect new research developments and that the red squirrel

conservation community remains abreast of the latest research.

It is also important to take red squirrel conservation issues into account when developments may impact the species, their habitat and their dreys. NIEA have outlined appropriate survey methodology (<https://www.daera-ni.gov.uk/sites/default/files/publications/daera/red-squirrel-survey-specifications.pdf>) which should be implemented through the planning process by appropriately qualified individuals.

4.7 Nature Recovery Networks

To address the twin biodiversity and climate crises, there requires a transformation in our approach from protecting single species and habitats to actively restoring nature at a landscape scale. Northern Ireland is committed to developing 'Nature Recovery Networks' (NRNs): these will provide a strategic, landscape-level approach to managing, creating, restoring, and enhancing habitats and landscapes, linking together ecological processes across protected areas and the wider landscape, while highlighting the link between the status of our natural world and human well-being. NRNs will enhance habitat connectivity and support higher species populations or greater species diversity, and are underpinned by the 'Lawton Principles' (Lawton et al., 2010), of 'bigger, better, more, and more joined up'.

To establish how NRNs could support populations of priority species, such as the red squirrel, an understanding of the landscape-scale connectivity and 'permeability' for that species is needed. This can then feed into decision-making frameworks for restoration and protection of habitats and landscapes. A connectivity model has been developed by Dr Josh

Twining to highlight how red squirrels are currently using the wider landscape in Northern Ireland (funded by Ulster Wildlife and NIEA).

This study was undertaken in two broad phases: 1) using single-species occupancy models for red squirrels and grey squirrels to determine habitat suitability and identify strongholds; 2) using circuit theory to

estimate functional connectivity between populations of squirrels to prescribe future focus of conservation efforts regarding habitat and species management on a regional scale (see **Figure 5**). This gives us a very detailed insight into how these two species can move across the country. See ANNEX 3 for full report.

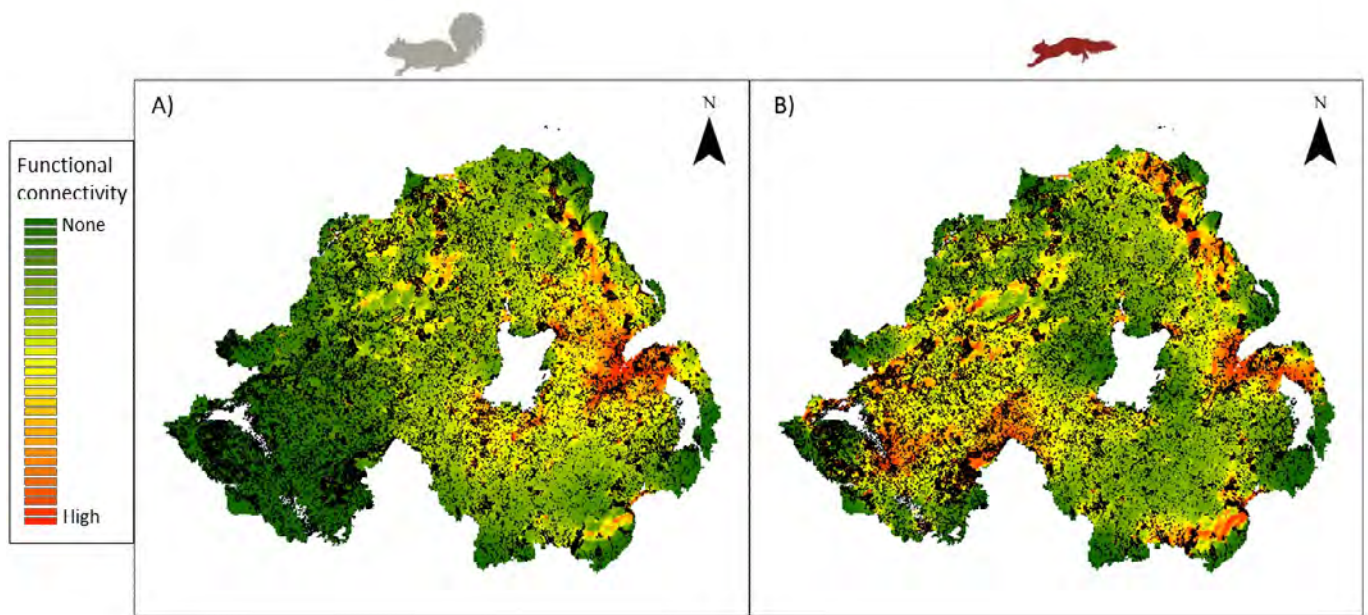


Figure 5: Estimated functional connectivity for grey squirrels and red squirrels throughout the entire region of Northern Ireland based on resistance-based connectivity models (Dr Josh Twining).

In terms of targeting habitat management and habitat creation, it must be noted that not all red squirrel habitat has high biodiversity value. Therefore, decision making towards delivering functional connectivity for red squirrels needs to be made in conjunction with the wider set of NRN priorities, and wider conservation objectives both locally and nationally.

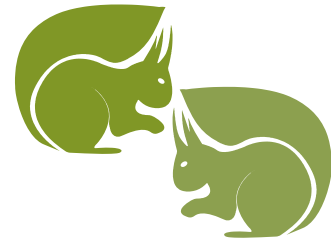
When creating and managing woodland it is vital that the tree species that benefits red squirrels the most are considered.

Native broadleaved woodland and native conifers, such as Scots pine, provide wider biodiversity benefits than non-native conifers. Recent research has also indicated the importance of native woodland for both red squirrels and pine martens (Twining *et al.* 2021). It is also important to note that trees will not be suitable in every context.

4.8 Summary of Actions



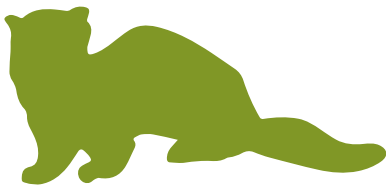
Grey squirrel management



Captive breeding releases and translocations



Public support/ awareness



Support pine marten recovery



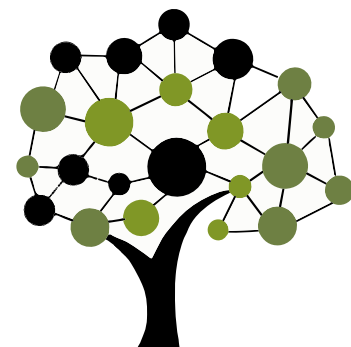
Future Policy and Research



Disease monitoring



Monitoring/ surveys



Nature Recovery Networks

5. Delivering Actions for red squirrels

Achievement of the aims outlined in this document will be challenging and require a coordinated approach involving a wide range of stakeholders.

It will be essential that local red squirrel conservation practice is based on as wide a collaborative effort as possible. Knowledge sharing and dissemination of best practice are required to maximise the impact of the conservation actions undertaken. To achieve the aims of this strategy, partnership will be key both locally within NI, but also within wider forums such as the UK Squirrel Accord.

Additionally, this document explicitly recognises that an All-Ireland approach is necessary to secure the long-term future of red squirrels on the island and existing north south relationships should continue and be further strengthened. An aligned approach at the border regions is also vital to ensure positive conservation outcomes.

Funding is vital for this work to be carried out and it is important to explore all appropriate funding sources, both short-term and long-term, to ensure that

red squirrel conservation is a continued priority.

Regular collaboration between statutory agencies such as National Parks and Wildlife Service and Northern Ireland Environment Agency regarding red squirrels already occurs (such as the regular assessment of the All-Ireland Mammal Red List). The potential for cross-jurisdictional red squirrel projects should be explored as a priority in the coming years.

We are very lucky in Northern Ireland to have so many people dedicated to red squirrel conservation. We are seeing positive changes to our local population through conservation action but we cannot get complacent. By all working together we can continue to fight for this charismatic native mammal.



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