PINE HOVERFLY CONSERVATION STRATEGY

2025-2030

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AUTHOR LIST

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EXECUTIVE SUMMARY

The pine hoverfly (*Blera fallax*) is a saproxylic (deadwood-reliant) insect native to much of the Palearctic. In Britain it is range-restricted and Critically Endangered. The British population of pine hoverflies has seemingly always been restricted to the area within and around the Cairngorms National Park (on both sides of the Cairngorm mountain range), but habitat destruction and land use change have exacerbated this restriction.

As of 2006, the species was confined to just one small forest patch in Strathspey. Pine hoverflies are a Scottish Biodiversity List and Cairngorms Nature Action Plan species, and are also one of the focal species for the Rare Invertebrates in the Cairngorms Project.

The Pine Hoverfly Steering Group (SG) has been leading on monitoring, conservation, and management of this species since 2003. The SG previously produced a draft conservation strategy for the pine hoverfly that ran from 2018-2023, with the objective of establishing sustainable populations at four sites by 2025 through captive breeding and licenced releases. This strategy has acted as a rough guide for pine hoverfly conservation activity but, during this time, a lot of progress has been made resulting in changes to the species' conservation programme. An updated strategy was needed to reflect these changes and to maintain momentum on the conservation of this species.

The workshop to produce this new strategy was held in March 2024 and was attended by nine of the 11 current members of the SG. During this one-day workshop, the SG identified priority work themes, drafted a vision statement, and devised goals and actions to deliver tangible improvements for the long-term prospects of the pine hoverfly in Scotland. The priority work themes identified for this strategy to address over the next five years were:

- Post release and remnant site monitoring
- Habitat creation in existing release and remnant sites
- Identifying new release sites
- Research
- Conservation breeding programme
- Policy
- Funding
- Data management and transfer
- Governance

The pine hoverfly is a flagship species for high quality, diverse Caledonian pine forest and plays key ecosystem roles both as a pollinator and a waste recycler, as well as being part of the forest food web. With the publication of this document, we have a strategy to increase this species' chances of long-term persistence in the Scottish landscape. By delivering against this strategy, we will also deliver for other wildlife, the Scottish Government, and the people of Scotland by contributing to the Cairngorms Nature Action Plan and Cairngorms National Park Partnership Plan, the Scottish Biodiversity Strategy, and Scotland's commitment to the targets set out in the Global Biodiversity Framework. Building on the promising progress in conserving pine hoverflies over the past five years, we are committed to working strategically to secure this species' future in Scotland.

Clarification of selected technical terms in this document are given in Appendix 1.

BACKGROUND AND CONTEXT

The pine hoverfly is one of the most threatened species of insect in the UK and has seemingly always been restricted to the area in and around the Cairngorms National Park. Part of the fauna of Scotland's boreal pinewoods, it was first noted by early entomologists in the late 19th century from specimens collected in Braemar.

There were occasional records from Strathspey and the Moray Coast up until the 1940s, followed by a marked gap in recorded sightings in the latter part of the 20th century apart from the discovery of a number of individuals in the 1980s at Loch Garten. Members of the Malloch Society searched for 10 years before identifying the larval habitat and subsequently finding a larva near Dulnain Bridge in Strathspey in the late 1990s. This discovery and the understanding of the species' larval habitat requirements prompted a widespread survey for further sites. Despite this survey, which covered the historical sites and more recent sites, pine hoverflies were only fund at two sites; both in Strathspey.

Like many invertebrates, this species has a generally annual life cycle and spends most of its life in the larval stage. Pine hoverfly larvae live in wet rot holes in Scots pine, which can be formed from windblown trees that snap or via heart rot caused by fungal infection, leaving holes that fill with water. The holes must hold water throughout the year to host the larvae successfully and rot holes suitable for pine hoverflies tend to develop in older pine trees. Adult pine hoverflies feed on nectar from flowering plants and work at RZSS on the conservation breeding programme for the species has demonstrated a strong preference for rowan flowers. Thus, suitable habitat for pine hoverflies will also have rowan present on the site, or close by. Rowan does not flower well in deep shade, so the best flowering is in sunny places such as open woodland or on the woodland edge. It is thought that modern forest management and commercial felling have decreased the number of natural rot holes because Scots pine is felled before rot holes can develop while also reducing forest cover and the structural complexity of remnant patches, limiting the amount of good habitat for pine hoverflies in Scotland and therefore in the UK.

Pine hoverfly larvae can develop to pupation within one year, but in low nutrient conditions may take more than one year to develop (Rotheray *et al*., 2016). Larvae of this species can freeze solid in winter, and revive unharmed. They feed on 'bacterial soup' in the rot holes they live in.

The pupal stage occurs in spring. The larvae can crawl out of the rot holes to pupate in cracks in a stump or in moss around a stump. The duration of the pupal stage appears to depend on temperature – it is certainly variable in different years and in captive populations has

been recorded as ranging from 13 to 57 days (Rotheray 2012, Allott, 2021). The adult hoverfly can be on the wing between 11 May and 24 August (Rotheray 2012).

Between 1990 and 2015, the majority of conservation work with pine hoverflies consisted of the extensive surveys by the Malloch Society mentioned above, artificial rot hole creation at known sites, and a pilot breeding and release programme for the species as part of a PhD study. As naturally occurring rot holes or decaying stumps suitable for pine hoverfly larvae are so rare or difficult to access, a management technique was developed to create artificial holes for monitoring via larval counts and as release sites for reintroduction work. These holes are created in cut stumps or logs by chain sawing or drilling a hole, which should be as deep as possible to hold water through droughts. The hole is filled in with sawdust and shavings, and covered with a cap to help it maintain water through droughts and prevent flushing out in heavy rainfall. Between 2000 and 2007, artificial rot hole creation focused on the two known remnant and indigenous locations for the species, Curr Wood and Anagach Woods.

From 2009-2012, Ellen Rotheray, a PhD student at Stirling University, researched the pine hoverfly and worked as Project Officer for the NatureScot-funded Species Action Framework. Dr Rotheray was the first person to breed pine hoverflies in captivity and her findings were key in understanding the species (Rotheray 2012). As a result of this captive breeding effort, a series of reintroduction releases took place. In 2009, 179 adult pine hoverflies were released at Rothiemurchus Estate and 43 larvae were subsequently found in artificial breeding habitat and up to 1km from the release site. In 2010, pine hoverflies were also released into Abernethy Forest and, in 2011, into Inshriach Forest. Unfortunately, subsequent surveys in 2014 suggested that these new populations did not survive long-term and the same surveys suggested that pine hoverflies were also now confined to a single location: Curr Wood.

In 2015, following these noted declines in Scotland's wild pine hoverfly population, the Pine Hoverfly Steering Group (SG) approached the Royal Zoological Society of Scotland (RZSS) and asked them to trial breeding pine hoverfly via a pilot project using animals brought over to Edinburgh Zoo from Scandinavia. The breeding methodology was based on Dr Rotheray's previous work on the species (Rotheray 2012). The Edinburgh Zoo team received pine hoverfly larvae from Finland in May 2015, and from Sweden in December 2016, December 2017, and September 2018. Unfortunately, none

of these animals produced eggs and thus did not complete a full breeding cycle. As a result, the decision was made to relocate the breeding programme to RZSS' Highland Wildlife Park (HWP) site, which is itself located in the Cairngorms National Park and thus has a very similar climate to the remnant pine hoverfly site in Curr Wood.

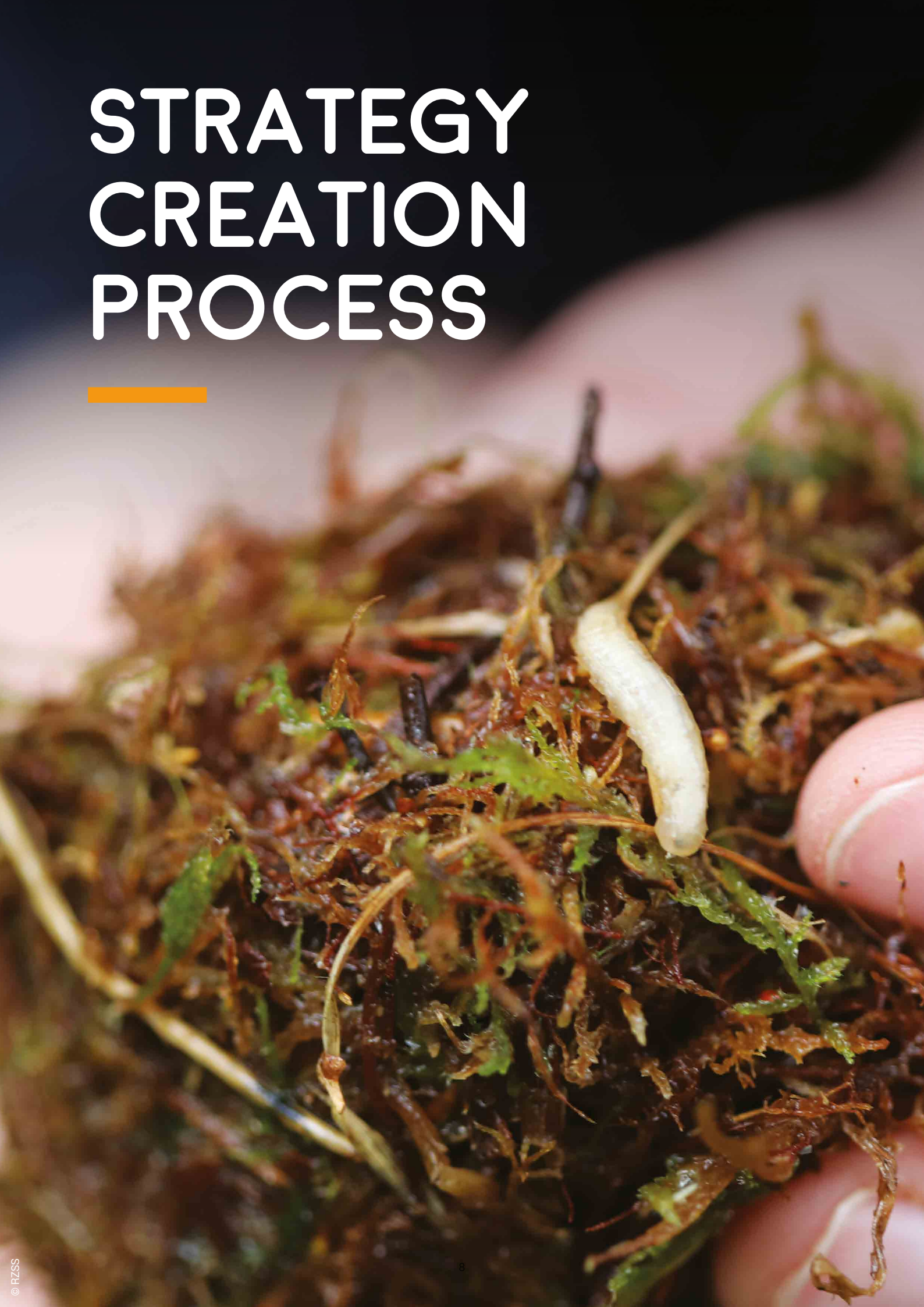
In October 2018, following one of the most successful larval surveys in Curr Wood of recent years, 25 pine hoverfly larvae were taken to HWP to establish a new breeding programme attempt. This new breeding attempt was successful and resulted in the production of 16 larvae in the 2018/19 breeding season, likely all produced by one or possibly two females. These 16 captive-bred individuals went on to produce 170 larvae in the 2019/2020 breeding season. In November 2020, a further two larvae were collected from Curr Wood to try and boost genetic diversity in the breeding population. From the 2020/2021 breeding season onwards, the conservation breeding programme went from strength to strength, with around 8,000 larvae produced in the 2020/21 breeding season and in every breeding season since, up to the time of writing this strategy in 2024.

This breeding success has enabled attempts to establish new populations of pine hoverflies via reintroduction releases. Release sites within Strathspey were identified based on the presence of Scots pine, rowan, and the site being likely to be managed and protected for conservation in the long-term. Three sites were initially identified for the first round of releases from the breeding programme: Garten Woods and Bognacruie in RSPB Abernethy Forest and Ryvoan in Forestry and Land Scotland's (FLS) Glenmore Forest Reserve. Staff from RSPB and FLS, plus private contractor Alban Tree Care, created artificial rot holes in Scots pine stumps and logs (with holes in logs being referred to as troughs) at all three releases sites (Garten Woods already had some holes from previous release efforts by Dr Rotheray and additional holes were created for the current project). These holes were allowed to fill with rainwater and, if successfully holding water, were used as sites for larvae releases.

The first rounds of pine hoverfly larvae releases took place in October 2021 and March 2022, with around 6,000 larvae being released across the three sites in total. In May 2022, an adult pine hoverfly was seen in Garten Woods by Jane Sears (RSPB) and Genevieve Tompkins (Rare Invertebrates in the Cairngorms), confirming that at least some of the larvae released had successfully pupated into adults, and marking the first sighting of an adult pine hoverfly in the wild in Britain in eight years. Larval surveys in September 2022 confirmed that pine hoverflies had successfully bred in the Garten Woods and Bognacruie sites. Another 6,000 larvae were released at the same three sites in October 2022 and March 2023.

For the October 2023 and March 2024 releases the strategy was changed slightly to try and determine whether populations might be able to persist in release sites in the absence of continued top-up releases of larvae. An additional release location (Anagach Woods) was added and no releases were conducted at Garten Woods. Thus, it was still possible to release around 6,000 larvae, but into Bognacruie, Ryvoan, and Anagach. Having recorded proof of breeding in the wild at Garten Woods for at least two years, it will now be a test site to help understand what might happen to the population in the absence of additional releases of larvae. Our aim is for populations to be self-sustaining rather than reliant on regular top up releases. Garten Woods has been left "fallow" since the last releases there in March 2023, with no releases taking place at this site and monitoring continuing to assess whether the site is self-sustaining. The 2024 larval survey at Garten Woods was inconclusive as it was a poor season for hoverflies (and other invertebrates), but pine hoverfly larvae were found, suggesting the population has persisted to some extent without releases. There will be no releases into Garten in 2024/2025, and the results of the 2025 larval survey will be used to determine next steps at this site.

STRATEGY CREATION PROCESS



The work to produce this strategy was undertaken by the SG with facilitation by SG member, Helen Taylor (RZSS). Nine members of the SG came together in an in-person strategic workshop hosted at the CNPA office in Grantown-on-Spey on 28th March 2024.

The workshop was divided into several sections, including development of a shared vision statement for 2055; prioritisation of work themes for the species; and development of goals and actions to meet the needs identified for the work themes. The results of the workshop were then collated and drafted into a strategy document, which was circulated around the SG for comments and revisions, and discussed at a further in-person meeting in February 2025, resulting in this final version of the strategy.

Members of the SG in March 2024 with their organisational affiliation and an indication of whether they were present at the workshop:

Name	Organisation	Present at workshop?
Jane Sears (Chair)	RSPB	Y
Carl Allott	RZSS	Y
Ellie Barrie	Rare Invertebrates in the Cairngorms (RIC)	Y
Anne Elliott	NatureScot	Y
Kenny Kortland*	Forestry and Land Scotland	N
Georgina Lindsay	RZSS	Y
Iain MacGowan	Malloch Society/National Museums Scotland	Y
Eileen Mathers	RIC Species Champion	Y
Amelie Sumpter/Chris Tilbury	RSPB	N
Helen Taylor	RZSS	Y
Hayley Wiswell	CNPA	Y

*Kenny Kortland subsequently moved to Scottish Forestry and Colin Leslie from Forestry and Land Scotland has had input into this strategy as it was being revised.

VISION STATEMENT FOR 2055

Connected, self-sustaining populations of pine hoverflies are found in suitable habitat in sites with secure, long-term management, across an appropriate ecological range. The pine hoverfly is a flagship species highlighting forest management practices that produce connected, diverse Scots pine forest.

The conservation breeding programme has been expanded to additional British zoos and facilities to support an expanding release programme. National, cross-sector awareness is driving consistent funding, community engagement, and ecotourism. Effective monitoring and management continue to be driven by a multi-agency steering group.

PRIORITY WORK THEMES

MONITORING POST-RELEASE AND AT REMNANT SITES

HABITAT CREATION IN EXISTING RELEASE AND REMNANT SITES

IDENTIFYING NEW RELEASE SITES

RESEARCH

BREEDING PROGRAMME

POLICY

FUNDING

DATA MANAGEMENT AND TRANSFER

GOVERNANCE

GOAL STATEMENTS AND ACTIONS

The SG has devised goal statements and priority actions for each of the priority work themes identified in the strategic workshop. For a detailed action delivery schedule, please refer to the Pine Hoverfly Conservation Action Plan, a living electronic document that can be obtained from the SG on request. The Action Plan gives details of lead organisations and specific deadlines for each action and breaks complex actions down into their component parts where needed.

MONITORING POST RELEASE AND INDIGENOUS SITES

GOAL

Establish well-resourced, statistically viable, efficient, monitoring programmes for:

1. existing release sites (by summer 2025)

2. release sites known to have a breeding population (unknown number - to be determined once breeding in the wild has been confirmed)

3. stump condition and number (by summer 2025),

4. dispersal distances from release sites (by September 2025)

ACTIONS

- Any site where a release has taken place will have full annual larval monitoring of all stumps/troughs until a sustainable population is established. Condition of stumps/troughs to be monitored at each survey to allow for calculation of numbers of stumps required for future releases.
- Any release sites that are evaluated as having a sustainable population of pine hoverflies, will be monitored via larval surveys every three years.
- In at least two selected release sites (initially Garten Wood and Ryvoan), experimental set ups of stumps placed at varying distances from the release site will be created to establish breeding range, monitored annually.
- All monitoring results will be written up annually and a summary made available on the RIC SharePoint.
- Work with Cairngorms Nature Strategy Group to continue evaluation of pine hoverfly status via the recovery curve and nature index metrics.
- Recruit at least 30 volunteers for larval surveys annually by advertising within RIC partner organisations and other conservation organisations/educational institutions as well as via local media such as newsletters and newspapers and events.
- Train volunteers for larval surveys by hosting annual in-person training events at HWP.
- Ensure existing volunteers and the general public are kept up to date on all activities related to pine hoverfly via a volunteer mailing list (to be reinstated) and local media such as newsletters and newspapers respectively.
- Reinstate an annual in person meeting for volunteers.

HABITAT CREATION IN EXISTING RELEASE SITES AND IN INDIGENOUS SITES, IF REQUIRED

GOAL

Ongoing, long-term planning for creation of stumps/troughs/tubs/live holes to maintain sufficient artificial habitat within release sites for releasing captive-bred individuals and monitoring the population at each release site.

ACTIONS

- Arrange training for one person per release location to be able to cut stumps and troughs at that site and continue to fund contractor annually to cut stumps/troughs.

- Each year after September larval survey, plan 18 months in advance for the number of stumps/troughs required to be created at each release site.
- Cut stumps and troughs in late autumn/ winter to be in place for egg-laying the following May.
- Supplement any shortfall by plastic tubs as a last resort.

EXPAND POPULATION BY IDENTIFYING NEW RELEASE SITES

GOAL

Create five pine hoverfly populations within the species' natural range by 2030 with two establishing populations in Deeside and three self-sustaining populations in Badenoch and Strathspey.

ACTIONS

- Identify at least four new sites for pine hoverfly releases by September 2025 with the aim of building on existing sites, or filling in gaps between sites, to establish sustainable populations.
- Create a criteria list for suitable habitat including guidance on habitat creation and management (source and update from existing) and circulate to new and existing partners and landowners to identify suitable new sites, by end of 2025.
- Identify potential new sites through review of historical range, habitat data, gaps between existing sites etc. by end of 2026.
- Obtain landowner permission, then inspect potential sites to confirm suitability by June 2024. (Completed)
- Maintain a map of possible future release sites that have been explored and discounted.
- Ensure release licence covers new sites and is up to date.
- Confirm designated site status and ensure suitable permissions are obtained, well in advance of any proposed habitat creation work (timeline determined by sites being selected).
- Carry out full larval surveys annually for three years on at least four potential release sites to determine the presence or absence of any native pine hoverfly. If no wild larvae are found after three years, the site is to be scheduled for larval release the following year, (e.g., for stumps and troughs created in autumn/winter 2024 and first monitored in September/October 2025, if not occupied, the first larval releases would be in October 2028). If wild larvae are found within the three years, site monitoring to be continued to determine the sustainability of the population.

RESEARCH

GOAL

Identify research priorities and establish links with educational institutes to encourage them to send students and academics to work on these priorities

ACTIONS

- Draw up a list of priority research topics (e.g., dispersal distance, minimum viable population, genetic compatibility, adult ecology) and prepare short description of each research topic by May 2025.
- Identify and reach out to volunteers, institutions and courses (e.g. MSc and Honours) where we might advertise project

opportunities (not funded by us) in August 2025, ahead of project selection for Sept 2026 and then on a rolling annual basis in line with academic timetables.

- Review research results and feedback into strategy as required or appropriate.

CONSERVATION BREEDING PROGRAMME

GOAL

Maintain a healthy, genetically diverse, safeguarded conservation breeding population that can support the aims of the strategy.

ACTIONS

- Maintain HWP breeding programme at current level unless wild situation dictates otherwise - breeding programme continuation and evolution to be reviewed in 2027 in line with RZSS internal project review process.
- Conduct disease risk assessment and implement any resulting precautions/changes to animal husbandry by end of 2025.
- Use results of genomic analysis to inform breeding programme and make more informed decision on bringing in wild larvae by end of 2025.
- Reconsider option of translocating larvae/pupae from Scandinavia if genomic analysis suggests this is required.
- Identify a new zoo/facility capable of and willing to hold an insurance population of pine hoverfly by end of 2025.

POLICY AND ADVOCACY

GOAL 1

Ensure suitable mature pinewood habitat is integrated in the Scottish National Forestry strategy by working with other groups with an interest in the relevant habitat and/or species with similar habitat requirements.

ACTIONS

- Contact groups and establish effective approach for feeding into the forestry strategy.

- Appoint a Nature Champion MSP for pine hoverfly (route into advocating in government) by end of 2026.

GOAL 2

Ensure the habitat needs of pine hoverfly are included in the Cairngorms National Park Forestry Strategy (CNPFS) and Cairngorms Nature Action Plan (CNAP) when they are being reviewed.

ACTIONS

- Ensure that pine hoverfly needs at species level and landscape level are integrated into the next Cairngorms Nature Action Plan which runs from 2025-2030.
- Engage with and update councillor Bill Lobban (Highland Council pine hoverfly species champion) on pine hoverfly project on an ongoing basis.
- Identify new Highland Council pine hoverfly species champion ahead of Bill Lobban's retirement in 2027.

NB: Cairngorms National Park Forest Strategy not due for renewal until 2038 therefore falls outside the scope of this strategy term

GOAL 3

Ensure inclusion of pine hoverfly in relevant site management plans.

ACTIONS

- Identify relevant landowner contacts for targeted sites within pine hoverfly ecological range once the range has been mapped (see research section).
- Organise visits for land managers interested in hosting pine hoverfly releases to "good" pine hoverfly habitat annually.
- Draft suggested template paragraph for interested landowners to include in site management plans (e.g., designated site plans, NGO reserve management plans etc.) including long-term forest plans.
- Engage with statutory consultees (Scottish Forestry and CNPA) in 2025 to ensure

they are aware of and looking out for pine hoverfly habitat in submitted site management plans.

FUNDING

GOAL

Ensure long-term secure, continuous funding from a variety of sources to maintain project viability and safeguard the achievements of the project so far.

ACTIONS

- Review funding situation at SG meetings as a standing agenda item.
- Feed into RIC funding strategy as part of RIC review and as required.
- Hold a dedicated SG meeting (with some externals) to brainstorm diverse funding sources (including corporates etc.) to take place in Q4 2025 or Q1 2026- part of this meeting to cover identification of brands with associations with forest/rowan/ invertebrates.

DATA MANAGEMENT AND TRANSFER

GOAL

All data from habitat management, surveys, and breeding programme is held in a safe location that is accessible by all partners and updated annually (possibly RIC database)

ACTIONS

- Establish a schedule to extract data stored on RSPB Merlin platform onto RIC SharePoint and set up access for all partners by end of 2025.
- Establish best practice for timely and efficient data capture (i.e., field paper-based data into electronic format) by end of Q2 2025.
- Ensure regular circulation of project relevant reports as they are produced.

GOVERNANCE

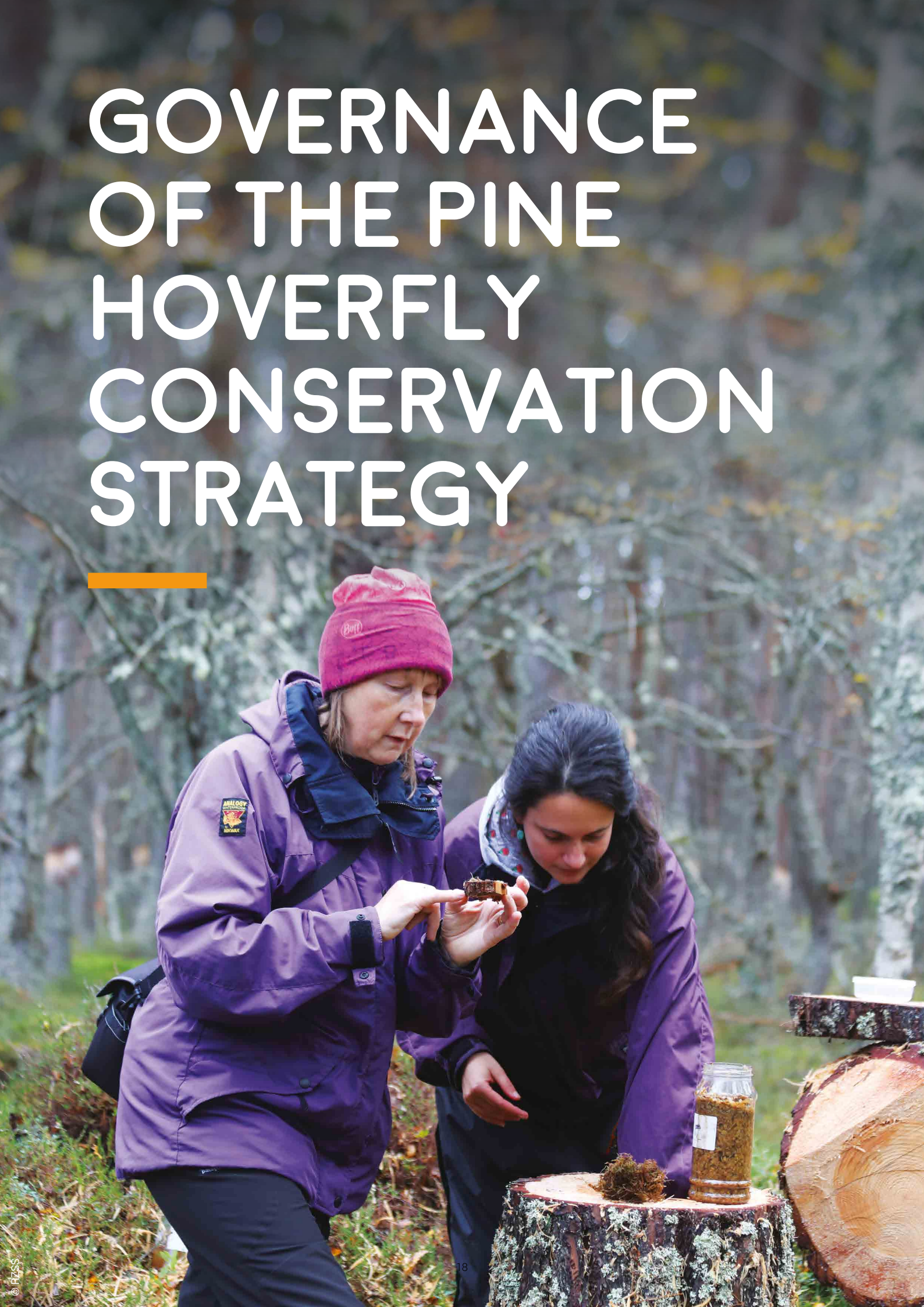
GOAL

The strategy is governed by the SG, which has its own Terms of Reference (ToR) for membership. Review membership alongside the strategy.

ACTIONS

- Draft ToR, including a clear statement of how the pine hoverfly steering group works alongside the RIC steering group, by end of Q2 2025.
- Hold meetings at least four times per year with additional meetings where required.
- Ensure progress against strategy is reviewed at each steering group meeting with an annual overview of the action table using a red, amber, green mechanic.

GOVERNANCE OF THE PINE HOVERFLY CONSERVATION STRATEGY



The SG comprises representatives from RSPB, RZSS, NatureScot, CNPA, FLS, Malloch Society/National Museums Scotland, and the RIC project. It is currently chaired by a representative of RSPB. Its role is to implement, monitor and review delivery of the Pine Hoverfly Conservation Strategy. It meets up to four times a year with the aim of holding one in-person meeting each year.

Each organisation can have up to three representatives who cover different aspects of the organisations' involvement in the conservation of pine hoverflies. They may consult with other members of their organisation to represent that organisation's views.

The membership and chairmanship of the SG will be reviewed at the start of the Strategy delivery period in 2025. If changes are made during the period 2025-2030, this will be at the agreement of all members.

An existing Memorandum of Cooperation between RSPB Scotland, CNPA, FLS, NatureScot and RZSS (available from RIC on request) provides a framework for cooperation and understanding, and facilitates collaboration regarding pine hoverfly conservation and the conservation breeding programme for this species in Scotland. This runs until 31 May 2027.

Delivery of the in-situ programme operations for the Pine Hoverfly Strategy is partly achieved through the RIC project; a time-limited partnership project with its own steering group. There is a large overlap in membership between the two steering groups, but the pine hoverfly SG includes specialists who are not on the RIC steering group. It is important that the lines of communication between the two groups are kept open and that each understands where decisions should be made, through agreed ToR (to be developed).

Reporting will be via RIC and RZSS plus other organisations' internal reports.

RELEVANT PUBLICATIONS

Ball, S.G. & Morris, R.K.A. (2014) A review of the scarce and threatened flies of Great Britain. Part 6: Syrphidae. Species Status 9: 1-130 Joint Nature Conservation Committee, Peterborough.

Rotheray, E.L. (2010) Restoring the endangered pine hoverfly in the UK pp. 21-24. In: Global Re-introduction Perspectives: 2010, Additional case-studies from around the globe. IUCN/ SSC Re-introduction Specialist Group, Abu Dhabi, UAE

Rotheray E.L., Greminger M.P., Nater, A., Krutzen, M., Goulson, D., Bussiere, L.F. (2011) Polymorphic microsatellite loci for the endangered pine hoverfly *Blera fallax* (Diptera: Syrphidae). Conservation Genetics Resources Technical Note DOI 10.1007/s12686-011-9488-2

Rotheray E.L., Lepais, O., Nater, A., Krutzen, M., Greminger M., Goulson, D., Bussiere, L.F. (2012) Genetic variation and population decline of an endangered hoverfly *Blera fallax* (Diptera: Syrphidae). Conservation Genetics DOI 10.1007/s10592-012-0371-9

Rotheray, E.L. (2013) Differences in ecomorphology and microhabitat use of four saproxylic larvae (Diptera, Syrphidae) in Scots pine stump rot holes. Ecological Entomology 38: 219-229.

Rotheray, E.L., MacGowan, I. (2015) 'Pine Hoverfly' Version 1.0. In: The Species Action Framework Handbook, Gaywood M.J., Boon P.J., Thompson D.B.A., Strachan I.M. (eds). Scottish Natural Heritage, Battleby, Perth.

Rotheray E. L., Goulson, D., and Bussiere, F. (2016) Growth, development and life-history strategies in an unpredictable environment: case study of a rare hoverfly *Blera fallax* (Diptera, Syrphidae). Ecological Entomology. Volume 41, Issue 1. Pages 85-95.

Rotheray, G.E., MacGowan, I., (2000) Status and Breeding Sites of Three Presumed Endangered Scottish Saproxylic Syrphids (Diptera, Syrphidae). Journal of Insect Conservation 4, 215–223.

Rotheray, G.E., Rotheray, E.L., (2012) Translocating the Pine Hoverfly, *Blera fallax*. Antenna Bulletin of the Royal Entomological Society 36, 36–41.

Taylor, H.R., Rotheray, E., Elliott, A, MacGowan, I, Sears, J. & Tompkins, G., (2021) Hovering on the edge of extinction: efforts to save the pine hoverfly. British Wildlife 32: 547-554

Taylor, H.R., Ritchie-Parker H., Wellcome Sanger Institute Tree of Life programme *et al*. (2023) The genome sequence of the pine hoverfly, Blera fallax (Linnaeus, 1758. Wellcome Open Res, 8:89

Taylor, H.R., Allott, C., Tompkins, G., PHSG, MacGowan, I. (in review). A large-scale conservation breeding and translocation programme to reintroduce a Critically Endangered saproxylic hoverfly to a Scottish forest ecosystem. J. of Insect Conservation and Diversity.

Taylor, H.R., Allott, C., Barrie , E., Elliott, A., Kortland, K., Lindsay, G.,MacGowan, I., Mathers, E., Sears, J., Sumpter, A., Tompkins, G., Wiswell, H. (in press) Reintroductions of the Critically Endangered pine hoverfly in the Cairngorms National Park, Scotland. In: Global Re-introduction Perspectives: 2024, Additional case-studies from around the globe. IUCN/ SSC Re-introduction Specialist Group, Abu Dhabi, UAE.

Verrall, G.H., (1874) Diptera at Braemar, Aberdeen and Aberfeldy, including six species not hitherto recorded as British. The Scottish Naturalist 1873–74, 199–202.

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Cairngorms National Park Authority

Cheeky Panda

Forestry and Land Scotland

Marvelous Europe Limited

National Geographic Society

Players of People's Postcode Lottery

RZSS

Scottish Government Scottish Zoo and Aquarium (Covid 19 Pandemic) Conservation Fund

The NatureScot Nature Restoration Fund

Various generous patrons

The Rare Invertebrates in the Cairngorms project is a partnership between the RSPB, Buglife Scotland, Cairngorms National Park Authority, RZSS, NatureScot and Butterfly Conservation Scotland.

This project was part-financed by the Scottish Government and the European Community LEADER 2014-2020 programme for the period between 2017-2019. During 2020-2021, the project was funded by the Cairngorms National Park Authority, RSPB Scotland, Cairngorms Connect (via the Endangered Landscapes Programme) and the Cairngorms Trust Green Recovery Fund. The project received NatureScot Nature Restoration Fund money for pine hoverfly habitat creation in 2021 and 2022. From 2022-2024, the project was funded by RSPB Scotland and the Cairngorms National Park Authority. As of 2025, the project is funded for three years by the Swires Trust in addition to ongoing funding from RSPB Scotland and the Cairngorms National Park Authority.

We are grateful to the following landowners for allowing/facilitating pine hoverfly habitat creation, releases and monitoring on their sites:

RSPB Scotland

Forest and Land Scotland

Anagach Woodland Trust

National Trust Scotland

Balmoral Estate

A multitude of individuals from various organisations have been involved with pine hoverfly conservation both in participatory and advisory roles. In particular, we thank the following:

Malloch Society/National Museums Scotland: Graham Rotheray

University of Stirling/Sussex: Ellen Rotheray

RIC: Gabrielle Flinn, Genevieve Tompkins, James Silvey, Claire Smith, Peter Gilbert, John Attiwell

CNPA: Stephen Corcoran, Sarah Henshall, Matthew Hawkins

RSPB: Amelie Sumpter, Christopher Tilbury, Andy Amphlett, Ross Watson, Pete Moore

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ORGANISATIONS INVOLVED IN DEVELOPING THIS STRATEGY

Cairngorms National Park Authority
Ùghdarras Pàirc Nàiseanta a' Mhonaidh Ruaidh

Forestry and Land Scotland
Coilltearachd agus Fearann Alba

NatureScot
NàdarAlba

RSPB

RZSS
THE WILDLIFE CONSERVATION CHARITY

OUR FUNDERS

Cairngorms National Park Authority
Ùghdarras Pàirc Nàiseanta a' Mhonaidh Ruaidh

Cairngorms Connect

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PART OF THE Cairngorms National Park

The Cheeky Panda

Forestry and Land Scotland
Coilltearachd agus Fearann Alba

LEADER

MARVELOUS!

NATIONAL GEOGRAPHIC

NRF NATURE RESTORATION FUND

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LET'S DO NET ZERO

PEOPLE'S POSTCODE LOTTERY

POSTCODE PLANET TRUST

RSPB

RZSS
THE WILDLIFE CONSERVATION CHARITY

Scottish Government
Riaghaltas na h-Alba
gov.scot

APPENDIX: DEFINITION OF TERMS

For the purposes of this strategy the following definitions have been used (in future strategies these might change):

APPROPRIATE ECOLOGICAL RANGE (FOR PINE HOVERFLY)

Conditions where pine hoverflies could establish, persist, and thrive based on available data from historic records in Scotland and current populations across the Palearctic.

ARTIFICIAL HABITAT (FOR PINE HOVERFLY)

The adult female pine hoverfly lays her eggs in cavities or 'rot holes' in Scots Pine which are created by the action of fungal rot and then fill with water to form a bacterial 'soup'. Artificial rot holes can be created in felled Scots Pine trees to mimic this natural habitat, by cutting holes with a chainsaw, either in the stumps left standing upright (rooted or unrooted), or as troughs in the felled tree lying horizontally, and filling them with woodchip. Live holes can also be created by drilling small holes into living trees.

BREEDING POPULATION

A population where there is evidence that the species is breeding, but the population has not yet been classed as self-sustaining.

DIVERSE SCOTS PINE FOREST

Either naturally derived or planted Scots pine forest which has features of remnant Caledonian pine forest, only found in Scotland in the UK (occurs as boreal forest in other parts of the globe). Scots pine is the dominant tree species but juniper and broadleaves are also present. The ground flora is well established and contains a mosaic of shrubs (heathers, Vaccinium species) grasses and vascular plants, many of which are specific to pine forest. The age structure of the forest is diverse, with trees able to reach veteran status and a variety of deadwood types are present, both on living and deceased trees. The forest contains a wealth of flowering trees, shrubs and vascular plants and tree regeneration can take place due to management of herbivore populations.

HISTORIC SITE/LOCATION

A site or location which was historically occupied i.e., with records from surveys in 1880s-2000 (e.g., Anagach Woods).

INDIGENOUS POPULATION

A population which has persisted within a historic site/location (e.g., Curr Wood).

LOCATION

A geographically distinct area, normally with a single landowner (e.g., Abernethy Forest, Glenmore, Anagach Woods). There may be multiple release sites within a location (e.g., Garten Wood and Bognacruie within Abernethy Forest; Ryvoan within Glenmore).

RELEASE SITE

A distinct space containing sustainable pine hoverfly habitat (i.e., artificial: stumps, troughs, or tubs, or natural mature pines with rot holes, and food plants such as rowan) where the next release site is beyond the known dispersal range of the species (i.e., a pine hoverfly could not fly between these two spaces) (e.g., Garten Wood and Bognacruie are two release sites within the location of Abernethy).

RELEASE ZONES

An area of artificially created pine hoverfly habitat (stumps, troughs, or tubs) within a release site. Any given release site may have one or several release zones. These zones are connected (i.e., a pine hoverfly could fly from one to the next in a stepping stone fashion).

SUSTAINABLE POPULATION

A population that shows a stable or increasing trend in number of individuals and/or area of occupancy without species-specific conservation intervention (i.e., releases) for at least five years