



Forestry and
Land Scotland
Coilltearachd agus
Fearann Alba

Forestry and Land Scotland

Biodiversity Duty Report

2021 to 2023

Introduction

The conservation and enrichment of biodiversity is a key priority for the Scottish Government, and this is reflected in the Programme for Government. The *Scottish Biodiversity Strategy to 2045* sets out the Scottish Government's ambitions for biodiversity and reflects a strong commitment to protect and enhance Scotland's species and habitats. As a Scottish Government agency, Forestry and Land Scotland manages Scotland's national forests and land on behalf of Scottish Ministers.

This summary report outlines actions carried out by FLS between 2021 and 2023 (inclusive) as part of its statutory duty to further the conservation of biodiversity. Further information about Forestry and Land Scotland and its work for biodiversity can be found on the organisation's [website](#).

Section 1: Information about Forestry and Land Scotland

Forestry and Land Scotland (FLS) is a relatively new executive agency of the Scottish Government, having been launched in April 2019. The purpose of FLS, in its unique position as both an executive agency and the largest land manager in Scotland, is to act as steward of the public forests and land and to manage them in a balanced way that supports and enables economically sustainable forestry. Conserving and enhancing biodiversity and the wider environment, and delivering benefits for people and nature, are key parts of the FLS mandate, which are delivered on a day-to-day, ongoing basis.

FLS therefore plays a key role in supporting the Scottish Government's ambitions and priorities for biodiversity, forestry, and land management – including increasing its contribution to addressing both the current Biodiversity Crisis and Climate Emergency. Our aim is to bring about a transformational change across the 636,484 hectares of national forests and land to maximize its contribution to biodiversity conservation, as well as Scotland's ambitious climate change adaptation and mitigation targets. To facilitate efficient delivery of these targets, FLS is organized into five management units, called regions: North Region, East Region, West Region, Central Region, and South Region.

The land managed by FLS is diverse and includes a range of habitat types. For example, FLS manages 40,612 hectares of Natural Forests, which comprise a mix of Ancient Semi-natural Woodlands (ASNW) and other semi-natural woodland types. A total of 8556.75 hectares of these various woodland types, including some of these Natural Forests, are protected as Natural Reserves, wherein no management takes place and old-growth characteristics are allowed to develop without constraint.

In addition to these Natural Forests, FLS manages 312,600 hectares of productive plantations. As well as yielding substantial amounts of sustainable timber, the management of these plantations creates a mosaic of stands of varying age and structure, which supports remarkable biodiversity. These plantations are crucial habitats for many species in Scotland. Furthermore, the timber they produce reduces the amount that is imported to Scotland, thereby protecting more biodiverse, often endemic-rich, natural forests across the global.

In addition to this woodland, FLS manages 232,343 hectares of open habitats, ranging from agricultural land and archaeological sites to upland heaths and peatland. These areas support a different range of plant and animal species. All in all, Scotland's national forests and land are diverse and provide habitats for incredible biodiversity, whilst producing commodities and supporting jobs. This is something that we should all celebrate.

Note – All of the figures quoted above were correct as of December 2023.

Section 2: Actions to further the conservation of biodiversity

On an ongoing basis, FLS carries out a range of actions to protect and enhance biodiversity. This includes improving and restoring existing habitats and creating areas of new habitat. Scotland's national forests and land cover approximately 9% of Scotland's total land area, but less than two-thirds are actually forest. Therefore, FLS works to improve open habitats as well as woodland, often in partnership with other organisations.

Designated sites. FLS manages 453 features designated as Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Special Protection Areas (SPA) or RAMSAR sites. In total, 89,297 hectares are designated as SSSI, SAC or SPA. The current percentage of these designated features that is in favourable condition is 92.7%. This has fluctuated slightly since 2020. For woodland features, the proportion in favourable condition is 83%. This has gone down slightly since 2020 due to recent site assessments and a change in methodology which more accurately assesses herbivore impacts – excessive deer impacts continuing to be the main cause of unfavourable condition in woodlands. The increased deer cull across FLS managed land is already demonstrating improvements in woodland condition and we are confident that there will be a significant reduction in the number of unfavourable woodland features in the next report.

A substantial amount of work has been undertaken to maintain favourable condition of designated features. Ongoing control of invasive species and felling of adjacent plantations being typical activities. More specific work has also been undertaken to protect species – for example, erection of a predator fence to protect rare ground nesting ducks; clearance of trees shading rare lichens.

We have acquired some new land since 2021 (particularly Glen Prosen) and designated features on these areas are yet to be brought into our allocation of designated sites on the database maintained by NatureScot. Once these have been added, the percentage of favourable sites is likely to go down due to past land management practices.

High conservation value forest and other land. FLS manages 40,612 hectares of Natural Forests, which comprise a mix of Ancient Semi-natural Woodlands (ASNW) and other semi-natural woodland types. Approximately 8,000 of this is ASNW and the remainder is of more recent origin. 89,297 hectares are designated as SSSI, SAC or SPA. Note there is overlap within these categories.

On FLS land, 30,383 hectares of woodland are classified Long-established Plantation Origin (LEPO) forest. We have recently carried out a desk assessment of this area which identified

that 7,861 hectares of LEPO are likely to be of High Conservation Value. We have issued guidance on management of this sub-set of LEPO to safeguard their conservation value.

Ancient Semi-natural Woodland (ASNW). In 2021, we commissioned Trees for Life to survey all of our Caledonian Pinewoods. This survey identified that many of these woodlands are in sub-optimal condition due to deer impacts and non-native regeneration. The most vulnerable pinewoods are in the west of Scotland and threats will be addressed through the Scottish Government's work for Scotland's Atlantic Rainforest (see below), which is being delivered in partnership with the Alliance for Scotland's Rainforests.

However, site visits during the period 2021 to 2023 identified that significant programmes of work are needed in the other pinewoods further east and we are exploring funding mechanisms to help us to tackle these threats – particularly clearance of non-native regeneration. The substantial and ongoing efforts taking place to reduce deer numbers across FLS managed land will have a very positive impact on all of our pinewoods. In the 1990s there was a major programme of Caledonian Pinewood restoration and work is needed now to consolidate these efforts and safeguard these important woodlands.

In addition to the pinewood survey, condition assessment data for the rest of our ASNW area, collected in the period 2021 to 2023, will help us to prioritise our rainforest work.

Atlantic Rainforest Programme. Scotland hosts a globally significant collection of rainforests along its western seaboard. These woodlands are the European headquarters for many species of lichen, bryophyte, and fern. Whilst the area of rainforest in Scotland is limited (approximately 30,000 hectares of core rainforest – this represents 6.5 % of global temperate and boreal rainforests) the quality of this habitat is much higher than elsewhere in Europe due to air quality and climate.

Forestry and Land Scotland manages around 30% of Scotland's rainforests. We manage some of the richest and most well-known sites, including the Sunart oakwoods, Glen Creran, Glen Shira, Glen Nant and Dalavaich oakwoods. There are also countless rich fragments of ancient Atlantic woodland along watercourses and within PAWS (there are 13,297 hectares of PAWS within the rainforest zone). Restoring this habitat makes an essential contribution to reversing the decline in global biodiversity. Rainforest restoration can also stimulate the creation of land-based jobs and skills in rural or remote communities across western Scotland.

Atlantic rainforest areas face considerable threats. The majority are overgrazed by deer, which simplifies woodland structure and composition and threatens the long-term survival of the rainforest habitat. In addition, rhododendron has invaded many of Scotland's Atlantic rainforests, creating dense shade that obliterates native flora. Rhododendron competes for moisture and nutrients and can ultimately replace the rainforest canopy.

In 2022, FLS secured £1.3 million in funding to undertake restoration in priority rainforest areas, with a further £1.5 million awarded in 2023. FLS is focusing its efforts on several activities including increasing deer management across priority rainforest areas in the west and

north of Scotland. Additionally, FLS is concentrating on rhododendron control and PAWS restoration across 658 hectares in key locations within Cowal, Argyll (Kintyre and west Loch Awe), the Loch Lomond Basin, and Wester Ross.

For example, in FLS West Region, the FLS environment team has been engaging with the Woodland Trust's Loch Arkaig project, the RSPB's Saving Morvern's Rainforest, and the Argyll Coast and Countryside Trust's Saving Knapdale's Rainforest project. These projects involve the removal of rhododendron and non-native regeneration on a landscape scale to prevent re-infestation from neighbouring seed sources. This enables the rainforest ecosystem to regain missing ecological functions, which are needed to support the full array of biodiversity; from the lichens and bryophytes to invertebrates and the woodland birds, and all the way up to the larger predator species, such as pine marten. By the end of November 2023 this restoration work had been carried out across 126 hectares, with at least another 60 hectares on course to be completed by the end of the year.

In addition to this direct action, various other initiatives have been underway in the period 2012 to 2023, including baseline surveys of rhododendron, training of personnel involved in the rainforest projects, and research to improve the effectiveness of rhododendron control.

Plantation on Ancient Woodland Site (PAWS). These are areas that were formerly ancient, native woodland sites, but which were planted with conifers for timber production. The aim of the FLS PAWS programme is to restore, where appropriate, these sites to native woodland of high ecological value. Around 30,000 hectares of PAWS have been identified in Scotland's national forests.

There has been an ongoing programme of PAWS restoration since the last report in 2020. Over 400 hectares of PAWS have been clear-felled or thinned in that time. Storm Arwen and felling in response to *Phytophthora ramorum* infections have been the main drivers for harvesting activity as well as the normal programme of forest restructuring. Specific targeted felling of PAWS has been undertaken too – for example in Glen Murrison and above Loch Shiel, to consolidate efforts to achieve landscape scale restoration.

Non-native regeneration continues to be the biggest challenge to habitat recovery, along with shading of veteran trees and other ancient woodland remnants by conifers in areas where felling is not planned for some time. The Rainforest Programme is already making good progress with removal of non-native regeneration – for example, in Dalavich and Knapdale forests in west Argyll and in Balmacara forest in Wester Ross. We have produced guidance on halo thinning and will be running workshops on this in the next few months – ensuring that staff and contractors have the skills to open up ancient woodland remnants, thereby safeguarding the ecological potential of our most promising PAWS.

We have also been supporting the James Hutton Institute and the Royal Botanic Gardens Edinburgh in their research to assess the efficacy of our PAWS restoration. This research will be used to improve future work.

Natural reserves. As part of the requirements of forest certification (UKWAS), FLS is required to create natural reserves (NRs). These are areas managed in perpetuity by minimum intervention and, on the national forest estate, they are predominantly woodland habitats. In total, 8,557 hectares are designated as Natural Reserves. That is 46% more area than required by UKWAS certification. Approximately 45% of this designated area is of plantation origin, the remainder are of semi-natural origin. A further 29,053 hectares are managed through minimum intervention but not permanently designated as natural reserves.

Woodland creation. Scotland has approximately 19% woodland cover, which is much lower than most European countries. For example, Finland, Norway, France, and Poland have approximately 72%, 37%, 36% and 29% woodland cover respectively. The Scottish Government has set ambitious targets for expanding woodland cover in Scotland and over the last decade FLS has been creating valuable areas of new woodland – much of it in areas close to towns and cities to facilitate access and recreation, and a large proportion of it comprised of native broadleaf tree species.

Whilst recognizing that areas of important open habitats also need to be protected, an expansion in woodland cover will yield a significant net increase in Scotland’s biodiversity. More woodland will also increase connectivity for woodland species, allowing them to disperse more easily, and this will enhance the viability of their populations. Woodland recovery will also improve soil quality over time – particularly in the uplands – to the enormous benefit of soil biodiversity.

The portfolio of our acquisition sites has broadened since 2020 and, as well as continuing to establish commercial conifer forest, we are now buying land to create significant areas of native woodland, some of which is in the rainforest area. We are also surveying previously open land above the planted forest and assessing the naturally colonised area.

In the period 2021 to 2023, the following new woodland was created on land managed by FLS:

Type of new woodland	Area (hectares)
New area planted – conifer	315
New area planted – broadleaf	379
New area regenerated – conifer	176
New area regenerated – broadleaf	287
Total area of new woodland	1157

In the period 2021 to 2023, FLS also carried out a lot of restocking of felled areas. In total, 12,007 hectares were restocked. This included 1,888 hectares of broadleaf planting and 199 hectares of broadleaves that were naturally regenerated.

Peatland restoration. The Scottish Government's Climate Change Plan aims to restore 250,000 hectares by 2030. The primary benefit of peatland restoration is in relation to climate change and storing carbon, though it has many other benefits including providing an internationally important habitat, improving water quality, and reducing flood risk.

Between 2021 and 2023 FLS has been intensifying its restoration efforts on an increasing area of degraded peatland, supported by a significant funding commitment from the Scottish Government. The condition of blanket bogs has been improved by removing drainage systems and the remedial treatment of peat hags. Afforested blanket and lowland raised bogs have been completely restored by the removal of plantation crops and tree regeneration, followed by a range of ground re-wetting actions, including the installation of peat dams and the backfilling of drainage ditches.

Site treatment completed (ha)	2021	2022	2023
Blanket bog condition improvement	127	38	179
Blanket bog restoration	427	880	535
Total	579	918	714

Non-peatland priority open habitat. Although peatland restoration has been a focus for FLS during the period 2021 to 2023, a range of other priority open habitats are found with Scotland's national forests and land. These range from upland heathlands and upland calcareous grasslands to lowland fens and coastal sand dunes, among others.

Benefits to priority open habitats accrue mainly through the deer control carried out by FLS throughout Scotland's national forests and land, which reduces grazing pressure on priority open habitats, allowing plant communities to recover. For example, in FLS North Region, deer populations are actively managed across 6000 hectares of upland heath and blanket bog, facilitating vegetation recovery across this spectacular site.

Other actions for priority open habitats include the removal of non-native-conifer regeneration and the use of controlled grazing to maintain vegetation in a preferred state for important plants and their associated biodiversity. For example, in Glenmore Forest Park, non-native-conifer trees that were colonising important upland heathland areas. FLS North Region removed these young trees from 190 hectares in 2021, 363 hectares in 2022, and from 370 hectares in 2023. In FLS East Region, 11 hectares of non-native regeneration was cleared from around the Allean Lochs to enhance areas of open water and wetland. Similar work is happening in other places managed by FLS.

Cattle grazing is used in some parts of Scotland's national forests and land to manage swards to the benefit of priority habitats and their dependent plant and animal species. This is usually done in collaboration with local farmers. For example, the following grazing management in FLS West Region maintains priority habitats and populations of rare species:

- Fiargall and Creag Chaise (Kilmichael): 147 hectares of upland heath and blanket bog grazed by cattle to manage vegetation for black grouse habitat.
- Barnagad (Knapdale): A 6-hectare field is grazed by cattle to manage the vegetation for Devil's bit scabious and marsh fritillary butterflies.
- Ardnackaig (Knapdale): 114 hectares of upland heath, blanket bog and birch regeneration is grazed by cattle and two Eriskay ponies to suppress bracken and Molinia.
- Loch Frisa (Mull): 145 hectares of upland heath and blanket bog grazed by cattle to maintain the open habitat.

Species conservation. FLS carries out and supports a very extensive range of conservation work for rare, endangered, and protected species all across Scotland's national forests and land. This is mainly in partnership with other organisations and individuals who have particular expertise. The work is predominantly focussed on vertebrates, particularly birds and mammals, which reflects the interests of stakeholders. However, FLS is expanding the range of work to include invertebrate species.

Between 2021 and 2023, FLS staff and partners collaborated on action for a large number of species, including capercaillie, golden eagles, white-tailed eagles, goshawks, common scoters, beavers, wildcats, water voles, red squirrels, freshwater pearl mussels and pine hoverfly. Key partners included NatureScot, the Raptor Study Groups, RSPB Scotland, the Royal Zoological Society of Scotland, Saving Scotland's Red Squirrels, and the Scottish Wildlife Trust. The following section gives some examples:

Refuges to protect capercaillie and other species and habitats in FLS North Region. Within the Cairngorms National Park, the expansion of recreational activities, along with the growth in visitor numbers and changes in visitor behaviour, has put significant pressure on protected species and habitats. Attempts at zoning areas to create refuges for wildlife have often been frustrated by the focus being on single species or sporadic and individual recreational activities. Therefore, when carrying out the 10-year review of the Strathspey Land Management Plan, forest planners and ecologists in FLS North Region decided to adopt an all-encompassing, science-based approach to develop effective refuges, which are called 'Vulnerable Habitats'.

Regional environment and visitor services teams worked with the planning team to map the Vulnerable Habitats; wherein special conservation measures are applied. These Vulnerable Habitats are relatively distant from tracks and recreational activity and long-term monitoring data and population modelling indicates that these areas are crucial for capercaillie. The management measures that are applied include seasonal and daily restrictions on the timing of activity, a presumption against large-scale off-track recreational events, and no new roads or

tracks. This management creates areas within the forest that are quieter, that will encourage positive changes to visitor behaviour and that will allow species and habitat some protection from the increasing visitor pressure.

The FLS North Region team were careful to ensure that they were not impinging upon visitor access rights under the Scottish Outdoor Access Code. Rather, the emphasis was on encouraging responsible access. A document outlining the Vulnerable Habitat prescriptions is used by FLS site managers to offer consistent advice to anyone seeking access to the forest. It has been particularly useful in discussing the frequent requests for “large events” as, previously, the response to those has varied, leading to some confusion among applicants. To date this has been well accepted both within the local teams as a framework for decision making and as an important step in ensuring consistent messaging with external stakeholders.

Action for dragonflies. In 2022, FLS signed a partnership agreement with the British Dragonfly Society (BDS) to collaborate on conservation action for dragonflies and damselflies across Scotland. This will last until 2025 and will almost certainly be extended beyond that date. Scotland’s national forest and land are disproportionately important for many of these species and BDS staff have already been advising on habitat improvements and habitat creation and have been providing training for FLS staff.

Species reintroductions. Between 2021 and 2023, FLS has collaborated with partners to reintroduce pine hoverfly, wildcat and beaver to Scotland’s national forests and land. Key partners included NatureScot, the Royal Zoological Society of Scotland (RZSS), and the Scottish Wildlife Trust. FLS have also been working with RZSS on plan to reintroduced long-horn beetles and other invertebrates into the Cairngorms Connect area.

Forest management and biodiversity. The main driver of overall biodiversity levels in Scotland’s national forests is silvicultural management. This is because the majority of the forest cover comprises production forest and is managed under sustainable management principles. Sustainable forest management is the stewardship and use of forested land that maintains biodiversity, productivity, regeneration capacity, vitality and potential to fulfil now and in the future relevant ecological, economic, and social functions at local, national, and global levels and that does not cause damage to other ecosystems.

FLS manages 382,232 hectares of this production forest, of which 312,600 hectares are productive plantations. The main silvicultural methods are clear-felling without thinning (mainly of Sitka spruce) followed by replanting, thinning of crops followed by eventual clear-felling and replanting, and thinning of crops to a low density of seed trees followed by natural regeneration.

The result of this varied management is that the forests comprise a mosaic of felled areas, young tree stands, thickets, unthinned mature crop and thinned mature crop, plus areas of natural tree regeneration. In addition, the remaining areas within Land Management Plans

(see Section 3) include permanent open space, watercourses with riparian areas, and non-wooded habitats. Furthermore, at a national level, Scotland's national forest estate is becoming more structurally diverse, as 'first rotation' plantations (i.e., those that have not yet been restructured), created in the 1950s and 1960s, are now being restructured and managed according to modern standards, which is creating more diverse forests.

This structural diversity in Scotland's national forests provides innumerable niches that support a vast array of species – measured in the many thousands (many tens of thousands if you include soil biodiversity). From species that use open areas to those that require interior forest habitats. The structural diversity and the overall biodiversity will continue to increase until all of the first rotation forest have been restructured. Recent research indicates that species richness of various taxa (plants, invertebrates, and birds) in managed plantations is surprisingly high and, somewhat surprisingly, approaching that of some semi-natural woodlands. However, the species assemblages of plants and animals in plantations were noticeably different, so plantations are not a direct replacement for native woodlands, which are invaluable for Scotland's biodiversity. Nevertheless, anybody who uses timber products that are produced in Scotland should celebrate the fact that plantations support significant biodiversity.

Deer management. Wild red deer and roe deer are an important part of Scotland's natural heritage. However, in many parts of Scotland they occur at densities that are high enough to cause damage to habitats, particularly native woodlands. Excessive deer browsing prevents tree regeneration and prevents the development of a shrub layer within forests. Both of these impacts have a negative impact on biodiversity; essentially by reducing the structural diversity of habitats and thereby reducing the number of niches available to biodiversity. In addition, deer cause significant damage to tree crops. In order to protect habitats and tree crops, FLS invests significant resources to sustainably manage deer populations using a range of different methods including culling. This work is carried out across Scotland's national forests and land, but with an emphasis on protecting vulnerable tree crops and woodland habitats.

Deadwood. Deadwood provides a habitat and food resources for thousands of species of animals, plants, bryophytes, lichen, and fungi (and enormous numbers of microbes). Scotland is a windy country and this creates deadwood in native woodlands and plantations on an ongoing basis. In native woodlands, deadwood is also created as trees are left to grow old and die. In plantations, huge amounts of certain kinds of deadwood are also created due to the process of timber production. For example, the stumps of felled trees are important deadwood habitats, and the 'brash' (branches) left on a felling site creates huge amounts of small diameter deadwood. However, certain types of deadwood, such as large-diameter logs and 'snags' (standing deadwood), are lacking in Scotland's woodlands and plantations, and the overall levels of deadwood in Scotland tend to be lower than in natural forests in other countries). To increase the amount of deadwood – in line with the UK forestry Standard and the requirements of forest certification – and the associated biodiversity, FLS has a

comprehensive deadwood strategy that ensures the deadwood resource in Scotland's national forests is enhanced on an ongoing basis.

Invasive non-native species control – rhododendron. In 2020, we commissioned an external review of our programme to control rhododendron. The consultants recommended that we focus our future efforts on a limited number of locations where there is a landscape scale, co-ordinated approach, and risks of re-invasion from neighbouring populations can be minimised. We have now identified where we can work effectively with Alliance for Scotland's Rainforest partners and other neighbours and work is underway to consolidate past management through the Rainforest Programme. In addition to these key landscapes, we are continuing to control rhododendron and other INNS on sites designated as SSSIs and SACs.

Invasive non-native species control – grey squirrels. Grey squirrels pose the greatest threat to red squirrel populations in Scotland because they can outcompete the red squirrels for habitat, and because they carry and transmit a disease called squirrel pox, which is usually fatal in red squirrels. To keep red squirrels in Scotland's landscapes it is essential to have sustained, targeted, landscape-scale grey squirrel population control over the long term. To this end, FLS is a partner in and co-funds the Saving Scotland's Red Squirrels (SSRS) project to carry out grey squirrel population control in a number of Scotland's national forests, and in adjacent areas from which grey squirrels could recolonise. All of this work is part of wider control efforts by SSRS and it is all aligned with the Scottish Strategy for Red Squirrel Conservation (2015). Further details are available on the SSRS website.

Section 3: Mainstreaming biodiversity

Furthering the conservation of biodiversity is a core part of the everyday work of FLS and it is integrated into every stage of the policy, plan, and delivery cycle. All management activities in Scotland's publicly owned forests and land are carried out in accordance with a range of policies and guidance that ensure the protection, conservation and enhancement of biodiversity is a mainstream activity. Each of the five FLS Regions has a team of environmental specialists that collaborate on a daily basis with the staff involved in felling and planting trees, or building roads, to protect and enhance biodiversity.

Standards, strategies and plans. All FLS work is guided by the United Kingdom Forestry Standard (UKFS), the reference Standard for sustainable forest management in the UK. It outlines the context for forestry, sets out the approach taken by UK governments to sustainable forest management, defines standards and requirements, and provides a basis for regulation and monitoring – including national and international reporting.

The UKFS emphasizes that the conservation of biodiversity is an essential part of sustainable forest management in the UK and outlines the forestry sector's approach to contributing to the United Nations' Convention on Biological Diversity, which provides the wider context for the Scottish Government's approach to forests and biodiversity. The UKFS Guidelines on Forests and Biodiversity provide specific guidance on forest management to conserve and enhance biodiversity, and informs FLS work on a day-to-day basis. Alongside the UKFS, the Scottish Forestry Strategy (SFS) and the FLS Corporate Plan (2022-202) also inform and guide FLS efforts to further the conservation of biodiversity.

Forest certification. FLS manages an area of Scotland's national forests and land that extends to 636,484 hectares. Most of this (611,650 hectares) is certified to the UK Woodland Assurance Standard (UKWAS), which is an independent certification standard for verifying responsible woodland management in the UK that reflects requirements of both the Forest Stewardship Council® (FSC®) and the Programme for the Endorsement of Forest Certification (PEFC) certification schemes. This independently audited standard requires FLS to manage the natural environment in a way that furthers the conservation of biodiversity.

Guidance. In the day-to-day management of Scotland's publicly owned forests and land, FLS staff follow a wide range of operational guidance. This guidance covers everything from protecting raptors and squirrels during forest operations, to ensuring watercourses and soils are not degraded during road building or tree felling. All of these guidance notes are available to view in the publication section of the Scottish Forestry website.

In addition to these forestry-sector-wide guidance notes, FLS also has a range of 'in-house' guidance notes that aim to reconcile forest management activities with the conservation of

biodiversity. Between 2021 and 2023, several pieces of new guidance were developed to enable FLS staff to adopt consistent approaches to emerging issues, and some existing guidance was updated to account for changes in legislation. These included:

- FLS General statement regarding native woodlands near peatlands
- Guidance on peat depth surveys to support afforested peatland management
- Choosing treatment methods to restore afforested peatlands
- What is peatland edge woodland
- Environment Standard Operating Procedure. Planting and restocking on peat soils
- Environment Standard Operating Procedure 4. Preliminary Ecological Appraisal
- Environment Standard Operating Procedure 5. Compiling environmental considerations
- Prioritising and programming PAWS management
- Overview of new PAWS guidance
- FLS Priorities for rhododendron control
- FLS Caledonian pinewood recovery survey data user guide
- Content of a Land Management Plan
- Red squirrel licence protocol
- Bird and animal survey licence protocol

Land Management Plans. FLS invests significant time in planning land management to further the conservation of biodiversity. It is a complex process of engagement, analysis, design, discussion, and agreement with stakeholders. The key output is the Land Management Plan (LMP), which is produced for every large forest or group of small forests managed by FLS. The LMPs are the forest-level plans that translate the strategic plans and policies into land management. Identifying environmental and biodiversity priorities within the LMP is an important part of the process, and each plan is written to further the conservation of these features. Engagement with stakeholders such as NatureScot and RSPB Scotland, as well as with local people and groups, is crucial to identify the most important environmental assets. This engagement is continued throughout the life of the LMP, and the partnerships developed in the planning process continue to inform the conservation of biodiversity.

In the period 2021 to 2023, FLS planners created or reviewed and updated 183 LMPs covering 373,602 hectares of Scotland's national forest. All of these plans incorporated actions to further the conservation of biodiversity.

Work Plans. On a daily basis, FLS carries out a wide range of forest and land management activities. To ensure these activities do not have an adverse impact on biodiversity, and to ensure opportunities to enhance biodiversity are taken, FLS uses a 'work plan' system for all forest management and most civil engineering work. The Work Plan system is also used to manage a range of other activities. The Work Plan is a fundamental tool in the process of delivery of plans 'on the ground' and is fully complementary with forest planning. The Work Plan process provides the means of co-ordinating other plans covering Operations, Environmental and Social remits. The Work Plan is a 'live' document that is created for every job, whether it is felling an area of trees or building a new section of forest track. All relevant FLS staff input to the Work Plan, and this ensures that relevant issues are highlighted.

Pre-operational surveys. FLS Environment staff contribute to all Work Plans, and this makes sure that operational staff are aware of environmental constraints and opportunities. As part of this core, everyday process, FLS Environment staff carry out pre-operational surveys prior to the commencement of operations. This means they visit each site to identify important habitat features, such as deadwood, and mark the sites of protected species, such as raptor nests and badger setts. They often deploy camera traps to ascertain whether setts or dens and other features are being used by protected species. In the three-year period from January 2021 to December 2023, FLS Environment staff carried out pre-operational surveys on over 2,800 work sites.

Once a pre-operational site visit has been carried out, mitigation measures are then written into the Work Plan. For example, an exclusion zone will be placed around a raptor nest, which means work cannot be carried out within that zone during the breeding season. Exclusion zones and timing restrictions on operational activities are two actions that are used very frequently by FLS to protect biodiversity.

Conservation sites database. FLS Environment staff maintain an extensive database of sites used by protected and priority species and areas of important habitats. Everything that is found during pre-operational surveys is recorded in this GIS-based database. Consequently, the number of records has grown considerably. At the end of 2012, there were 10,333 environmental features (resting places, breeding sites etc.) on the system. By the middle of 2023, this had grown to 25,715 features. All of this data is used to inform operational planning and to enact mitigation to protect biodiversity. Reconciling wildlife and habitats with operational activities is a daily and ongoing process for FLS staff and the protection of biodiversity is very much a mainstream activity for the organisation.

Section 4: Nature-based solutions, climate change and biodiversity

FLS is responding to the climate emergency by proactively creating resilient forests and open land habitats that will continue to make a positive contribution to biodiversity enhancement and climate change mitigation, whilst also being future proofed against wildfire, more frequent storms and flooding, and new or damaging pests and disease. Here are some examples of nature-based solutions being used by FLS to combat climate change and enhance biodiversity:

Nature-based solutions. FLS is working with partners to develop projects that enhance biodiversity and help tackle other challenges. For example, we have been working with Scottish Water on land we manage at Loch Katrine, the catchment that provides Glasgow's drinking water. Native woodland expansion and peatland restoration activity will not only support important habitats but will also protect water quality, prevent emissions from eroding bogs and capture carbon as more trees regenerate through our active management.

Elsewhere, FLS is working with Transport Scotland at the Rest and Be Thankful to establish new native woodlands which will complement hard infrastructure solutions to improve slope stability, mitigate landslips and road closures on the A83. FLS is also exploring further opportunities for partnership working with the private sector on projects that contribute to carbon mitigation, climate adaptation and biodiversity goals.

Another example of a nature-based solution was the removal of conifers from the confluence of the River Feshie and River Spey, which is resulting in the establishment of natural riparian woodland in this area. The River Feshie carries large quantities of gravel that have for many years been deposited at its confluence with the River Spey. This creates a dam or 'plug' effect, which has been implicated in rising water levels and associated flooding events on adjacent farmland. One solution to this issue was to use machines in the river to dig out the accumulation of gravel, but a more natural solution was sought.

Within the FLS Strathspey Land Management Plan, therefore, further actions were proposed to create a natural flood and gravel deposition area at the confluence. This has involved felling of conifers, removing cattle grazing, and allowing natural decay of existing flood defences. In short, the FLS land in this area is transforming into a riparian woodland floodplain, which will slow the river, when in flood, allowing it to deposit gravel over a wider area. This will avoid the need for intrusive in-river management and create a nature-based solution to the issue by restoring a natural flood plain. It will also benefit and add to the value of the designated features on this part of the confluence. The deposited gravel is also important habitat for nesting waders and a fascinating community of invertebrates

In another river enhancement project, FLS East Region supplied over 500 logs, with the root plates attached to the Dee Catchment Partnership in 2022 and 2023. These are being used to further their work on installing large woody debris dams in tributaries of the River Dee. Also in East Region, FLS has partnered with Suntory, a whisky company, to deliver peatland and wetland restoration and riparian improvements in Gartly Forest. Working alongside the James Hutton Institute, FLS environment staff drew up proposals to incorporate into a new land management plan that would restore peatland and improve water quality. In 2022, FLS undertook the first phase of this project by improving the condition of the Moss of Leith Hall, within Gartly Forest, through the removal of tree regeneration, plus drain blocking and ground smoothing. The restored bog will now provide clean water in perpetuity.

Climate Change Adaptation. Forest planning for resilience. During [Land Management Planning](#) FLS selects land use to best deliver against the management objectives including the biodiversity crisis, the Climate Change emergency and threats from pests and diseases. As plans are prepared, forest planners consider the future threats and build resilience into the plans including habitat maintenance, creation and strengthening, particularly along linear riparian corridors and designated sites.

Climate Change Adaptation. Tree species diversification. To build resilience in the face of a changing climate, Land Management Plans continues to shift towards including a greater diversity of tree species, including both a wider range of conifers and of broadleaves. In addition, FLS has been increasing the proportion of native broadleaf trees in Scotland's national forests. Between 2012 and 2020, the area of broadleaf trees in Scotland's national forest increased from 32,189 hectares to 42,642 hectares. By the end of 2023, this had increased to 46,953 hectares of broadleaf tree species.

Flood risk management. Flood risk is Scotland's greatest adaptation challenge and FLS will play its part to help reduce flooding. There is a strong link between the natural processes, biodiversity, and Natural Flood Management (NFM). Flood risk is a key consideration of forest planning including woodland creation, phasing felling and replanting, peatland restoration and slowing the flow of water from the land. FLS connects directly with SEPA's [Flood risk management plans](#) and with Local Authorities on their Local Flood Risk Management Plans. 43% of the FLS estate is upstream of SEPA's Objective Target Areas – "areas prone to flooding". On the estate, the careful riparian management and landscape scale tree cover helps to slow the flow of water flowing towards the areas prone to flooding downstream. Some local partnerships exist in places where specific measures are being taken including Strathard.

River Basin Management Planning. FLS continues to connect to priorities set out in the Scottish Environment Protection Agency's River Basin Management Plan for Scotland (2021 – 2027). Actions to tackle climate change and flooding almost always have significant benefits for biodiversity, and vice versa. For example, increasing the extent of woodland cover, to lock up carbon, usually increases the number of species of plants and animals that can live in these

areas. Similarly, re-establishing woodland along burns and rivers, to stabilise banks and reduce flooding, creates new habitat corridors that connect up areas of woodland, allowing species to disperse and establish new populations. In reverse, actions to enhance biodiversity, such as habitat improvement or deadwood retention, often increases the capacity of an area to store carbon over longer terms.

Renewable Energy. More than 1GW of electricity generation capacity is installed on FLS land in the form of wind and hydro power. One gigawatt is enough energy to power over 700,000 homes. As part of our efforts to support the Scottish Government's ambitious emissions reduction targets and tackle the climate emergency, FLS continues to explore the potential of the renewable energy resource on the land we manage. In 2022, FLS employed a full-time, permanent Renewables Ecology Advisor to work with renewable energy companies. This post will ensure that mitigation associated with energy developments is optimized and that the maximum possible benefits for biodiversity are accrued.

Section 5: Connecting people with nature, visitor strategy, public engagement, and workforce development

Connecting people with nature. Everyone can visit and enjoy Scotland’s national forests and land to connect with nature, have fun, and benefit their health and wellbeing. FLS manages some of the best places to visit in Scotland, with over 300 destinations including six Forest Parks, mountains, riversides, lochs, waterfalls, beaches, and waymarked trails. FLS also looks after some of the most iconic views in the country, from Queen’s View in Perthshire to Glen Affric in the west Highlands.

FLS manages the national forests and land in an inclusive and open way and strives to make the forests and land, and organized activities, more accessible to everyone. People from all backgrounds and communities are actively encouraged to enjoy and benefit from the national forests and land, but we are also committed to doing more to reduce the impact of people on priority habitats and species.

FLS also manages five national Nature Reserves (NNR), which are home to nationally or internationally important species and habitats. The reserves are primarily managed for wildlife, but people are encouraged to visit them to enjoy nature in responsible ways. For example, visitor centres and trails are designed such that visitors can explore the NNRS with minimum disturbance to the habitats or wildlife.

Visitor Services teams in each of the five FLS regions work hard to encourage people to visit Scotland’s national forests and land. Currently FLS welcomes over 10 million visitors each year, generating around £110 million added value to the Scottish economy. Visitor numbers across Scotland fluctuated during and after the coronavirus pandemic in 2020. This is illustrated in the table below, which shows the pre and post pandemic visits for Dalbeattie forest in the south of Scotland. Visitor numbers decreased during 2020 when movement restrictions were in place then increased significantly in 2021. Visitor numbers in 2022 were down compared to 2021, but up on pre-pandemic levels, probably due in part to people holidaying at home. At the time of writing, the number of visits in 2023 is unknown.

Year	Number of visits
2019	61,430
2020	51,721
2021	69,397
2022	65,069

Most of the land managed by FLS – over 635,000 hectares – has a network of tracks on which people can enjoy recreation. Most people visit to walk, exercise their dogs and to cycle. However, a large proportion visit to see wildlife. Therefore, many FLS destinations are equipped with specially designed nature hides for getting the best view of the local fauna. In these hides, and on the trails, FLS provides information panels or sometimes even guided tours, with knowledgeable staff on hand to help people make the most of their time in the woods.

Visitor strategy. We want to have more people participating in – and benefitting from – access and outdoor activities more often on Scotland’s national forests and land. To help us achieve this, we have developed a new 10-year Visitor Strategy (2022 – 2032).

Climate Change is one of the four strategic priorities in our Visitor Strategy, and we will ensure the FLS visitor offer makes a full contribution to our national ambitions to become a Net Zero society by 2045. To help us achieve this, we will focus on two key areas:

1. We aim to ‘reduce emissions and waste’ by:

- Working with others to look at sustainable and active travel options for our key visitor sites.
- Developing an urban recreation offer close to where people live.
- Developing our own and working with businesses who will develop sustainable tourism solutions.

2. We aim to ‘adapt to change’ by:

- Working to protect, maintain and enhance areas of high conservation value near visitor sites.
- Continuing to invest in key adaptation actions to build the resilience of Scotland’s national forests and land’s recreation trail network.

Public engagement. FLS employs a large Visitor Services team that engages with the public all across Scotland. This engagement comes in many forms, including events, guided walks and every-day, face-to-face communication with visitors. Communicating the importance of Scotland’s national forests and land for biodiversity is a core message and this chimes well with the huge numbers of people who visit to see wildlife. A large number of other FLS staff give talks to the general public and special interest groups, on an ongoing basis.

The FLS public-facing website includes extensive information about biodiversity and in places the public can visit to observe wildlife. FLS also invest considerable effort in supporting television companies to use Scotland’s national forests and land to make documentaries about Scotland’s environment and biodiversity.

Working with volunteers. FLS works with volunteers on a range of conservation and biodiversity enhancement projects, and they make an invaluable contribution to furthering the conservation of biodiversity in Scotland's national forests. For example, an outstanding volunteer group is involved in monitoring wild-living cats and hybrid wildcats on FLS land in the Strathbogie Wildcat Priority Area near Huntly, in East Region. The members of this group deploy camera traps throughout the area and gather invaluable data that informs FLS management. In 2021, FLS purchased an additional twenty camera traps for the group to use and these are collecting vital information on a daily basis – managed entirely by the volunteers.

In North Region, FLS staff are working with the Caithness Environment Volunteer Group to create wildflower meadows for pollinating insects and rare bumblebees, including the greater yellow bumblebee. Work has been ongoing in spring and summer 2023 to grow a wide range of wildflowers in polytunnels in Lairg, which will be planted out in the autumn of 2024 by the volunteers in two meadows in Sibster. These meadows are part of a species project within the NatureScot-led Species on the Edge Programme, and are in large, open areas within a forest that was planted in 2011 on a former agricultural site.

The work started in 2014, with controlling and reducing the fast-growing rye grass and creating spaces that would allow the less vigorous, pollinator-attracting flowering plants to take root and establish. Work continued to grow and in 2017 a hedge was planted at one of the meadows both to provide more blossom and to create a 'bank' and tussocky grasses, where Great Yellow Bumblebees like to nest. Regular autumn cuts over the past few years have helped the meadows to properly mature.

Workforce development. FLS is always seeking to improve their staff's awareness of, and expertise in, biodiversity, conservation, and the environment. A range of in-house training is provided, and staff are encouraged to undertake training by external providers, such as the Chartered Institute of Ecology and Environmental Management (CIEEM) and the Institute of Chartered Foresters (ICF). Obtaining membership of these organisations is also encouraged and a many staff in the FLS Environment team are members of CIEEM.

In addition, in 2022, FLS hosted five paid internships for ecology and environmental undergraduates. The five students worked for FLS for an entire year and were involved in a wide range of environmental management and ecological research. This work experience will be invaluable for the students when they graduate and will enhance their likelihood of employment in the sector.

Section 6: Research and monitoring

FLS funds and otherwise supports a wide range of applied research on biodiversity. Typically, this involves collaboration with conservation organisations and academic partners and numerous students have done their theses based on fieldwork in Scotland's national forests. Below is a selection of the research that has been carried out between 2012 and 2023 and is ongoing.

Biodiversity Index. Most biodiversity change in Scotland's national forests and land is brought about by silvicultural and land management choices, which mainly affect lower taxa. For example, a decision to increase the proportion of native broadleaf trees can significantly influence biodiversity across a forested landscape. Structural parameters such as these are therefore 'proxies' for biodiversity and have the potential to act as biodiversity indicators. An appropriate suite of indicators could be combined and used to infer changes in biodiversity, thus providing an index of biodiversity and changes in biodiversity.

Public forestry agencies have a statutory duty of care to safeguard and enhance the biodiversity value of the forests they manage. However, they often lack the information and tools with which to evidence progress towards these obligations and to justify landscape scale decisions. To help demonstrate the impact of management and policies over time, Forest Research (FR), Forestry and Land Scotland and Forestry England (FE) have co-developed the [FOrest Biodiversity Index \(FOBI\)](#). This is a quantitative, transparent, and repeatable approach for assessing the biodiversity potential of publicly owned forests in Britain.

Red squirrel research. Reconciling timber production with wildlife conservation is a major challenge for FLS and much effort is expended by FLS staff to protect red squirrels from harm during forest operations. However, knowledge of the likely impacts of forest management on squirrels is lacking. From 2018 to 2022, FLS collaborated with Inverness College of the University of the Highlands and Islands to investigate the impact of forest operations on red squirrels. Specifically, the study is looking at the impact of crop-thinning operations on red squirrel breeding activity, survival, population density, home range size and drey use. This is being done by fitting GPS and radio collars to the squirrels and following them before, during and after forest operations. The results so far, suggest that the impact of these routine thinning operations during the breeding season on red squirrels were minimal.

In the period 2020 to 2023, the following papers on squirrel research were produced:

Kortland, K., De Raad, L., Lurz, P., White, A. & Slade, A. 2022. Red squirrels and forestry – is it time for a review of policy and practice? *Scottish Forestry*, Volume 76, No. 2.

De Raad A.L., Lurz P.W.W. and Kortland, K. 2021. Managing forests for the future: balancing timber production with the conservation of Eurasian red squirrel (*Sciurus vulgaris*). *Forest Ecology and Management*, 493(6). DOI: [10.1016/j.foreco.2021.119164](https://doi.org/10.1016/j.foreco.2021.119164)

Slade A, White A, Kortland K, Lurz PWW. 2021. Natural strongholds for red squirrel conservation in Scotland. *Nature Conservation*, 43, 93–108. DOI: <https://doi.org/10.3897/natureconservation.43.62864>

Slade, A, White, A., Kortland, K., & Lurz, P.W.W. 2020. An assessment of long-term forest management policy options for red squirrel conservation in Scotland. *Hystrix Italian Journal of Mammalogy*, 31(2), 137-147. DOI: <https://doi.org/10.4404/hystrix-00351-2020>

Cairngorms Connect Predator Project (CCPP). This is a collaboration between the Cairngorms Connect partners (FLS, RSPB Scotland, Wildland Ltd. and NatureScot), Aberdeen University, St Andrews University, members of the Highland Raptor Study Group, and the Endangered Landscapes Programme. The CCPP started in 2018 and aims to improve understanding of the predator community and its impacts on priority species such as capercaillie. This collaboration is providing excellent opportunities for post-graduate study and the findings are being used to inform conservation management by FLS. FLS has supported the following PhD studies, which are developing applied solutions to furthering the conservation of biodiversity:

- Diversionary feeding of predators of capercaillie
- Impacts of recreational activity on wildlife communities
- How do wildcats and hybrid cats co-exist with other predators?

In the period 2021 to 2023, the CCPP produced the following papers:

Waggershauser, C. N., Taberlet, P., Coissac, E., Kortland, K., Hambly, C., & Lambin, X. (2022). Interspecific coprophagia by wild red foxes: DNA metabarcoding reveals a potentially widespread form of commensalism among animals. *Ecology and Evolution*, 12, e9029. <https://doi.org/10.1002/ece3.9029>

Zalewska, K., N. Waggershauser, C., Kortland, K., & Lambin, X. 2021. The best defence is not being there: avoidance of larger carnivores is not driven by risk intensity. *Journal of Zoology*. DOI: <https://doi.org/10.1111/jzo.12910>

Navarro_Waggerhauser, C. D., Ruffino, L., Kortland, K. & Lambin, X. 2021. Lethal interactions among forest-grouse predators are numerous, motivated by hunger and carcasses, and their impacts determined by the demographic value of the victims. *Ecology and Evolution*, 11(12). DOI: [10.1002/ece3.7574](https://doi.org/10.1002/ece3.7574)

Capercaillie research. FLS is supporting a range of research on capercaillie on an ongoing basis with a number of partners. In the period 2021 to 2023, FLS was involved in producing the following papers on this species:

Nicholas I. Wilkinson, Molly Doubleday, Andrew Douse, Andy Ford, Leah A. Kelly, Kenny Kortland, Juli Titherington, Simon R. Wotton & Steven R. Ewing. 2023. Further declines of the Western Capercaillie *Tetrao urogallus* in Scotland as shown by the 2021–2022 winter survey, *Bird Study*, DOI: <https://doi.org/10.1080/00063657.2023.2286298>

Matthew Geary, Robert Moss, Kenny Kortland. 2023. Could refuges from human disturbance stem the decline of Capercaillie in Scotland? *Submitted*. DOI: [10.22541/au.169999129.91506302/v1](https://doi.org/10.22541/au.169999129.91506302/v1)

Robert Moss, Fiona Leckie, Sorrel Jones, et al. 2023. Capercaillie *Tetrao urogallus* relocation after increased disturbance along woodland tracks. *Submitted*. DOI: [10.22541/au.168372252.27774317/v1](https://doi.org/10.22541/au.168372252.27774317/v1)

Wildcat research. As a partner in Scottish Wildcat Action, FLS has supported the production of the following research reports:

Campbell, R.D., Kortland, K., Strong, R., Tallach, N., Cumberbirch J. and Mason, G. (2023). Scottish Wildcat Action final report: Land Management. NatureScot, Inverness.

Kilshaw, K., Campbell, R.D., Kortland, K., and Macdonald, D.W. (2023). Scottish Wildcat Action final report: Ecology. NatureScot, Inverness.

Section 7: Biodiversity highlights and challenges

Here are a few highlights of the biodiversity work carried out by FLS and partners between 2021 and 2023:

The return of the wildcat. FLS is a partner in the Saving Wildcats project, which is led by the Royal Zoological Society of Scotland. Other partners include NatureScot and the Cairngorms National Park Authority. In 2019, the partnership secured an EU LIFE grant of £3.2 million to set up a conservation breeding centre for wildcats in Kincaig, with the aim of re-establishing a self-sustaining population of this species in the Cairngorms Connect area of Strathspey. As well as providing funding for the project, FLS provides a wide range of in-kind support; from logs for the breeding enclosures, to providing sites for releases and in-field logistical help.

In summer 2023, 19 of the captive-bred wildcats were released into the wild, with the majority being placed in FLS forests in FLS North Region. Initially, the wildcats spent much time foraging in clear fells within the forest, but, gradually, most have moved to the edges to forage on adjacent open ground. Further releases are planned for 2024 and 2025 and FLS will continue to support this amazing project as much as possible.

Beaver translocations to FLS land. In November 2023, a male and female beaver were translocated to a hill loch on FLS land in East Region – over 250 years since they last occurred at this site! This pair immediately settled down and started building a lodge. In addition, four beavers were translocated to Knapdale forest in FLS West Region in early December 2023, to bolster the population and increase the genetic diversity. All of these beavers are from other areas of Scotland where they had been causing issues for land managers – such as flooding high-quality agricultural fields.

The expertise of the Beaver Trust was central to this project, and they did the trapping and releases under license from NatureScot. NatureScot also licensed FLS and provided much valuable advice. All of this work is done as part of the Scottish Government's Beaver Strategy (2022-2045) and further releases on FLS land are planned in 2024 and beyond – as part of the ongoing management of Scotland's growing beaver population.

Cairngorms Connect. Cairngorms Connect is a partnership of neighbouring land managers committed to a bold and ambitious 200-year vision to enhance habitats, species, and ecological processes across 60,000 ha in the heart of the Cairngorms National Park. FLS is working in partnership with RSPB, NatureScot and Wildland Ltd. in this, the largest habitat restoration project in Britain. Between 2021 and 2023, the following management actions were achieved on FLS land: 123 hectares of non-native conifers were removed; 63 hectares of clear fell were

scarified to stimulate regeneration of native tree species; and 328 hectares of plantation were restructured for biodiversity; and over 15,000 broadleaf trees were planted (56% birch, 9% aspen, and 35% a mix of willow, alder, oak, and cherry). The work is funded by the Endangered Landscapes Programme.

Pine marten conservation in Galloway Forest Park. The pine martens in Galloway Forest Park (GFP) are an important outlier population and FLS has been supporting Dr Johnny Birks and John Martin's conservation work for this species. Research suggests that pine martens breed more successfully in large cavities in trees, but these are limited in plantations, so artificial boxes may be a way of improving breeding success. In 2018, 50 new den boxes were erected, bringing the total number of boxes in GFP to 142, spread across four zones.

Each May during the period 2012 to 2023, boxes were checked for use during the natal period. This was done by using thermal imaging cameras, which detect the heat of a marten if the box is occupied. Those boxes showing a positive thermal image then had a wildlife camera attached to an adjacent tree and video footage was gathered to confirm occupancy. In 2023, fourteen boxes were thermally positive with the camera footage confirming pine marten using the boxes for breeding. This novel approach is allowing the FLS South Region ecologists and their partners to monitor the pine marten population without disturbing them and enables them to more effectively manage the population in forests that are managed for timber production.

Trossachs Pearl-bordered Fritillary Restoration Project. The aim of this project was to determine whether or not pearl-bordered fritillary was still present in the Great Trossachs Forest National Nature Reserve, which encompasses woodlands at Inversnaid, Loch Katrine and in Glen Finglas. The partners comprise Butterfly Conservation, CLEAR Services Ltd, FLS, RSPB Scotland and Woodland Trust Scotland. Excitingly, surveys in the summer of 2019 located 64 adult pearl-bordered fritillaries in 27 locations. On the back of these remarkable survey results, further surveys and habitat management work are now being planned on FLS land. Since 2019, surveys have been carried out each spring to help us learn more about the distribution of the Pearl Bordered Fritillary in the Great Trossachs Forest. 21 volunteers have helped with the surveys and PBF have now been found at more than 60 locations in sheltered woodland glades.

In 2022, a PhD student from Stirling University completed a study aimed at observing egg laying behaviour to help preserve colonies and guide habitat management to encourage the butterflies to colonise new areas. These results have informed new habitat management plans and groups of volunteers will be helping with the practical work to deliver these plans. The first volunteer workday has been organised in partnership with Butterfly Conservation and will take place in November 2023. The bracken needs to be bashed down and raked away because over time, dead bracken builds up a thick layer that prevents the growth of wildflowers, including violets – the foodplant of the caterpillars. More volunteer workdays and surveys are planned for 2024.

Focus on FLS South Region. To highlight the range of actions carried out by FLS regions, the following is a list of some of the biodiversity conservation, restoration and research work carried out between 2021 and 2023 by staff in FLS South Region.

- Tweed Valley Osprey Project. As part of the refurbishment at Glentress, the viewing opportunities have been upgraded with the installation of new camera's and viewing screens with sound also now available to further enhance the visitor experience.
- Worked with Sasha Dench of Conservation Without Borders to follow migrating Ospreys from the Tweed Valley to Africa and to produce a film highlighting the issues and opportunities to help these birds during their incredible migrations.
- Ongoing Goshawk monitoring projects with two PhD students.
- South of Scotland Golden Eagle Project. FLS provided a site for release pens and supplied carcasses to feed the birds.
- Ongoing hen harrier management and monitoring on the Arran Moors Special Protection Area.
- Extensive programme of pond and wetland creation as part of water quality and general environmental improvement. Significant dragonfly habitats created.
- Mabie Butterfly Reserve. New interpretation installed in 2023 and ongoing monitoring and partnership project with Butterfly Conservation Scotland. Additional roadside habitat managed to expand the core populations. Volunteer group from BCS carried out habitat maintenance work in 2023.
- New nightjar project started with BTO and RSPB to capture, tag and monitor the birds at Ironhirst to help identify preferred local habitats.
- Ongoing Black grouse management and monitoring project in Galloway as part of national monitoring.
- Black grouse habitat enrichment as part of upper edge planting schemes near lek areas, with native broadleaves being planted, non-native conifer being removed, and habitat corridors being created to link suitable sites and improve access.
- Riparian management in partnership with Galloway Fishery Trust. This includes the monitoring of water quality, the removal of non-native conifer regeneration from riparian areas, and the planting of broadleaves along water courses to provide shade. Electro-fishing surveys carried out with the Annan Fishery Trust on the Water of Ae and tributaries.
- In 2022, a trial to manage cattle grazing with "no fence" collars started in the Glentroll Oakwoods. The cattle were placed in the woods to trample the bracken and disturb the ground to encourage native broadleaved seeds to become established. The trial will continue in 2024.
- Montane woodland project ongoing in Galloway with enrichment planting and non-native tree removal.
- Bat box schemes across the region and events to raise awareness to the general public. Emergence surveys at Cardronna, where over 600 pipistrelle bats were recorded emerging from the building.
- Ongoing cross-border projects with Forestry England on water vole, and habitat management across the Kielderhead SSSI.
- Ongoing work to support Saving Scotland's Red Squirrels, with training programme for volunteer groups across South Scotland in Grey squirrel trapping.
- South Region hosted an overseas student for three months in spring and summer, 2023, and employed a trainee, undergraduate ecologist on the FLS internship scheme.

A similar breadth of biodiversity conservation, restoration and research work is delivered across the other four FLS regions on an ongoing basis. Most of this kind of project work is done with partners and is increasingly predicated on published ecological science, which ensures the best possible outcomes for the investment.

Future Challenges. In Scotland, long-term data show that the abundance and distribution of species has declined significantly over recent decades. The State of Nature Report for Scotland (2023) is the most precise scientific update on Scotland's nature. This reports a 15% decline in average species abundance across closely monitored wildlife since 1994. In the last decade alone, 43% (172) of the species have declined strongly. Therefore, the biggest challenge for FLS is to help turn this around over the coming years by ensuring that, alongside our important species-specific conservation work, the wider silvicultural and land management choices that are made, which particularly affect lower taxa, all help to improve the estate's overall value for biodiversity.

As stated by Biodiversity Minister Lorna Slater in March 2023, the finance gap for nature in Scotland for the next decade has been estimated to be £20 billion. Given the volatility of the timber market – which provides a large proportion of the funding for the biodiversity work of FLS – and the general economic outlook, generating and obtaining extra funding to deliver an even bigger range of action for biodiversity across Scotland's national forest and land will be challenging. FLS is exploring all possible funding streams on an ongoing basis, including holding initial discussions with potential private sector partners in 2023.