



Third Natural Capital Report

Building Natural Capital

December 2023

HIGHLANDS[™]
REWILDING



Deer at Bunloit, Scott Hendry, Field Ecologist (Bunloit)

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Foreword

When we produced our first natural capital report two years ago we committed to publishing an annual update on our work tackling the twin crises of climate change and biodiversity collapse, and improving community prosperity through nature recovery. Each year when the report comes around I reflect on the highlights of the year. As always there are too many to mention in this short space.

This time last year we were at the early stages of our crowdfunding campaign. By the end of May this had exceeded all expectations (and our initial target of £500,000), ultimately raising £1.2 million from 757 crowdfunders. In August we invited all our shareholders to a video conference in which we updated them on our plans, finances and the work of the science team. The vast number who got in touch afterwards to share their enthusiasm for what we're doing has continued to provide the motivation that drives us forward.

The purchase of the Tayvallich estate in Argyll in May marked another huge success. Not only for the chance to spend time in such a beautiful part of the country, and the opportunities for our work in natural capital science that Tayvallich's rich tapestry of habitats provide, including the restoration and expansion of the Atlantic rainforest, but also because it brought to the team talented Tayvallich locals including Ewan, Rowan and Erik. The support and positivity of the Tayvallich community has turbo-charged this element of our mission, with initiatives such as the signing of a Memorandum of Understanding, the establishment of the estate management board and progress in selling land for much-needed local housing. Together these form a unique model for community empowerment in land management and nature recovery.

A further boost to our efforts around community prosperity came with the news we have been awarded funding under the FIRNS scheme. Our project on joint ventures will explore the great potential for scalable community benefits from rewilding. The project is supported by NatureScot in collaboration with The Scottish Government and in partnership with the National Lottery Heritage Fund. The 18 month project started in October and it will be fascinating to see what can be achieved.

In this, our Third Natural Capital report, we focus on how we are working to build the natural capital of our Bunloit and Beldorney estates. Every time I walk around either estate, I notice new evidence of the power of nature to adapt and recover.

The progress we have made this year would not have been possible without the incredible team of staff, the shared expertise of an extensive network of collaborators and local communities, the advice and guidance of our board of directors, and the support of our investors and shareholders. My thanks to all and onwards to the next year.

Jeremy Leggett

Founder and CEO of Highlands Rewilding





Executive Summary

Following our two previous Natural Capital Reports describing our baseline surveys of Bunloit and Beldorney estates respectively, this third report outlines progress and plans on these estates and on our third – Tayvallich estate in Argyll.

As we advance our model for nature recovery, community prosperity and ethical profitability, both Highlands Rewilding and the natural capital landscape around us are developing quickly. We provide an overview of these developments below. As well as purchasing a third estate in this past year, we have welcomed several new colleagues, started several new projects, and developed new collaborations with local communities.

We have also been awarded Wildlife Estates Scotland accreditation for both Bunloit and Beldorney; part of the Europe-wide Wildlife Estates scheme, which recognises land managers meeting rigorous standards of wildlife management and conservation to promote a wide range of social, economic and environmental benefits of conservation.

Much more is planned for the year ahead, most importantly in terms of land management and ongoing monitoring of biodiversity, greenhouse-gas and socio-economic changes. On Bunloit, we have developed plans to restore our degraded peatlands and improve carbon storage, particularly where commercial conifer plantations once stood. We are adapting



our grazing plans to focus on the main qualities of our species-rich grasslands, working with a neighbouring farmer. We are gradually thinning forestry compartments and introducing native broadleaves, allowing natural regeneration to occur and spread out from the edges. Clearings and deadwood will provide other crucial habitats, and we will reintroduce missing species to these habitats where possible, beginning with wood ants. We will focus on allowing natural regeneration in our native woodlands, and develop agroforestry approaches around our small 'food forest'.

In Beldorney, we will expand and improve wetland habitat, while continuing to use - and experiment with - regenerative grazing in our grasslands. We will re-plant 15 hectares of clearfelled forestry with native broadleaves and identify further opportunities for regeneration and planting. Remaining commercial forestry compartments will be gradually thinned and replaced with native broadleaves, creating a network of wildlife corridors across the estate. We will also plant fruit and nut trees to establish multi-functional landscapes, and restore our small area of degraded peat.

Plans for management of Tayvallich estate are being made over the course of an initial year of engagement with the local community and a wide range of experts, and a programme of in-depth baselining work. Some of this has yielded results already, and we look forward to many more discoveries as we head towards next summer. Meanwhile, our ground-breaking collaboration with the Tayvallich Initiative is establishing a prominent example of how nature recovery and community prosperity can be achieved together, through a detailed but transferrable collaborative framework.

We hope the progress and plans reported below will be of wide interest, and will contribute to Scotland's efforts to set new standards in the use of nature-based solutions for climate, biodiversity and social challenges.

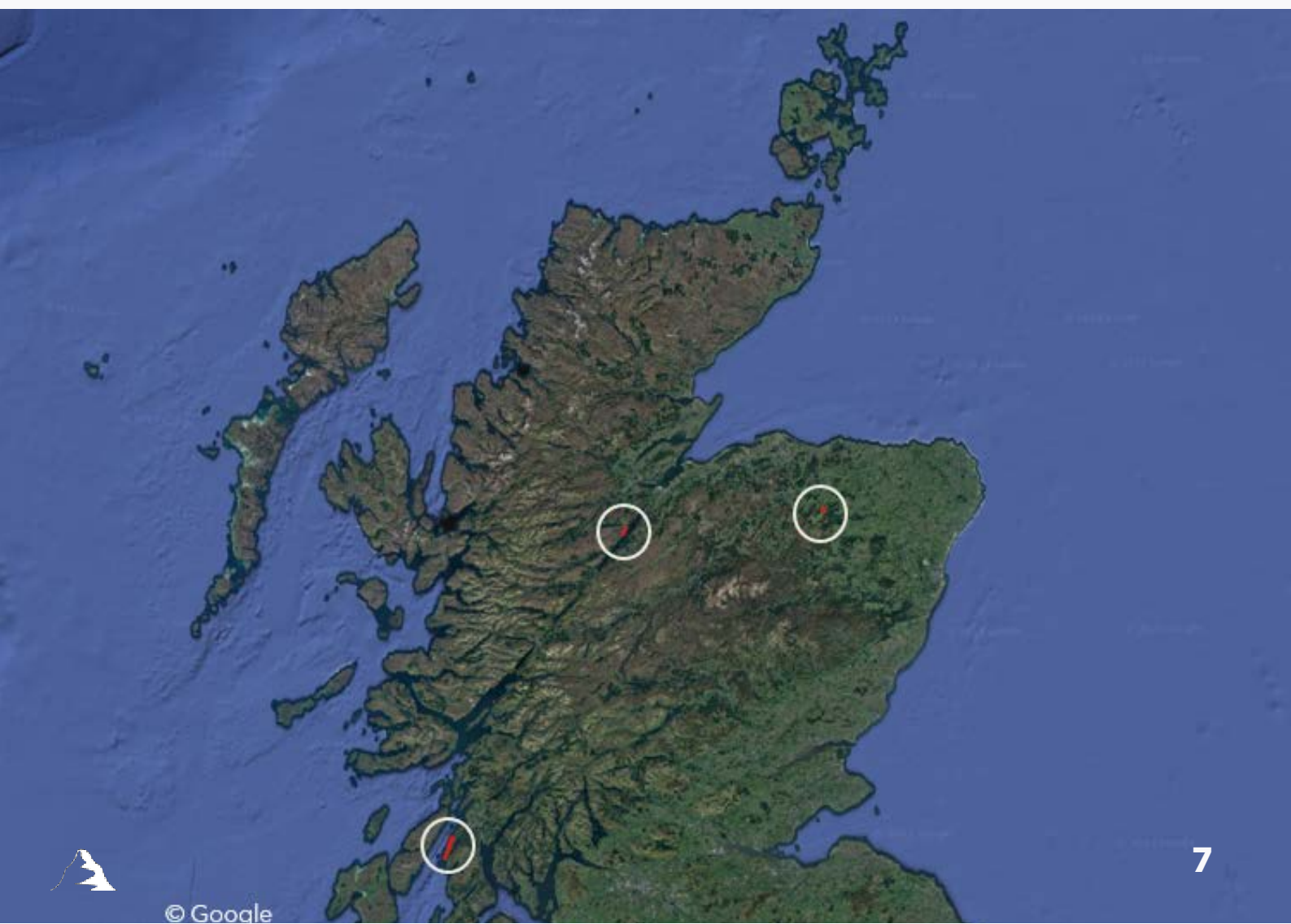


Highlands Rewilding Update

2023 has been an exciting year for Highlands Rewilding, including a highly successful crowd-funding campaign, receiving the first loan for nature recovery by a UK-Government-backed bank (the UK Infrastructure Bank), and the purchase of Tayvallich estate. We are now a mass-ownership company, with more than 800 shareholders, none of whom own more than 13% of the company, and many of whom are local to our estates. We also now employ 27 people (and rising), 17 of whom live in the communities where we work, and only 5 outwith commuting distance.

This increasing community-centredness is further prompted by our community engagement programme. In the past year we have developed a ground-breaking Memorandum of Understanding with the Tayvallich Initiative, a local community body set up to consider community ownership of land, outlining a unique collaborative approach to nature recovery and community prosperity. We have published our [Engagement Roadmap](#) to establish the principles on which we will further develop collaborative relationships with local communities, and we continue to explore options with communities around our Bunloit and Beldorney estates.

Figure 1: The locations of all three Highlands Rewilding estates



Scientifically, we have continued to plan and monitor changes, and to establish experiments to inform future management decisions. We've established several important new collaborations in addition to those already in place, and have received grant funding for some of these. Our work on mycorrhizal fungi, insect monitoring and habitat classification through Artificial Intelligence promises to be particularly interesting, while our exploration of models for community engagement has strong social scientific significance.

We've gathered a summary of our development in a timeline on our [website](#), and give further details in this document of our main activities on natural capital in the past year. We look forward to another active twelve months!

Working with communities

Highlands Rewilding exists to create measurable environmental and socio-economic benefits. By restoring natural processes and habitats, we aim to help tackle the climate and biodiversity crises, while also involving local communities in our land management and its benefits. These 'nature-based solutions' with multiple benefits for people and nature are essential to resolving some of the stark challenges that face us in this time of global change.

There are huge potential gains in this approach. Scotland has a disproportionate amount of environmental degradation and responsibility for climate change, but also a crucial role to play in reversing these processes – especially in our carbon-rich peatlands and highly diverse temperate rainforests.

At the same time, we have serious economic and social challenges, many of which can be traced back to our history of dispossession and lack of opportunities to connect with and benefit from our land.

Key to overcoming this challenge is involving local people in the management of land they live on or near to. This is a big step in much of the Highlands, where we have a highly concentrated pattern of large-scale private ownership, and commensurately little existing involvement for rural communities. Community ownership of land, where possible, is often the best way of taking this step, allowing land to be managed for local needs within broader societal and policy requirements. But community ownership is not always – or even often – possible, and where it is, managing the array of different objectives for land management is still difficult.

To understand and deliver local aspirations on our own land and, hopefully, elsewhere, we have been working on methods for engaging local communities. These are methods not only of telling people what we're doing, but of actively involving them in management aims and decisions, and entirely giving control over to them in some cases.

There are four main reasons to do this:

The first is simply that local people should have meaningful input into land management.

The second is that such input tends to improve outcomes for everyone, particularly by ensuring that local knowledge is brought to bear.

The third reason is that engagement of this kind can help to build relationships and capacities on both sides, increasing



community cohesion and ideally leading towards eventual community ownership.

Finally, if we can establish a practical template for engagement of this sort, it is more likely to be widely adopted and to generate these benefits elsewhere.

Although the reasons to do this are clear, ways of doing it are not. Many different communities have legitimate interests in land management, and they differ greatly from place to place. Defining and engaging with these communities requires time and resources on all sides. When it happens, engagement takes many forms, none of which are guaranteed to succeed.

Fortunately, as we work to improve our own engagement, others are also thinking about these issues. We have been consulting widely in recent months, and we've reviewed standards and recommendations from the Scottish Government, Scottish Land Commission, Community Land Scotland and others. We've also worked with research partners, particularly at the Leverhulme Centre for Nature Recovery at Oxford University, reviewed academic literature, and consulted with local people on the findings we've made. This has resulted in our [Engagement Roadmap](#), setting out the principles by which we will further develop our engagement processes.

We have also made several practical steps forward in our collaborative work with the Tayvallich Initiative, described in the Tayvallich section of this report. Through this we have identified a series of shared objectives for estate management, including increasing community agency over the land via a local estate management board, sale of land to the community, and increasing estate-related jobs and skills. Some of these steps will be relevant

to our other estates, and we continue discussions around Bunloit and Beldorney to develop place-specific activities there. An important theme across estates is the extent to which we can contribute to cultural – and particularly Gaelic – heritage as well as natural heritage, and we are currently discussing options for this.

Community agency is quite rightly and increasingly recognised as a core part of nature recovery. We're involved in several projects to establish best-practice in this field, and are delighted to have received funding for our own work from the Facility for Investment Ready Nature in Scotland (FIRNS) scheme, supported by NatureScot in collaboration with the Scottish Government and in partnership with the National Lottery Heritage Fund. This grant will allow us to develop ideas for 'joint ventures' between Highlands Rewilding and local communities; small business opportunities to capitalise on the ecosystem services provided by nature restoration. This grant also means that we can employ a Community Engagement Coordinator to work with our local estate teams, as well as a Marine Rewilding Lead to focus on the marine environment at Tayvallich.



'The Puddle' at Tayvallich (July 2023)



Scientific research

We make our estates available as 'open air laboratories' for scientific research, and our long-term collaboration with Oxford University's Leverhulme Centre for Nature Recovery and Nature-Based Solutions Initiative capitalises on this, providing experimental sites for their researchers and ensuring that we contribute to and act on the best available information. We have developed, or are in the process of developing, many other collaborations as well, with several research funding proposals having been submitted in the past few months, in partnership with universities across Scotland, the UK and beyond.

Confirmed projects include one on improving the accuracy of AI-mapping of habitats from remotely-sensed data and three on community engagement standards and methods.

Meanwhile, we continue our programme of in-house data gathering and research, making all outputs freely available for others to use where we can. This includes submitting our biodiversity data to the [National Biodiversity Network \(NBN\) Atlas](#) and taking part in the national [BIOSCAN](#) and [BeeWalk](#) schemes. Research topics and findings are described in detail in each of the estate sections below.



Highlands Rewilding and Oxford University's Leverhulme Centre and Nature-Based Solutions Initiative teams assessing Tayvallich's Temperate Atlantic Rainforest and Bunloit's native woodlands



Ongoing land management at Bunloit and Beldorney

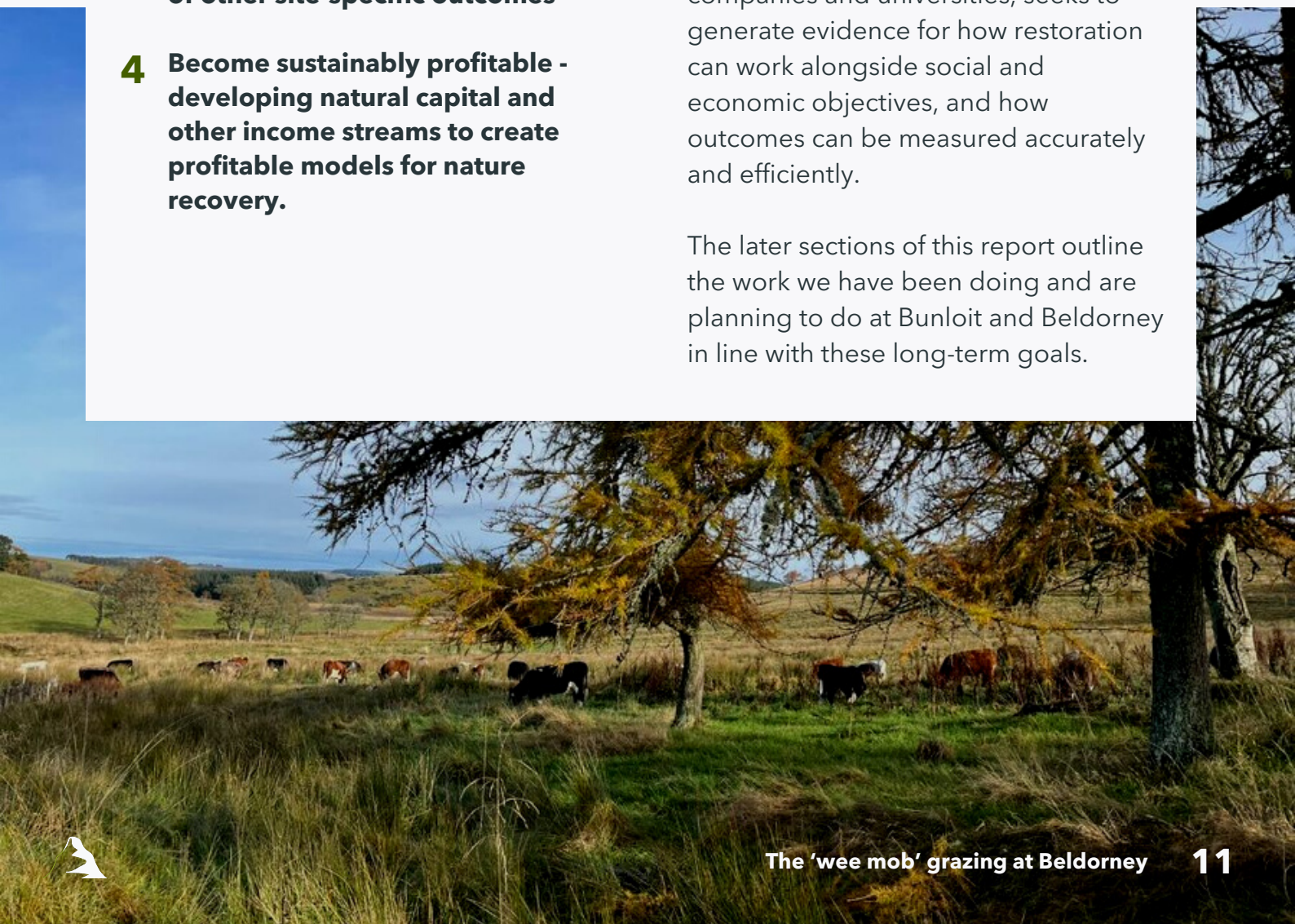
We have four long-term goals:

- 1** **Meaningfully reduce emissions and increase sequestration of carbon - within our restored soils (primarily peatlands), grasslands and woodland areas.**
- 2** **Meaningfully increase biodiversity - through the ongoing creation and enhancement of native, biodiverse habitats.**
- 3** **Increase community agency over, and benefits from, land management, including via local employment, housing, and a range of other site-specific outcomes**
- 4** **Become sustainably profitable - developing natural capital and other income streams to create profitable models for nature recovery.**

To achieve these goals, we employ a combination of land management activities: ecological restoration, regenerative agriculture, mixed forestry, and recreational management, and carefully monitor outcomes including through experimental research.

Our main environmental objectives are to generate and measure biodiversity uplift, including in terms of rare species, valuable habitats, ecosystem structure, function and resilience. We seek to re-establish natural processes where possible to facilitate these changes. Our research programme, in-house and in collaboration with many other companies and universities, seeks to generate evidence for how restoration can work alongside social and economic objectives, and how outcomes can be measured accurately and efficiently.

The later sections of this report outline the work we have been doing and are planning to do at Bunloit and Beldorney in line with these long-term goals.



The Natural Capital Landscape

The term 'natural capital' has taken on an economic focus in recent years as ecosystem markets have developed. It is usually defined more broadly; for example by the [Natural Capital Coalition](#) as "the stock of renewable and non-renewable resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people". It is in this sense that we use the term here, but with a focus on emerging political and economic drivers that affect the management and measurement of natural capital.

Among these emerging drivers, ecosystem – and particularly carbon – markets are perhaps the most significant. Markets such as these have the potential to bring substantial investment into nature conservation and restoration, but they can also result in 'greenwashing' and counterproductive effects if they create a false impression of meaningful action. This has been the case with some carbon offsets that have inaccurate carbon benefits or that are used by organisations to claim consistency with net-zero pathways, without appropriate plans to reduce emissions first.

Highlands Rewilding is not currently selling carbon or other ecosystem-based credits or offsets. Instead, we are engaging with these markets as they develop to help ensure their reliability and ultimate effectiveness. We intend to sell any credits we generate ex-post, after measuring change with a broad range of methods over a period of several years. At that point we intend to sell via markets, and to buyers, in which we have confidence. This means, for example, that markets will meet the highest standards of integrity and rely on the most robust methods available, and that buyers have verified plans for emissions reductions in line with the [Science Based Targets initiative](#). Our position on carbon offsetting is summarised in a [blog](#) we published earlier this year, and the sections below summarise our observations of key developments in natural capital policies and markets over recent months.



International

The key international development in the past year has been the adoption of the Kunming-Montreal Global Biodiversity Framework by 196 nations in December 2022. This Global Biodiversity Framework (GBF) has 23 targets to be met by 2030 and four global goals, which together aim to preserve and restore biodiversity.

Within these, efforts to de-incentivise unsustainable use of biodiversity and to incentivise sustainable use are prominent, including by “leveraging private finance, promoting blended finance, implementing strategies for raising new and additional resources, and encouraging the private sector to invest in biodiversity”. These efforts form part of a target to mobilize “at least \$200 billion per year by 2030”.

These efforts are being supported by a range of international organisations including the Taskforce on Nature-related Financial Disclosures (TNFD) and the Giving to Amplify Earth Action (GAEA) initiative, which seeks to develop Public-Private-Philanthropic partnerships.

As mentioned above, the Science Based Targets initiative (SBTi) seeks to help companies reduce emissions in line with the Paris climate goals, and has expanded into the Science Based Targets Network, which seeks to identify methods and targets for other Earth systems including biodiversity. Meanwhile, the Biodiversity Credits Alliance (BCA) seeks to develop robust science-led principles for the development of a voluntary biodiversity credit market, and to mobilize financial flows towards biodiversity custodians while recognising local knowledge and contexts.

The Voluntary Carbon Markets Integrity Initiative (VCMI) adopts a similar goal for high-integrity carbon credits that genuinely contribute to the Paris targets.

United Kingdom

The UK is one of the most nature-depleted countries in the world, and is now ranked as making insufficient progress towards the Paris targets by the independent scientific project Climate Action Tracker.

At the same time, a great deal of activity is underway to establish and improve ecosystem markets here too. Across the UK's four constituent nations, the British Standards Institute (BSI) is working to put in place transparent, consistent, high integrity standards for nature markets, starting from the UK Government's earlier Nature Markets Report¹.

In England, Biodiversity Net Gain (BNG) policy has been developed to require developers who cannot avoid habitat loss on their sites to create compensatory habitat on- or off-site, generating a biodiversity uplift of at least 10% according to Defra's Biodiversity Metric.

Beyond this, a number of private biodiversity credit schemes are in operation or development, with Operation Wallacea, rePLANET, Plan Vivo, Pivotal, CreditNature and Verra among the organisations contributing to credit development, verification or marketisation. Such credits can also be verified by independent bodies such as the Biodiversity Futures Initiative, Accounting for Nature, the Organisation for Biodiversity Certificates or, where no credits are being sold, the Global Biodiversity Standard.



Two carbon codes are in operation across the UK: the Woodland Carbon Code and the Peatland Code, which provide quality assurance standards for carbon credits derived from woodland creation or peatland restoration.

Several more frameworks of this kind are in development. The Soil Carbon Code is moving towards a set of minimum requirements for soil carbon credits in the UK marketplace, while the Agroforestry Carbon Code and Hedgerow Carbon Code are under development.

Meanwhile, a number of organisations offer to quantify and facilitate sale of carbon credits, and voluntary standards such as Wilder Carbon link carbon and biodiversity benefits and engage only with UK companies who have net zero commitment and strategy to minimise carbon footprint. Similar activities are underway in the coastal zone, with a UK Saltmarsh Code, Seagrass Carbon Code and Sea Kelp Code under discussion or development.

Scotland

In addition to the UK-wide developments above, the Scottish Government has recently made clear its ambitions to tackle the biodiversity crisis with the publication, in September 2023, of the updated version of the '[Scottish biodiversity strategy to 2045: Tackling the Nature Emergency in Scotland](#)'.

The overall vision of this strategy is that, by 2045, Scotland will have restored and regenerated biodiversity across our land, freshwater and seas.

The successful delivery of this mission will be aided by a [Strategic Delivery Framework](#), which is out for consultation at the time of writing. This framework is comprised of, in addition to the Strategy, a Natural Environment Bill (containing statutory targets for nature restoration) and five-year Delivery Plans (detailing the necessary actions). Also included is a monitoring and reporting framework to check the efficacy of actions, which is crucial – we will only know if we are successfully restoring and regenerating our biodiversity if we are measuring it.

These aspirations are backed by a range of funding measures such as the Nature Restoration Fund, the Facility for Investment-Ready Nature in Scotland, Peatland ACTION funding for peatland restoration, and developing farm payments including through the Agri-Environment Climate Scheme (AECS). Meanwhile NatureScot are developing a landscape scale natural capital tool (in which Highlands Rewilding is involved through the co-design process), and a range of organisations are developing natural capital credits (recently reviewed for the Scottish Government by McVittie et al, 2023²).

These developments are supported by governmental guidance, such as the [Interim Principles for Responsible Investment in Natural Capital](#), mixed public, private and voluntary bodies such as the Scottish Forum on Natural Capital and the Scottish Nature Finance Pioneers, and private-sector working groups like the Nature Finance Certification Alliance, in which we are also involved, which aims to create an informed and robust marketplace.



Bunloit



Overview

Bunloit is a 511 hectare estate on the shores of Loch Ness, comprising a mosaic of habitats including grasslands, peatlands, heathlands and scrub as well as native broadleaf woodlands and non-native conifer plantations.

We reported on the estate's baseline in our [First Natural Capital Report](#) and in the following section we explain how we're working to increase the natural capital from that baseline.

Our short-term objectives for Bunloit are:

Peatlands - We are working with Peatland ACTION to restore our degraded peatlands and improve carbon storage. Plans are in place to start work in the winter of 2023/2024, including in areas of cleared coniferous plantations (forest to bog restoration).

Grasslands - We will continue to graze a small herd of Highland cattle, owned and managed by a neighbouring farmer, across the grasslands to maintain and boost biodiversity. We are reducing bracken encroachment through mechanical control, targeted grazing and tree planting.

Forest management - We will manage the remaining forestry compartments sensitively, with the aim of gradually thinning over time and replacing with native broadleaves, allowing natural regeneration to occur and spread out from the edges. We will create clearings within forests and leave deadwood standing and lying. We are investigating potential invertebrate reintroductions (starting with wood ants).

Agro-forestry - We will continue with our small forest garden, planting additional fruit and nut trees, interspersed with fruit bushes. This is located adjacent to the farm buildings and holiday cottages to maximize visitor and community interactions and benefit.

Forest Regeneration - Our native deciduous woodlands are currently showing signs of over-browsing and there is little natural regeneration or understorey. We will increase deer control to enable natural forest regeneration.

Community - We will continue our programme of community engagement and school classes, encourage access to the estate through improved signage and footpaths, while developing other opportunities for community involvement in land management.

Monitoring

Since we reported the baselining in the First Natural Capital Report we have set up several long-term monitoring studies.

Monitoring terrestrial invertebrates

Terrestrial invertebrates include bees, spiders, flies, wasps, beetles, earthworms, moths, butterflies and many more. In fact, this group contains the majority of the world's animal species and they really are the 'little things that run the world'.

Invertebrates play disproportionately important roles in our ecosystems, for example by pollinating flowering plants, decomposing waste, recycling nutrients in the soil and providing food for many other animals.

Because they are so species-diverse, monitoring their presence provides valuable information about the landscape and quality of habitats that are present. Even small changes in land management and habitat quality will be reflected in the numbers and types of invertebrate species present.

For this reason, this group is important to consider when monitoring biodiversity even though the vast diversity of species has also traditionally limited this approach. Even small-scale sampling will yield a huge number of species, which requires one of the (all too rare!) people who have specialist taxonomic knowledge to spend a great deal of time identifying them.

Using DNA metabarcoding to identify species has transformed this approach - large numbers of specimens can be

speedily identified by matching their DNA to records held in databases.

We have been working with NatureMetrics to use this approach, in combination with more traditional, targeted surveys of butterflies and bees, to build up a picture of the terrestrial invertebrates present on both Bunloit and Beldorney estates. Subsequent analysis and interpretation of species lists by Vicky Wilkins, of the Species Recovery Trust, has yielded valuable information about the quality of habitats and we will use this information to guide our management to boost biodiversity and improve overall ecosystem function across our land.

We're also part of the Wellcome Sanger Institute's BIOSCAN project, which aims to study insect species genetic diversity and species interactions for one million insects over five years across the UK. Each month we set up a Malaise trap, as shown in the photo below, for 24 hours at both Bunloit and Beldorney to capture flying insects. These insects are sent to the Sanger for DNA metabarcoding, and we will receive the species information, providing us with fascinating insights into how species change throughout the year and over time.



BIOSCAN Malaise trap set up on Bunloit Estate

We are also walking bumblebee transects on both Bunloit and Beldorney. Two transects are walked at both estates every month from March to October and all bumblebees and other bees observed are recorded. This data is submitted to the Bumblebee Conservation Trust as part of their citizen-science BeeWalk survey scheme. As well as helping us to understand our bee populations, this data is contributing to the national picture of how bumblebee populations change through time in response to land-use and climate change, which can help detect the early warning signs of population declines.

Bunloit's terrestrial invertebrates

During August and September 2022, we had 15 Malaise traps up across Bunloit Estate, each accompanied by three pitfall traps to survey flying and ground-dwelling invertebrates respectively.

These traps were each in place for two weeks, after which the catch was sent to NatureMetrics, where it was analysed using DNA metabarcoding to identify the species present. In total, 583 different species were found, although not all of these were identified to a named species due to gaps in the genetic databases. More information on some of the identified species can be found in the relevant estate sections below.

The species list from the Malaise and pitfall traps, combined with that from butterfly transects and dragonfly observations, was analysed by Vicky Wilkins from the Species Recovery Trust. Vicky used Pantheon, which is an analytical tool developed by Natural England and the Centre for Ecology & Hydrology to assist invertebrate nature conservation in England. Priority species highlighted by Pantheon were also

cross-referenced against the Scottish Biodiversity List.

In total, 27 priority invertebrate species have been identified on Bunloit so far (see Table 1), although it's likely we would find even more with further targeted surveys, for example for moths.

The National Biodiversity Network (NBN) Atlas reveals that there are 65 priority species previously recorded within a 5km radius of Bunloit, which suggests that we have a great opportunity to support higher numbers of important species. Bunloit is also located directly adjacent to the East Inverness-shire Important Invertebrate Area, which includes Glen Affric, a known invertebrate hotspot, providing us with further opportunities.

Some important species that we could potentially attract with further habitat restoration include the Pinewood mason bee (*Osmia uncinata*), which is only found in a few locations in Strathspey, Deeside and east Inverness-shire and nests in old longhorn beetle holes in dead Scots pine trees. It requires open areas with bare ground and plenty of bird's-foot trefoil to feed upon.

Other opportunities include the White-faced darter (*Leucorrhinia dubia*), which might benefit from our peatland restoration, as this dragonfly requires deep, acidic bog pools with rafts of sphagnum moss at the edges. Also, the hairy wood ant (*Formica lugubris*) might be a suitable species for reintroduction – an idea we are pursuing. We could also potentially attract a few more rare spiders, which are dependent on Caledonian pine woods, including the Caledonian sac spider (*Clubiona subsultans*), the wood ant spider (*Diplocephalus torva*) and the crab spider *Philodromus emarginatus*.

Table 1 Priority invertebrate species identified on Bunloit to date

Taxon group	Species		Status	Species Quality Score	Habitat Associations	Sites
	Latin	Common				
Spider	<i>Agnyphantes expunctus</i>		Nationally Scarce	4	Predatory larva & adult, tree associated, requiring canopy & scrub at wood edge/glade, associated with birch, juniper & larch	Malaise 12
Spider	<i>Agyneta olivacea</i>		Nationally Scarce	4	Open habitats	Pitfall 8
Spider	<i>Hilaira pervicax</i>		Nationally Scarce	4	Predatory larva & adult, wetland species, associated with acid & sedge peats, sphagnum/moss lawn	Pitfall 8
Spider	<i>Pityohyphantes phrygianus</i>		Nationally Scarce	4	Predatory larva & adult, associated with conifer foliage, juniper & pine	Malaise 4
Spider	<i>Zora nemoralis</i>		Nationally Rare; Vulnerable; IIA species	8	Predatory larva and adult, found in heather and moss in woodland habitats	Pitfall 4
Beetle	<i>Choleva glauca</i>		Notable	4		Pitfall 11
Beetle	<i>Quedius xanthopus</i>		Notable	4	Predatory larva & adult, beneath loose bark, conifer or broadleaved, decaying wood, heartrot and wood mould	Malaise 14
Fly	<i>Medetera petrophila</i>		Data Deficient	8	Predatory larva & adult, decaying broadleaved wood, particularly birch	Malaise 6
Fly	<i>Fannia ornata</i>		Nationally Scarce; Near Threatened (provisional)	4	Predatory larva & saprophagous adult, conifer woodland litter	Malaise 15
Fly	<i>Fannia ringdahlena</i>		Nationally Scarce (provisional)	4	Saprophagous larva & adult, broadleaved woodland litter	Pitfall 4, Pitfall 5
Fly	<i>Platypalpus tuomikoskii</i>		Nationally scarce	4	Predatory larva & adult	Malaise 9
Fly	<i>Chrysotus femoratus</i>			4	Saprophagous larva, predator adult. Wetland, mud/shallow litter	Malaise 3, Malaise 5
Fly	<i>Sargus flavipes</i>			4	Saprophagous larva, tall sward & dung/carrion	Malaise 1, Malaise 6
Moth	<i>Amphipyra tragopoginis</i>	Mouse moth	Section 41 species; Scottish Biodiversity List	1	Commonly distributed but declining, occupying a range of habitats. Caterpillars feed on a variety of herbaceous plants, including willow	Malaise 2
Moth	<i>Antitype chi</i>	Grey chi	Near Threatened	1	Moorland & grassy hillsides are preferred habitat, larvae feed on a number of low-growing plants and shrubs	Malaise 3
Moth	<i>Eugnorisma glareosa</i>	Autumnal rustic	Near Threatened; Section 41; Scottish Biodiversity List	1	Inhabits woodland fringes, moorland and sandy or chalky soils. Widely distributed, not always common and declining in Scotland, living on wide variety of plants and grasses.	Malaise 7
Moth	<i>Helotropha leucostigma</i>	The crescent	Least Concern; section 41 research only	1	Species of damp, marshy woodland and moorland. Larvae feed on the stems of marshland plants, such as yellow flag Iris	Malaise 6
Moth	<i>Hydraecia micacea</i>	Rosy rustic	Least Concern; section 41 research only; Scottish Biodiversity List		Damp open tall sward habitats, larvae live on a range of low plants, especially dock (<i>Rumex</i> spp.), feeding beneath the ground on the roots.	Malaise 2
Moth	<i>Elachista alpinella</i>			4	Open habitat, associated with sedges.	Malaise 7
Butterfly	<i>Erebia arthiops</i>	Scotch Argus		4	Open tall sward habitats. Associated with moor grasses	Malaise 13
Butterfly	<i>Boloria euphrosyne</i>	Pearl-bordered fritillary	Section 41 Priority Species; Scottish Biodiversity List; IIA species		Requires violets as the caterpillar foodplant, associated with woodland clearings, well-drained habitats with mosaics of grass, bracken and scrub & open deciduous wood pasture in Scotland. It requires abundant foodplants growing in short, sparse vegetation, where there is abundant leaf litter.	Butterfly transect
Butterfly	<i>Boloria selene</i>	Small pearl-bordered fritillary	Section 41 Priority Species; Scottish Biodiversity List		Damp, grassy habitats as well as woodland clearings and moorland.	Butterfly transect
Butterfly	<i>Coenonympha pamphilus</i>	Small heath	Near Threatened; Section 41 Priority Species; Scottish Biodiversity List		Heathland, moorland, grassland and coastal habitats. Caterpillars feed on a variety of grasses such as fescues and meadow-grasses.	Butterfly transect
Butterfly	<i>Speyeria aglaja</i>	Dark green fritillary	Near Threatened		Found in a range of flower-rich grasslands often with patches of scrub, including moorland and wet flushes; acid grassland with bracken; and occasionally woodland rides and clearings.	Butterfly transect
Caddisfly	<i>Stenophylax vibex</i>		Nationally Scarce	4	Unmodified fast flowing streams	Pitfall 5
Dragonfly	<i>Somatochlora metallica</i>	Brilliant Emerald	Nationally Scarce; Vulnerable	8	Open lochs/small pools with some water movement and sphagnum moss or overhanging margins with some nearby shelter such as trees	Local recorder
Dragonfly	<i>Somatochlora arctica</i>	Northern Emerald	Nationally Scarce; Near Threatened	4	Moorland bogs and pools, often with much Sphagnum	Local recorder

Categories of conservation status from Pantheon are denoted by different colours in the table and fall into three types:

- **GB Rarity:**
 - Nationally rare (recorded from between 1-15 10km x 10km squares)
 - Nationally scarce (recorded from between 16-100 10km x 10km squares).
- **Threat of GB extinction (post-2001 IUCN criteria):**
 - Critically Endangered
 - Endangered
 - Vulnerable
 - Near Threatened
 - Data Deficient
 - Least Concern
- **Policy, legislative or other listing:**
 - Section 41 list of Priority species (England)
 - Scottish Biodiversity List (Scotland)
 - Species is associated with an Important Invertebrate Area (IIA).

NB. Conservation status of species evaluated using pre-1994 criteria are denoted in black. 'Notable' is the only category here.

Species Quality Scores (SQS) are based on their conservation status:

1 = Species that have no GB rarity status (even if classed as IUCN threatened).

4 = Species currently classed as Nationally Scarce but not threatened.

8 = Species currently classed as Nationally Rare but not threatened.

8 = Species currently classed as Nationally Rare or Nationally Scarce, also considered IUCN Vulnerable.

16 = Species currently classed as Nationally Rare or Nationally Scarce, also considered IUCN Endangered.

32 = Species currently classed as Nationally Rare or Nationally Scarce, also considered IUCN Critically Endangered.

Soil eDNA

In August 2022, a total of 54 soil samples were collected from across the estate. In each of the 15 Malaise/pitfall sampling locations, three soil samples were collected (each of which consisted of five sub-sample cores), at least 20m apart. An additional nine samples were collected to ensure that all the soil sampling locations from 2020 (see our First Natural Capital Report) were revisited. These soil samples were sent to NatureMetrics for DNA metabarcoding to identify soil fungi and invertebrates.

For the soil invertebrates, 47 of the 54 samples yielded results and a total of 231 taxa were detected, 18.2% of which were classified to a named species. The majority of taxa were nematodes, followed by arthropods including mites and springtails. There were also a number of tardigrades, rotifers and platyhelminthes, giving a glimpse of the vast diversity of fauna that exist in soils. The number of taxa found varied by habitat type, with the highest number found in grassland soils (an average of 44 taxa were found across the five grassland samples, ranging from 22-74) and the lowest number in the peat (an average of 15 taxa across five samples, ranging from

8 to 23), which is unsurprising given the wet and acidic nature of peatland soils.

For the fungi, 50 out of the 54 samples yielded results and a total of 1,022 taxa were detected, 16.5% of which were classified to a named species including the endangered Glistening Waxcap fungus *Gloioxanthomyces vitellinus*. Again, the number of taxa found varied by habitat with the highest numbers found in grasslands, deciduous woodlands and scrub (averages of 96, 81 and 83 respectively) and the lowest numbers in peat and the coniferous plantations (averages of 44 and 62 respectively).

The highest number of taxa found in a single sample was 139 and this was from the ancient birch woodlands of Craig Bhallach.

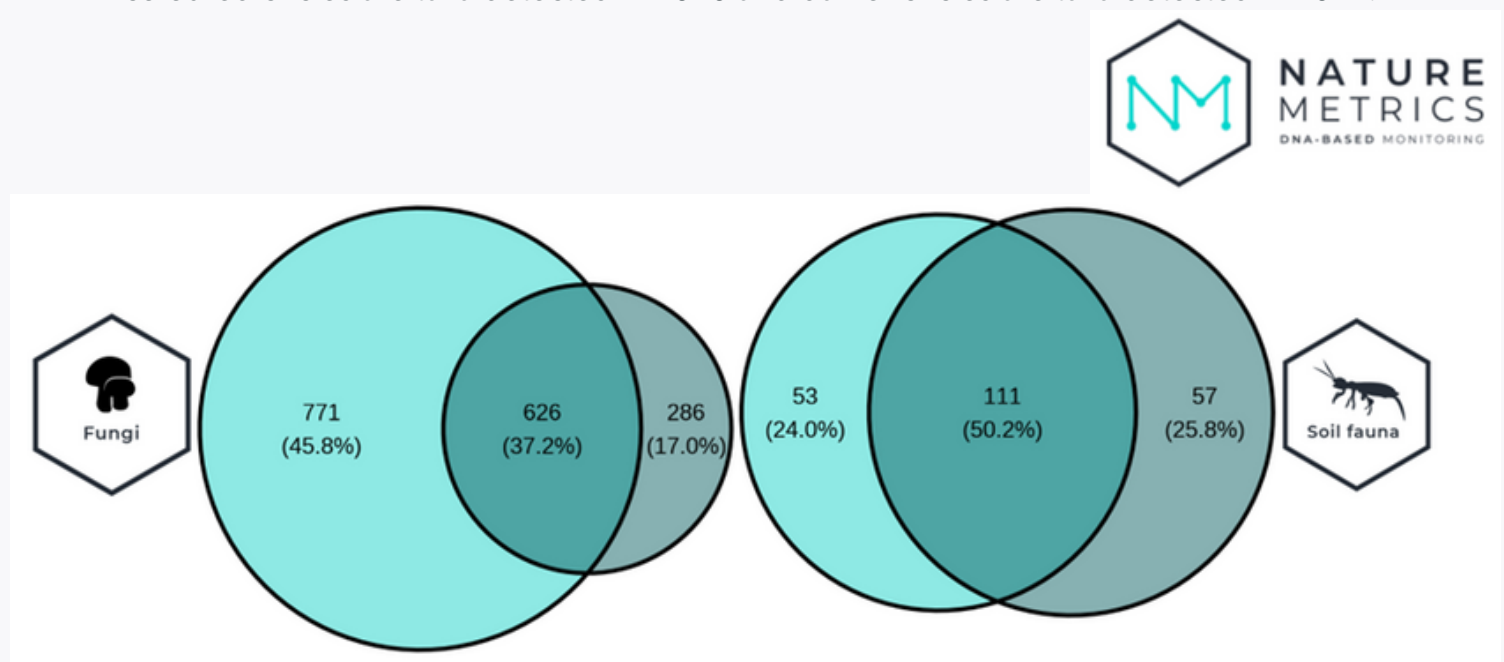
As 40 of the samples were collected from the same locations as those collected in 2020, NatureMetrics was able to carry out an interesting comparison between the results.

However, as samples were collected in October 2020 and in August 2022, it is difficult to disentangle the confounding effects of year and time of year at this stage. Nevertheless, a few interesting observations have been made.

Figure 2 shows that, while some taxa were found in both years, a substantial proportion were unique to the sampling year, and the overall number of fungi taxa was lower in 2022 than in 2020.

Interestingly the decline in fungal taxa was largely driven by a reduced number of ectomycorrhizal fungi in 2022, which may be due to the clearfelling of a number of plantations. We hope to see this diversity restored and eventually increased as we replant these areas with native broadleaves.

Figure 2 Venn Diagram summaries of the overlap of taxa detected across sampling points. Lighter coloured circles are taxa detected in 2020 and darker circles are taxa detected in 2022.



Browsing impacts

Bunloit Estate is home to a diverse mix of fauna, including three deer species; red *Cervus elaphus*, sika *Cervus nippon* (a non-native species that is by far the most commonly-photographed animal by camera traps on the estate) and roe *Capreolus capreolus*.

The number of deer make restoration of our native woodlands very difficult because saplings are heavily browsed and have little chance of reaching maturity - a problem starkly illustrated by the almost total lack of young trees in many areas.

Indeed, similar problems exist across Scotland, with deer populations at record highs and a widespread acceptance that these need to be reduced in order to fulfil afforestation and woodland restoration targets.

We have been culling deer on Bunloit since the estate was purchased, to try and bring

densities down to a level at which regeneration of trees can occur. Evidence from elsewhere in Scotland is that such densities are around two animals per km², and certainly less than five per km².

These densities are very difficult to apply to Bunloit because of the size and shape of the estate – surrounding areas have high densities and deer move in and out of the estate regularly, with sizeable groups habitually occupying some edge areas. Informal counts by our stalker suggest that we have generally had between 10 and 15 deer per km², with a recent count suggesting that we are now below 10.

Because robustly controlling deer numbers in the absence of fencing is so difficult, our aim is to focus attention on areas where numbers tend to be particularly high and/or where impacts are particularly great. Our objective is therefore not a particular density of animals, but to achieve browsing impacts in line with restoration of our native woodlands.



For this reason, it is crucial that we observe the impacts of browsing in woodland areas to monitor woodland restoration and the effects of deer control. We therefore carried out browsing impact assessments at the end of summer 2023, using the Woodland Herbivore Impact Assessment Method³.

This method assesses browsing impact using seven criteria: 1) bark stripping; 2) ground disturbance; 3) basal shoots; 4) epicormic/lower shoots; 5) seedlings and saplings; 6) preferentially browsed or grazed plants and 7) other plants. The surveys were conducted to assess the most recent season's browsing impacts on four distinct woodland types: Scots pine dominated woodland of plantation origin (Upper Lenie woods); upland ancient mixed broadleaf woodland with sessile oak (Rùsgaich); juniper woodland; and upland birch woodland (Creag Bhallach). The results for each habitat are reported in the relevant area section but the overall conclusion was that browsing pressure, particularly from sika deer, remains high on Bunloit Estate, with most negative impacts occurring in the oak and birch woodlands

with signs of historically high browsing pressure. Browsing pressure appears lower in the Scots pine woodland with some natural regeneration and recent seasonal growth on historically browsed species.

Creating accessible routes throughout the estate is a priority to facilitate deer management and we will repeat the assessment each year to monitor progress.

In order to more fully understand the impacts of browsing on the vegetation, we have also set up five exclosure plots in different habitats across the estate (oak woodland, juniper scrub, peatland, pine woodland and birch woodland). These are 20m by 20m fenced off areas (1.8m high fencing with posts and five rails), to exclude all browsing animals. On completion, each will be thoroughly surveyed for ground vegetation (species presence and percentage cover), along with a neighbouring unfenced area. These areas will be monitored over time to see how the vegetation changes.





Young wild boar, Bunloit (Spring 2021)

Impact of wild boar

Wild boar (*Sus scrofa*) were once common throughout Britain, and played a unique role in ground disturbance and the numerous ecological processes associated with it. We can't be certain how long boar have been absent, but habitat loss and hunting seem to have made them extinct in Scotland by the 17th century at the latest (along with their natural predators)⁴.

In recent years, however, boar have been making something of a comeback. European boar have escaped from farms or been released illegally, and have begun to re-hybridise with their domesticated cousins. The resulting 'feral pigs' have spread into several areas of Scotland, including the Bunloit estate. Due to their murky background, these new arrivals are officially considered an Invasive Non-Native Species⁵.

Boar are large animals that cause obvious ground disturbance and are particularly contentious as a result. We are currently monitoring their impacts in as much detail as possible.

There are a number of reasons to reserve judgement and gather evidence in this way.

While rooting by boar and pigs is obviously destructive in the short term, it can be useful where plants such as bracken, which can otherwise dominate large areas, are broken up. But it can also be beneficial even in species-rich areas, where it enables rare species that are normally outcompeted to spread to new ground, potentially increasing diversity⁶⁻⁸. There's also evidence that the consequent changes in plant communities favour other native species that require some level of disturbance for their life cycles and food sources⁹⁻¹¹.

Similarly, impacts on soil carbon may be less problematic than they appear. Rooting exposes soil and can increase soil carbon emissions, although it is unclear whether the general effect is positive, negative or neutral^{12,13}. But rooting also mixes surface organic matter into the soil, and has been found to increase the amount of stable mineral-associated carbon^{14,15}.

Of course, even beneficial effects can become negative at high intensities¹⁶. As for deer, determining the number of boar on Bunloit is extremely difficult because the animals are hard to spot and distinguish from one another, and move far and fast.

Even knowing numbers, however, it would be

very hard to set a target density, and this would vary between, for example, working pasture and native woodland. Nevertheless, we can check numbers approximately, and assess impacts precisely.

We're doing this through a growing programme of monitoring, involving:

- Counting the number of boar recordings on our camera traps (which show a large decrease between 2022 and 2023, although we're cautious about interpreting this as solid evidence of population loss because our network of cameras is small and other factors could affect recordings).
- Hosting an independent project on interactions between deer and boar and developing other research projects in collaboration with universities.
- Walking transects across the estate to record the extent of boar disturbance.
- Placing quadrats to record long-term vegetation change along these transects.
- If possible, adding long-term soil sampling to these quadrats, to track soil chemistry changes related to boar activity.
- Establishing exclosure plots to test the effects of removal of deer and boar activity.
- Wider monitoring and information sharing with neighbouring landowners.

We don't yet have final results from this work, but our transects are already producing interesting data. We have 43 transects on the estate (plus a few on neighbouring land, with the landowner's permission), each of which is 250 metres long. These transects were first walked in spring 2023, and within each 5-metre section we recorded the percentage of ground disturbed by rooting out to 2 metres either side of the transect line. Results show a clear gradient of intensity that is greatest in the oak and birch woods on the lower slopes of Bunloit (right-hand side of the image), reaching up to 30% of ground disturbance on one transect (with an average of 7.15% across them all).

We will repeat these and record change over time, but the spatial patterns along transects are also interesting, with clear signs that different habitats are being used differently (intensive but patchy disturbance in birch woods, much more extensive in oak and pasture, and limited but highly localised disturbance in pine woods).

Our intention now is to expand this research and collaborate with neighbours to assess numbers and, where possible, monitor impacts on other land.

Figure 3 Map of Bunloit estate showing average percentage of disturbed ground per transect

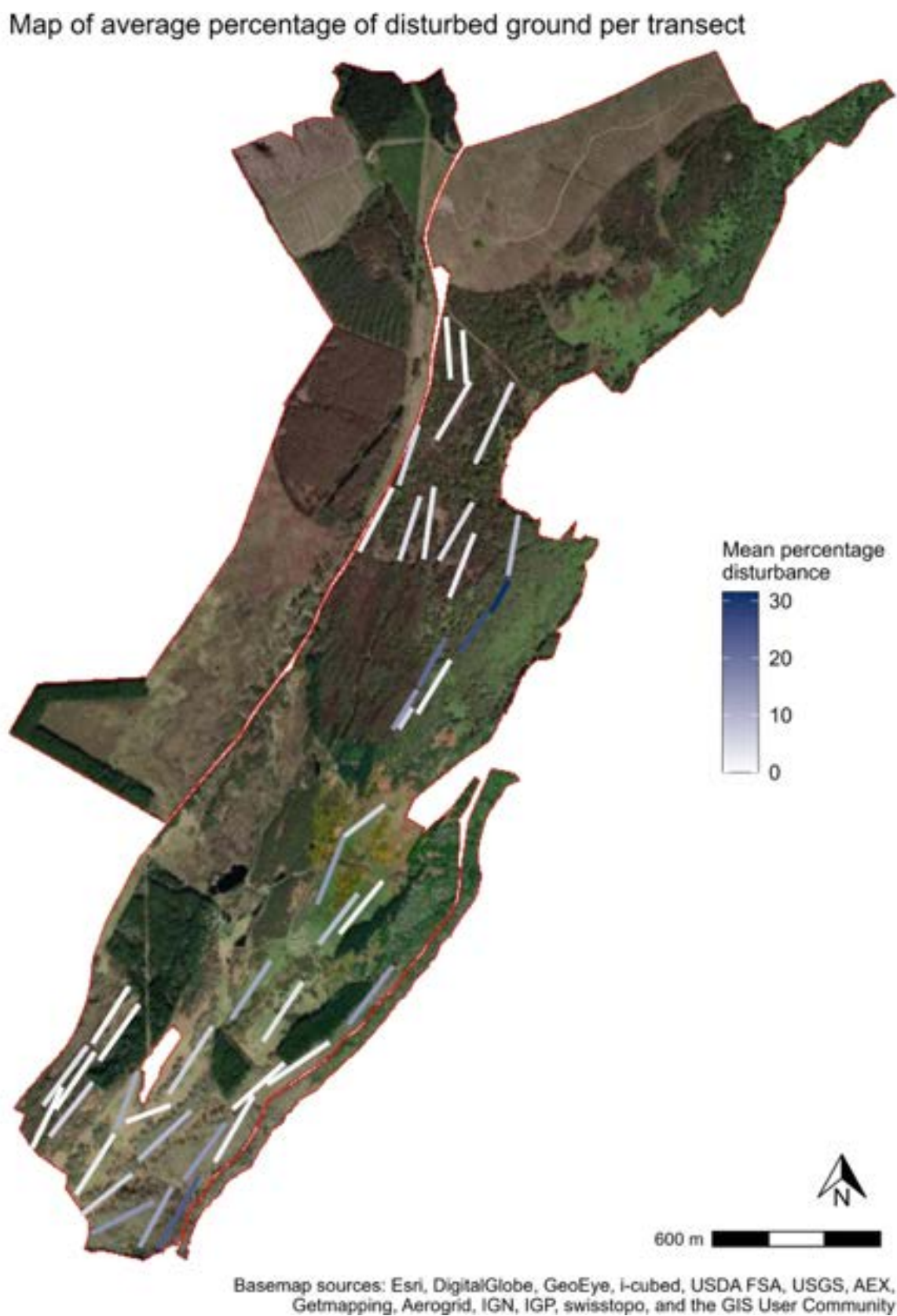


Figure 4 Map of Bunloit Estate showing locations of disturbance quadrat pairs

Map of Bunloit estate showing locations of quadrats studied



Basemap sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Habitat condition survey

While Bunloit has been extensively surveyed over the past 3 years, we are still gathering information about pressures on the habitats here and on the consequent conditions of those habitats. Formal methods for assessing habitat condition do exist, and this year we've used the UK Government's Defra metric (designed in England as part of Biodiversity Net Gain) with the UKHabs classification system.

This approach is not specifically designed for Scotland but gives a robust and standardised guide for our future management decisions.

Figure 5 Map of habitat condition on Bunloit estate



Figure 5 shows the results of Bunloit's habitat condition survey. Relatively few parts of the estate (a total of 79 hectares) are classified as being in good condition. 193 hectares are classified as being in moderate condition, and 240 hectares (nearly 47% of the estate) in poor condition. The main causes of moderate or poor condition are the presence or recent removal of non-native conifer plantations, lack of regeneration in native woodlands, peatland drainage, and the presence of gorse scrub.

We will deal with each of these as described in the sections below, with a view to achieving good condition of habitats across the estate over the coming years, informed by our ongoing monitoring programmes.



Land Management Plans

We have divided the estate into 14 land management areas. The following section will describe each area and how we are proposing to manage it in turn, starting from the Lon Mhor bog and working clockwise around the estate.



Figure 6 Map of Bunloit estate land management areas



1.Lon Mhor bog

Figure 7 – Lon Mhor bog maps

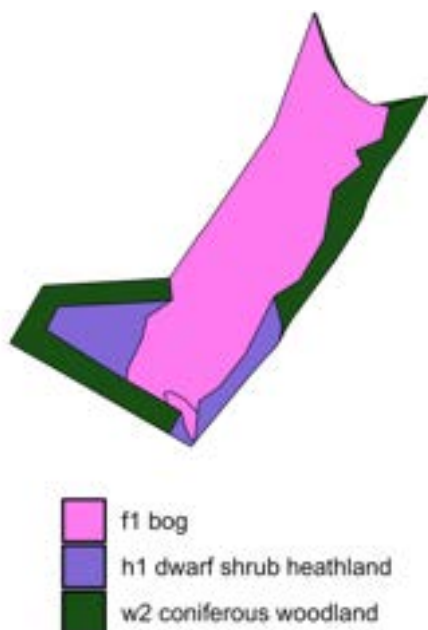
Map showing location within estate



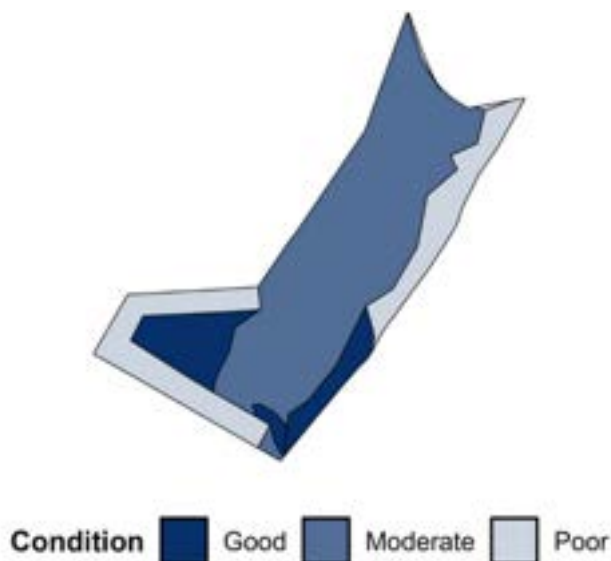
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



The Lon Mhor bog sits to the west of the Bunloit Road and covers just under 57 hectares. The majority of the area is bog and a peatland depth mapping exercise, undertaken in May 2021 and described in the First Natural Capital Report, showed substantial stores of carbon in the peat here. However, this peatland is actively eroding due to historic drains and is a net emitter of carbon.

The area is therefore part of our peatland restoration plans, which are being carried out through Peatland ACTION. Drains and gullies in this area will be blocked to stop erosion, raise the water table locally and reduce water loss over the site. This should provide peatland vegetation the conditions that it requires to grow.

The triangular shape of the Lon Mhor clearfell covers an area of approximately 7.5ha and was previously planted with Sitka spruce and lodgepole pine, which was felled in 2022. This area will not be restocked with trees as the peat here has an average depth of 0.5m and the trees were only growing at yield class 4, which is at least half of what it should be for a productive plantation (the yield class is a measure of the productivity of trees, in cubic metres per hectare per year). The area will be allowed to naturally regenerate into an area of scrub, heath and peatland.

Within this area there is also a strip of coniferous (pine) woodland regenerating along the edge of the road. This has been assigned a poor condition; one that will improve over time as the woodland matures and develops greater structural diversity and

species richness. **We will assist the regeneration by removing any non-native tree species and ensuring the presence of dead wood.**

The Malaise trap and pitfall traps (ID 8) located in the open peatland area next to the clearfell captured a total of 68 species (44 in the Malaise and 24 in the pitfalls). The pitfalls captured two Nationally Scarce money spiders; *Agyneta olivacea*, which is adapted to open habitats, and *Hilaira pervicax*, which relies on acid peat, sphagnum and mosses. Further restoration of this site will encourage other priority species that rely on open moorland areas. The few scattered trees and nearby scrub are also beneficial, as the Malaise trap caught species that are broadleaved woodland specialists, including flies and a few moths.



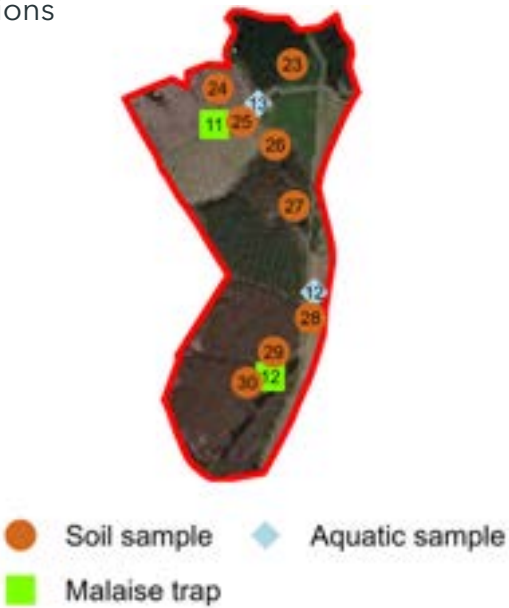
2. Clunebeg woodland

Figure 8 Clunebeg woodland maps

Map showing location within estate



Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



Clunebeg woodland covers an area of approximately 78.5 hectares and is comprised of several different forestry sub-compartments of different age and species mixes. A 15.8 hectare area in the north-west corner (previously a Sitka spruce plantation felled in 2019) will be restocked with native trees. This area is currently classified as neutral grassland in poor condition, due to the *Deschampsia* grasses dominating over the clearfell. An access track splits the area into two and the northerly half, below the road, is the site of a research trial in collaboration with Oxford University's Leverhulme Centre for Nature Recovery and Rhizocore Technologies. This is a fantastic opportunity to assess the effects of Mycorrhizal fungi inoculation on tree growth, native

woodland regeneration and soil properties in a previously clearfelled site (see box on next page). The area has been divided into thirty 30m by 30m plots, randomly assigned to one of three different treatments:

Treatment 1: Ten plots will be planted with broadleaved trees that have ectomycorrhizal fungal associations (see box).

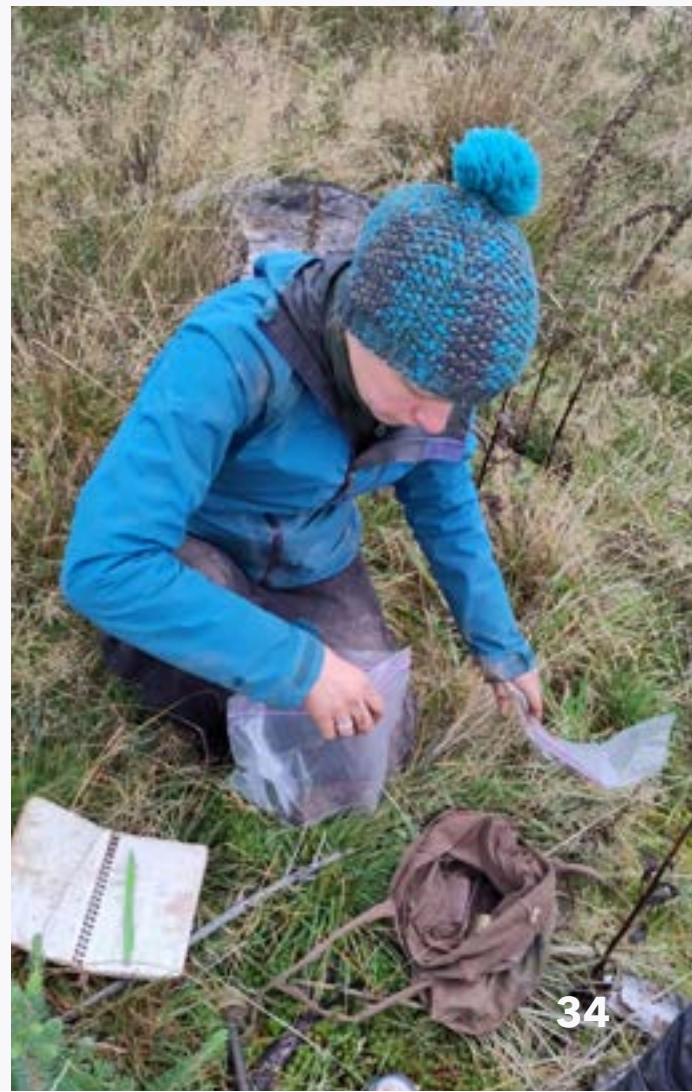
Treatment 2: Ten plots will be planted with the same broadleaved tree species as in Treatment 1, but each tree will be planted with an ectomycorrhizal fungus pellet, potentially 'fast-tracking' relationships between fungi and trees.

Treatment 3: Ten plots will be left unplanted and allowed to naturally regenerate with native broadleaved trees.

Around the thirty plots, there will be 10m buffer areas, which will be planted with tree species that have Arbuscular mycorrhizal associations, including rowan, bird cherry and crab apple. We will monitor tree growth in all the plots as well as properties of the soil, including carbon and nutrient stocks.

The other half of this area of Clunebeg, above the access track, will be planted with the same tree species but without experimental treatments. Landscape analysis of the entire Clunebeg compartment has confirmed that the plots will not be visible from afar - straight lines will be avoided by mixing species and areas outwith the trial plots will contain a mix of all species. Due to the surrounding coniferous plantations, Sitka spruce is naturally regenerating across the site and this will require ongoing management.

Experimental plot set up & soil sampling on Clunebeg, during a brief break from the rain (autumn, 2023)



Mycorrhizae - the hidden world beneath our feet.

Mycorrhizae are associations between fungi and plant roots, which create vast* networks in the soil, connecting trees and plants across large areas (and sometimes, but controversially, called the 'wood wide web'). These relationships are most often mutually beneficial (symbiotic), as the fungus helps the plant to take up water and nutrients from the soil, and in turn the plant provides the fungus with nutrients created by photosynthesis. There are two main types of mycorrhizae:

Ectomycorrhizal fungi surround the tree's roots, without actually penetrating them. These fungi are more common in colder climates and form symbiotic relationships with trees such as birch, oak and pine.

Endomycorrhizal fungi infiltrate the plant root and are more common globally, being present in over 80% of plant species, including most grasses, flowers and vegetables. One type of these are known as arbuscular mycorrhizae and these are found in trees such as rowan, cherry, apple, holly and juniper.

**It has been estimated that, globally, the mycorrhizal hyphae in the top 10cm of soils would stretch over distances of approximately 4.5×10^{17} km, which is half the width of our galaxy!*

To the east of the clearfell area is an area of mature Sitka spruce, which has never been thinned. Due to the lack of previous management within this woodland block it will need to be clearfelled at some point – it is unfortunately too late to thin now, as it would be too susceptible to windblow.

However, no felling will take place here for at least five years, after which the neighbouring area of new broadleaved trees will be at least two metres tall.

The rest of the Clunebeg area offers much greater potential for transition to continuous cover forestry. The younger (approximately 20 year-old) blocks of Sitka spruce will be thinned and can act as a demonstration site for how Sitka can be managed as continuous cover woodland.

The southern area of Clunebeg is predominantly Scots pine plantation, which has been previously thinned. We will start management here with continued thinning, aiming for 8 – 10m spacing among trees over a 30 year period, which will allow natural regeneration and an increase in age classes, gradually improving the overall condition and biodiversity of the woodland.

The Malaise and pitfall traps (ID 11) located in the Clunebeg clearfell captured a total of 81 species. Only 34 of these were in the Malaise trap, which was the lowest richness across Bunloit, and most species were broadleaved woodland flies, with a few species indicating open habitat, tall sward and scrub. The pitfall traps, however, captured a total of 47 species, which was the second highest pitfall

trap diversity from across the estate and included the notable beetle *Choleva glauca*, which is a small species often found in carrion or the nests of mammals. There were also a number of beetles, spiders and harvestmen that indicate broadleaved woodland, as well as open tall sward and scrub, again indicating a habitat in transition.

The Malaise and pitfall traps (ID 12) located further south, towards the edge of the Scots pine plantation, had again a relatively low diversity with 47 species in the Malaise and 32 in the pitfalls. There was a Nationally Scarce spider *Agyphantes expunctus*, which is found in canopy and scrub at woodland edges and is associated with birch, juniper and larch.

There were also some species associated with wetlands, acid peatland and marsh, which is not surprising given the location near the peatland. Transitioning management towards continuous cover would certainly boost the diversity of species found in this area.

The Great Glen Way currently passes through this area but it is mainly confined to the public road. We are investigating the options for re-routing the footpath so it passes through the woodlands, which would be a great opportunity for visitors and hikers to see more of the estate, as well as being a safer alternative.



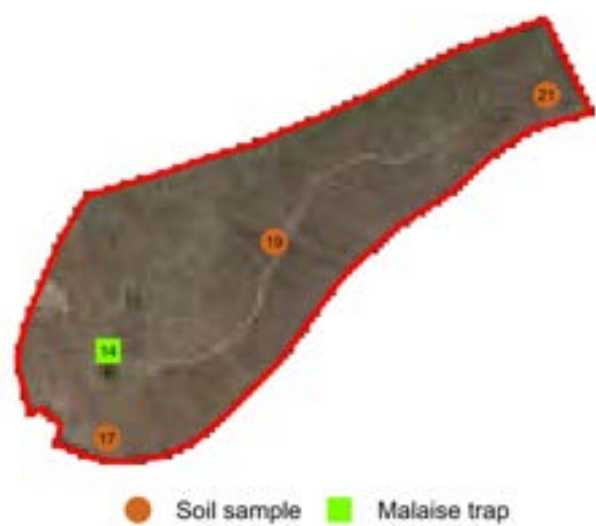
3. Borlum Wood

Figure 9 Borlum Wood maps

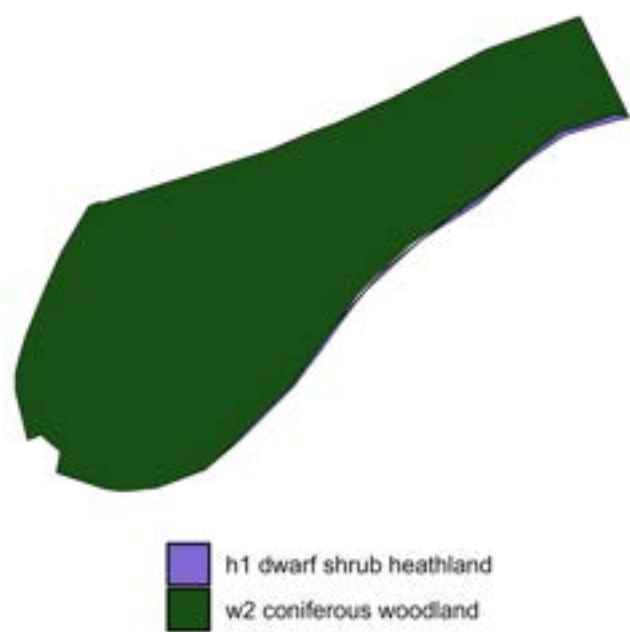
Map showing location within estate



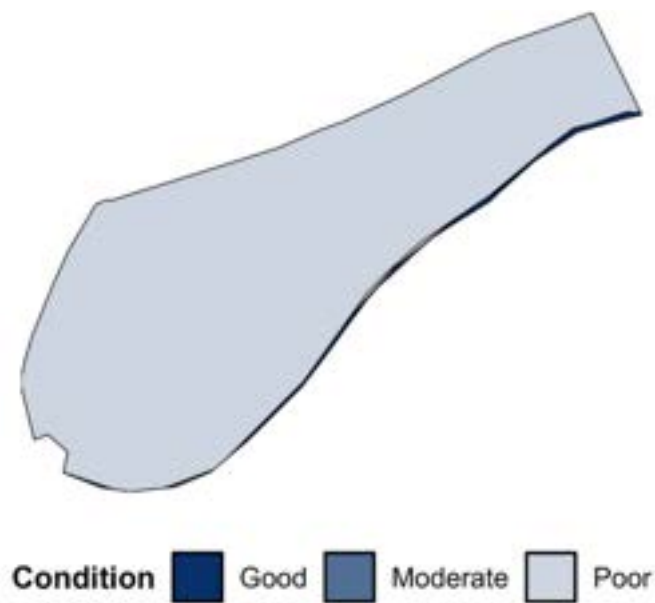
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



Borlum Wood covers an area of approximately 40 hectares. It was previously a block of productive conifer, planted in 1963 and felled in 2016 by a previous owner. It was restocked in 2019 before Highlands Rewilding took over management and this planting was carried out with a productive woodland in mind. The area is now a block of even-aged Sitka spruce and Scots pine with naturally regenerating birch throughout, the growth of which has been enabled by the deer-fence that surrounds this area.



Birch regeneration in Borlum Wood (September 2023)

Our plan here is to remove some areas of Sitka spruce, to enable the native broadleaved trees to establish and break up the even-aged productive conifer. This will create areas of woodland that will not be felled so that any future forestry operations will not have such large impacts in the landscape.

The Malaise and pitfall traps (ID 14) here caught 54 and 44 species respectively and we would hope to see this diversity increase as the woodland matures.

The presence of a Notable rove beetle *Quedius xanthopus* in the Malaise trap is a good indicator that at least some broadleaved woodland should be retained within the plantation – this species uses decaying wood heart rot and wood mould in broadleaved woodland. Areas of open habitat are important too, as indicated by the presence of flies, spiders, beetles and harvestmen that rely on an open, tall sward.

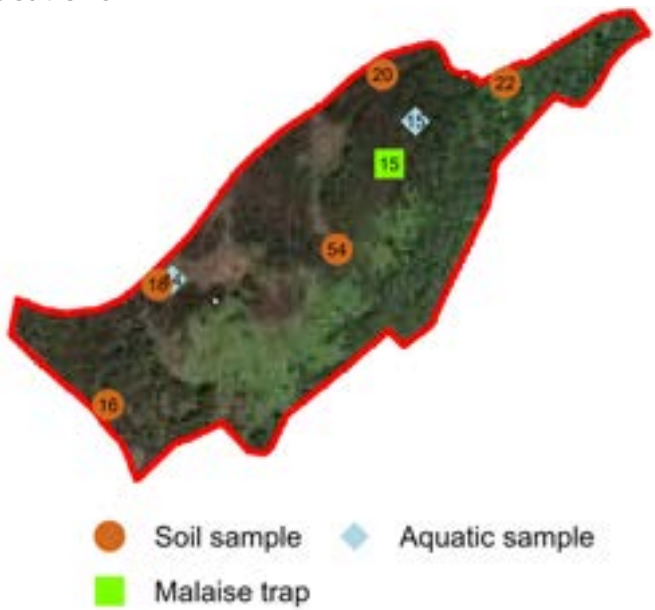
4. Strone grazings

Figure 10 Strone grazings maps

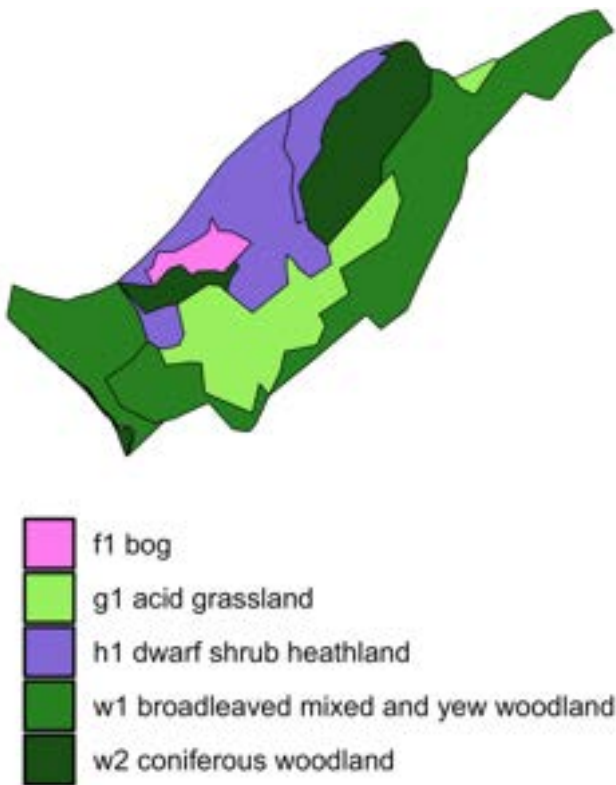
Map showing location within estate



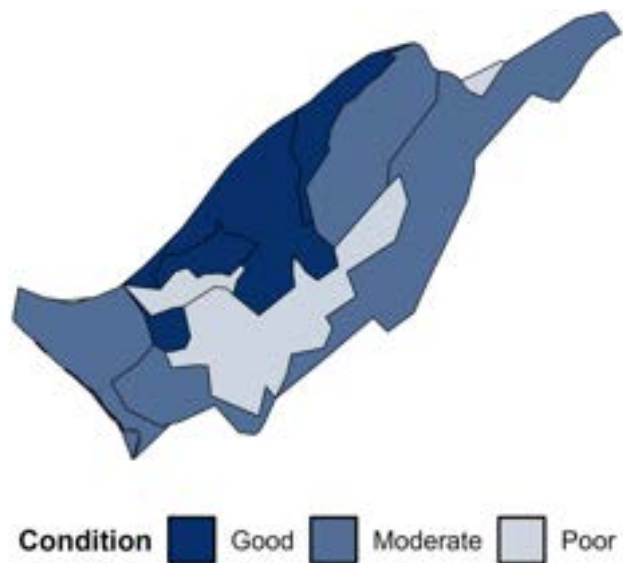
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This is an area of just under 70 hectares, part of which is registered Common Grazing land.

The mosaic of heath and bog remains in good condition and we plan to maintain this through removal of self-seeded non-native conifers where needed.

There are a number of footpaths here and we plan to improve these, with the addition of board walks over the waterlogged and boggy areas. Over 12ha of this area has become dominated by bracken, which we need to reduce through mechanical control and potentially light grazing with cattle. This will improve the condition of the habitat and hopefully restore it to heathland, as also recommended by our first vegetation survey carried out by Plantlife (see first Natural Capital Report).

The Malaise trap here captured a total of 96 species, which was the second highest Malaise trap richness from across the estate and included the Nationally Scarce fly *Fannia ornata*, which is a saprophagous species living in coniferous wood litter. The pitfall traps captured a lower diversity (19 species),



Dragonfly walk with Anna Macfie, August 2023

which is not surprising given the boggy nature of much of the soil, but there was a good mix of beetles, spiders and flies indicative of broadleaved woodland and open, tall sward and scrub habitats.

Aside from the species captured in the traps, this area has a fantastic diversity of dragonflies and the potential to attract more.

We are fortunate to have dragonfly enthusiasts living close by and Anna Macfie offered the first 'dragonfly walk' in the summer, which was a fascinating insight into the diversity of these beautiful insects. We plan to ensure the bog pools in this area and the neighbouring pine woods continue to provide good habitat for dragonflies, by blocking small drains and removing non-native trees where appropriate.



5. Upper Lenie woodlands

Figure 11 Upper Lenie woodlands map

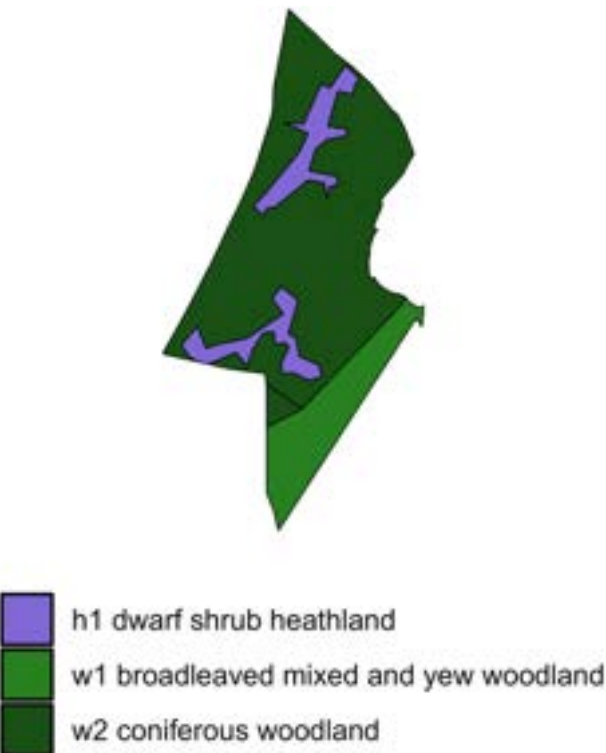
Map showing location within estate



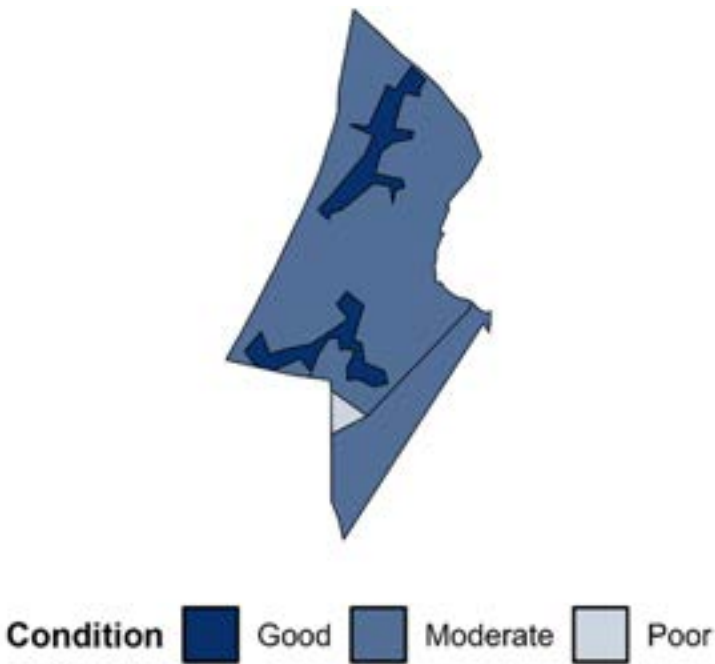
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



Upper Lenie woodland comprises just under 40 hectares of (mainly) coniferous habitats, most of which are in Moderate condition. Our browsing impact assessment found that browsing pressure was lower in this woodland than elsewhere on the estate.

Tree species within survey locations included Scots pine, European larch, downy birch, goat willow, rowan, western hemlock and Sitka spruce. Bark stripping and ground disturbance was low throughout. Seedlings and saplings were most common here compared to the three other survey areas, with high levels of natural Scots pine regeneration with no to very low signs of browsing damage in two survey locations. Heavily browsed rowan saplings were present in one survey location, whilst rowan seedlings were present in another with no signs of browsing pressure evident. However, these seedlings were <10cm so may be susceptible to browsing as they grow and become more noticeable. Substantial natural regeneration was evident on overturned root plates, as with the oak wood, and natural regeneration of rowan and downy birch has occurred on the wildlife hide green roof, safe from browsing pressure. Historically browsed holly was observed with healthy new growth which suggests, along with the Scots pine regeneration near the road, that deer management is having a positive effect on natural regeneration here. To aid natural regeneration in this area, scarification by horses, if used for horse-logging, could be tried and assessed.

The regeneration allows us to plan for diversification and improvement of the woodlands, particularly through deadwood creation and veteranisation, as recommended in Plantlife surveys. As well as helping to create more deadwood habitat for insects and bryophytes, this will diversify woodland structure and encourage lichen colonisation.

The Malaise and pitfalls (ID 13) in this area captured a reasonable diversity of insects (48 and 45 species respectively).

There was one priority butterfly Scotch Argus *Erebia aethiops*, which is associated with open habitats and moor grasses and illustrates the benefits of woodland glades. There were further moths, flies, a caddisfly and a stonefly in the catch and the pitfalls captured spiders, beetles and harvestmen, including one spider which is a peat bog specialist. We aim to boost the diversity of this area by providing further habitats, such as standing dead wood.

When species reintroductions are mentioned in the context of a rewilding project, thoughts tend to turn to wolves or lynx. However, in this area of pine woodland we are considering reintroducing a much smaller species, but one which plays a big role in the ecosystem: the wood ant.

In Scotland, there are two 'true' wood ant species; the Scottish wood ant *Formica aquilonia* and the hairy wood ant *Formica lugubris*. Their ranges overlap but the Scottish wood ant is less common and found in older, closed canopy woodland, while the hairy wood ant is often found along woodland edges or clearings. Both are important ecosystem engineers as they disperse seeds, affect tree growth, cycle nutrients, impact other invertebrate populations and also provide a source of food for other species including some birds and spiders.

Wood ants are easily recognisable by the large mound nests they create on the forest floor – and their absence is noticeable in Bunloit's pine woods (although they are fairly close by with a small nest observed near Grottaig, approximately 5km south).

The DNA results from our pitfall and Malaise traps detected seven sequences that could

be classified into the ant family, but only two of these were named to species level; *Myrmica ruginodis* & *Myrmica scabrinodis*, both of which are common red ant species. Of the other five sequences, four were also in the *Myrmica* genus but one sequence was classified to the *Formica* genus, to which the wood ants and relatives belong. As we have not observed any mound nests this DNA is likely to come from another relative, potentially the large black ant *Formica lemani*, which can live alongside wood ants.

We are currently investigating the potential of translocating wood ants to the pine woods, following expert advice.



Upper Lenie woodlands, and sword-leaved Helleborine (*Cephalanthera longifolia*); a rare indicator of ancient woodland

6. Creag Bhallach birch woods

Figure 12 Creag Bhallach birch woods maps

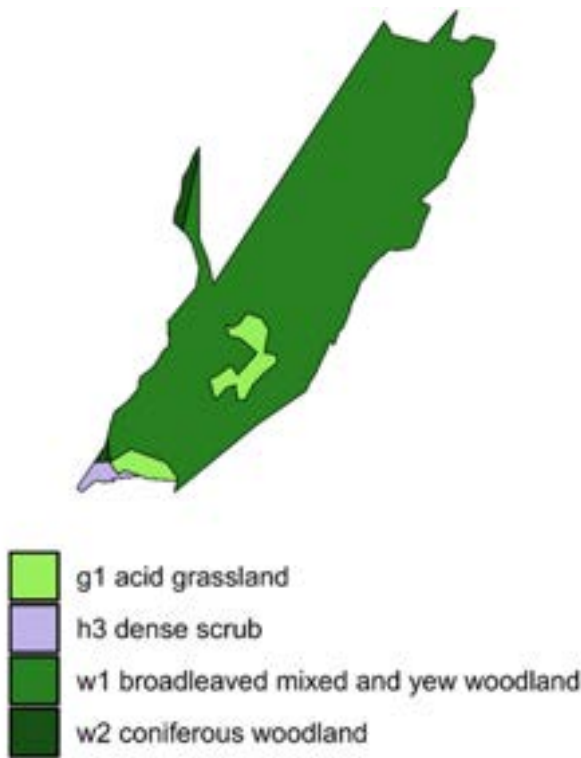
Map showing location within estate



Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



These ancient, semi-natural woodlands cover an area just under 30 hectares and have been assigned a moderate condition score, due to their lack of natural regeneration. The browsing impact survey showed that this woodland is composed of only mature trees, with no diversity in age.

Tree species found within survey points were downy birch, goat willow and hazel. Ground disturbance throughout the birch woodland was low, with only one survey point showing a very high level of wild boar ground disturbance. No seedlings or saplings were located during the surveys. One survey point was located within a south-facing natural woodland clearing which has become dominated by bracken, with dog violet and wood sorrel in the ground story herbaceous layer.

We aim to increase deer management in this area to gradually improve the condition of these woodlands and we will consider protecting individual saplings, particularly in the bracken area, to help them establish.

The hazel woods found in this area (and into Rùsgaich Woods, below) are particularly significant, being identified as having great conservation importance in Plantlife surveys.

We plan to retain and expand this habitat, while keeping nearby pasture areas open to maintain light levels for the highly unusual lichens found in these woods.

The Malaise and pitfalls (ID 10) bordering this area captured a total of 85 species (64 and 21 respectively). The Malaise caught mainly broadleaved woodland flies and open sward moths and the pitfall had mainly broadleaved woodland beetles and harvestmen.

Increasing the age structure of this woodland with more regeneration will boost the numbers and diversity of insects in this area.



Primroses in Craig Bhallach birch woods

7. 'Bill's plantation'

Figure 13 Bill's plantation maps

Map showing location within estate



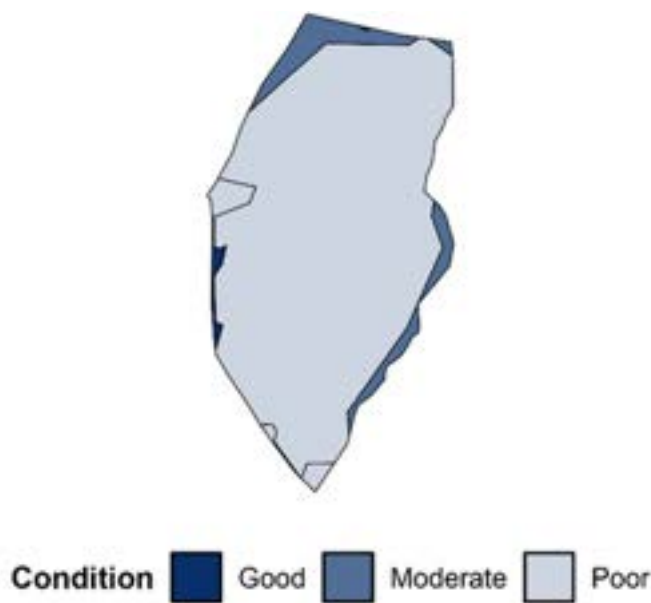
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



Bill's Plantation, also known as Woodend, was planted in 1989 and totals approximately 26.5 hectares. Within this plantation there are pockets of deep peat, with an average depth of 1.32m and a maximum depth of more than 6m; the trees planted in these areas are showing very poor growth.

We are seeking permission to remove 6.8ha of mixed Sitka spruce and Lodgepole pine to restore the peatland areas via a forest-to-bog project.

The long-term plan for this woodland is to gradually fell and convert to a native woodland.

The Malaise and pitfalls (ID 9) here captured a surprisingly high diversity for such a species poor woodland with no understorey (57 species in the Malaise and 34 in the pitfalls). The Malaise trap had mainly flies, including the Nationally Scarce *Platypalpus tuomikoskii* but also a couple of bugs and moths, which were mostly indicative of shaded broadleaved woodland and wetland. Gradually improving the structure of this woodland, including restoring open

peatland clearings, will provide habitat for many more species and the diversity in such a mosaic could be significant.



8. Gorse scrubland

Figure 14 Gorse scrubland maps

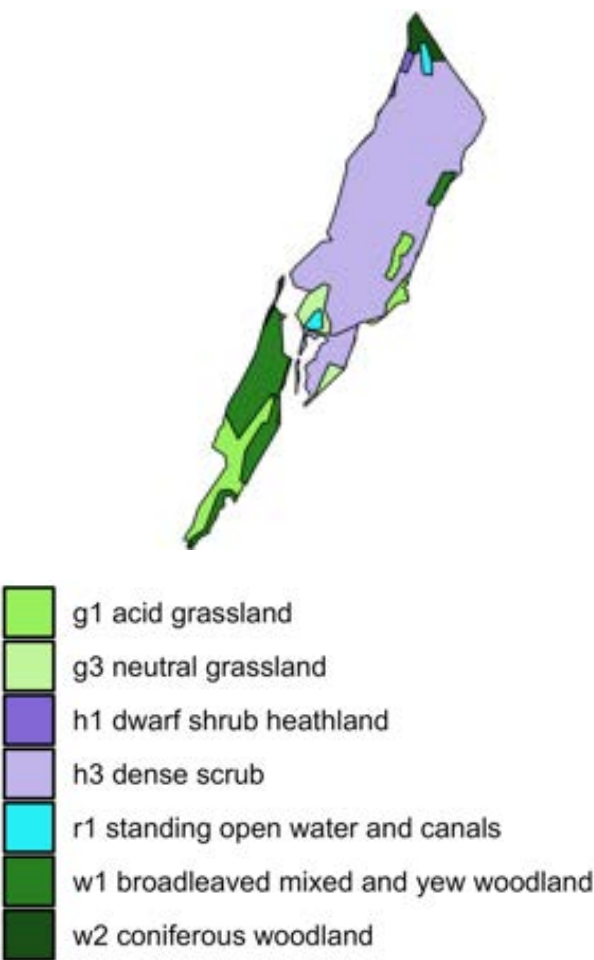
Map showing location within estate



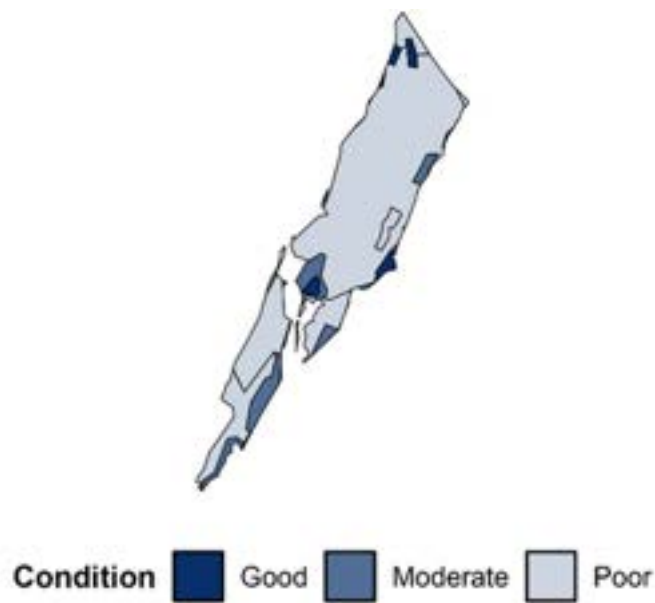
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This area, dominated by gorse scrub, covers just over 23 hectares and is situated between the upland peatbog and the lower pastures. This has been assigned a poor condition due to how its habitat structure is considered within the Defra metric. Gorse is a dominant species here (over 80% cover) with, inevitably, limited age range.

The scrub also has very well defined edges (i.e. no ecotone) with few glades or rides, which all point to a habitat in poor condition. However, it is important to note that this habitat actually has many benefits, particularly for birds, insects and regenerating trees. This is reflected in the results for the Malaise and pitfall traps (ID 1), which captured a total of 128 species (77 in the Malaise and 51 in the pitfalls), which was the second highest combined diversity from across the estate.

Species included large numbers of flies including the indicator species *Sargus flavipes*, which has saprophagous larvae and is associated with dung and carrion. There were also many deadwood flies, some nectivores of shaded woodland floors, soldier flies of damp areas and hoverflies and moths of tall scrub. The pitfalls captured a number of predators of tall sward and scrub, as well as a few leaf litter species, including ground beetles, a harvestman, a wolf spider and millepedes.

The gorse scrub is also beneficial for protecting young trees from browsing and there are very many growing in this area, which will in time shade out the gorse and improve the structure of the habitat. We will also work to prevent the gorse from spreading into the pastures.

This area also includes a couple of small lochans, which are vital water habitats. However, the aquatic sample taken for eDNA analysis from one of these lochans only found three species, which indicates a poor water quality.

There is certainly room for improvement and the aquatic environment will hopefully benefit from the neighbouring peatland restoration, which will result in a greater water retention across the area.





Areas of gorse provide valuable protection from browsing for young trees and the gorse scrubland has a great deal of regeneration of native species, around water bodies such as this small lochan (June, 2023)

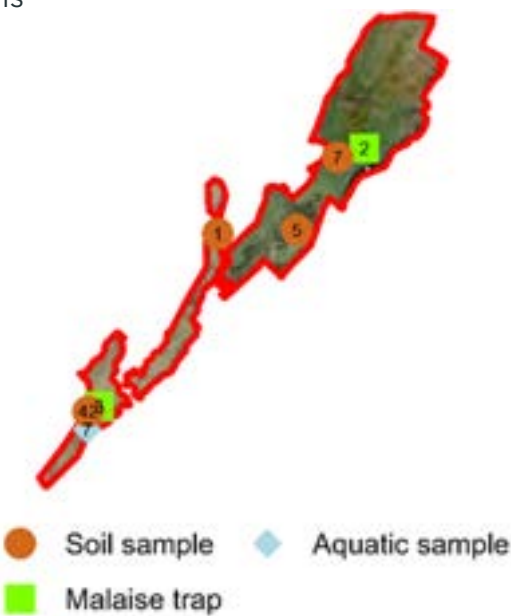
9. Pastures

Figure 15 Pastures maps

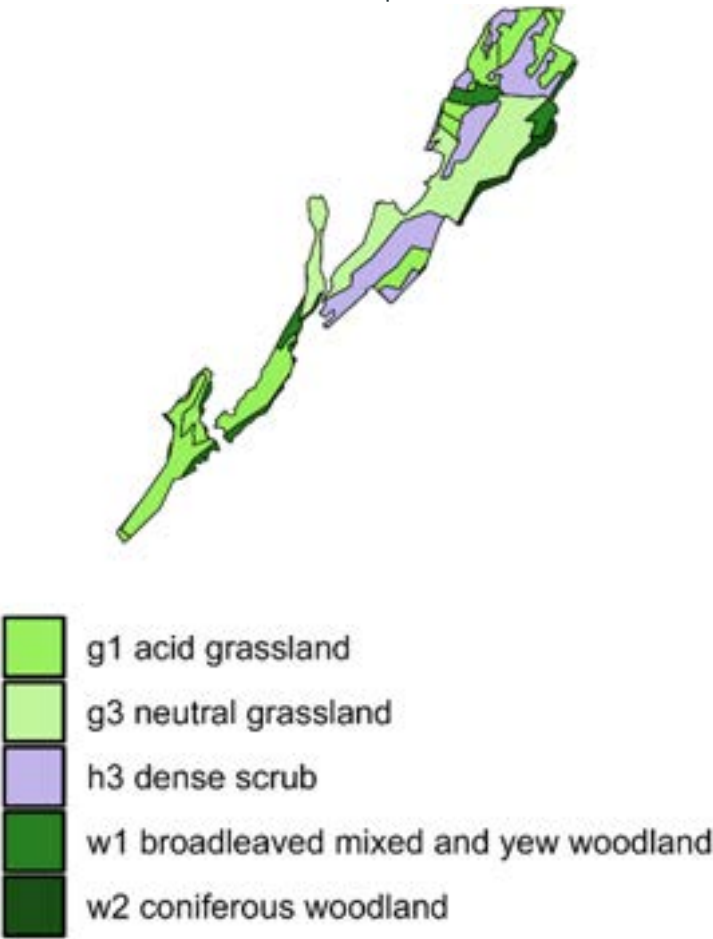
Map showing location within estate



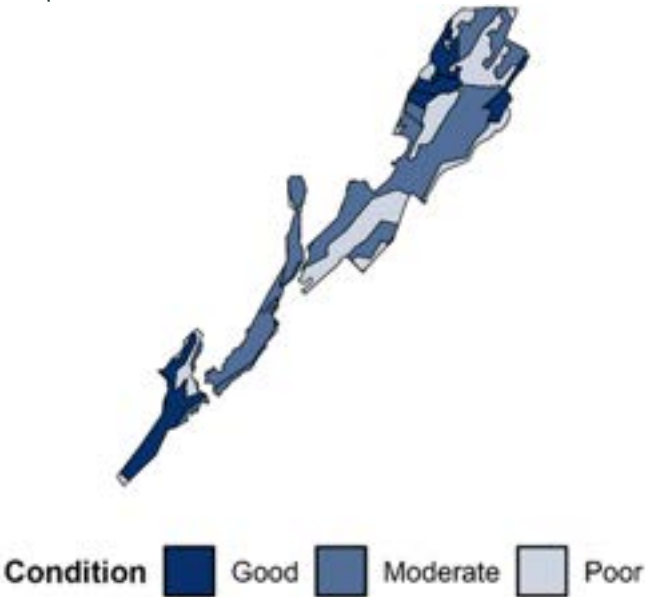
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This area of grassland, covering just under 27 hectares, is a valuable, long-established habitat and our aim is to maintain and improve its condition and overall species richness.

This will be aided by cattle grazing; a neighbouring farmer grazes a small herd of Highland cows here. The cattle are currently allowed to roam across a large area of the pastures and, as they have favoured locations, some areas are becoming overgrazed and others undergrazed.

To solve this, we have been gathering the equipment (including electric fencing and water supplies) to enable us to contain the cows within smaller areas and we will now start to move them more regularly. This is similar to the adaptive multi-paddock grazing approach we use at Beldorney. Once we have established this approach we will further develop our grazing regime and also consider annual hay cuts in places.

Bracken encroachment on to the pastures is another issue we are tackling. Whilst bracken provides a valuable habitat to some species, it has a tendency to dominate and spread over large areas, resulting in a loss of biodiversity. We have had some success with spreading hay for the cattle over the winter in bracken dominated areas. The trampling damages the rhizomes, causing less vigorous growth the following spring. We are also purchasing a bracken-roller attachment for our ATV, which will be used in spring to damage the fronds and slow growth.

Relatively poor, bracken-dominated areas also give us the opportunity to establish softer woodland edges and new wood pasture, which is a crucial habitat for lichens and many other species.

There were two Malaise and pitfalls situated in the pastures (ID 2 in the north and ID 3 in the southern area). Both captured similar numbers of insects, with the traps in the north having a slightly higher diversity (67 and 35 species in the malaise and pitfalls respectively, compared to 61 and 30 species in the south). A couple of priority grassland moths were found, including the Near Threatened moth *Antitype chi*, as well as two Scottish Biodiversity List moths; the mouse moth *Amphipyra tragopoginis* and rosy rustic *Hydraecia micacea*. The pitfalls captured good numbers of spiders, including wolf spiders, ground beetles and rover beetles. These ground predators, as well as some of the flying insects, are benefitting from the mosaics of open areas created by the boar diggings. The traps to the south picked up quite a few wetland specialists as well, including the indicator fly *Chrysotus femoratus* and stoneflies. This shows the presence of a high quality water body nearby. The mixed grazing regime that we plan, which creates different sward heights, as well as allowing for scrub structure around the edge of the grasslands, will increase the invertebrate species richness on these sites.





10. Food forest

In the Second Natural Capital Report we mentioned the small food forest we are creating close to the Bunloit farm buildings. Over the winter a total of 35 fruit trees were planted, predominantly apple with a mix of other fruits

Table 2 Summary of fruit trees in the food forest

Type	Number planted
Apple	15
Pear	5
Plum	5
Cherry	3
Damson	3
Cobnut / Hazel	4

Within this there are no more than two of any given variety of fruit tree. The apple varieties planted include Coul Bush, James Grieve, Alderman, Bakers Delicious, Bloody Ploughman, Cats Head and Golden Monday. The plum trees include Victoria, Denbigh, Majorie’s Seedling and Opal.

The fruit trees have been pruned to begin setting out a good structure to them.

A hedge has been planted around two sides of the food forest, which will provide shelter when it has grown.

Old fence posts have been used to provide protection for some of the fruit trees in the food forest. Within each enclosure there is typically one fruit tree and a number of fruit bushes (including currants and gooseberries) and herbs.

Mulched areas have been created using wood chip from a local arborist and the saw dust from the milling of our timber. We are also building a hügelkultur bed, which is built up firstly with a layer of wood, then finer woody material and finally soil and a mulch on top. The layer of wood has several functions. It firstly acts as a slow release of nutrients to the plants growing in the bed, as the wood breaks down over time. It also acts as a sponge and holds water, giving a more steady supply to the plants. Finally, it creates a mycorrhizal lens where fungal activity will be high, and builds the soil as the wood breaks down. Thus it is beneficial to many of the plants that will be grown here and it will add to the diversity of habitat available to soil organisms within the forest garden. We will plant it up with wild strawberries, blueberries and various raspberry varieties.





Creation of a food forest: from tree nursery and herb, flower and fruit understorey to protective fencing

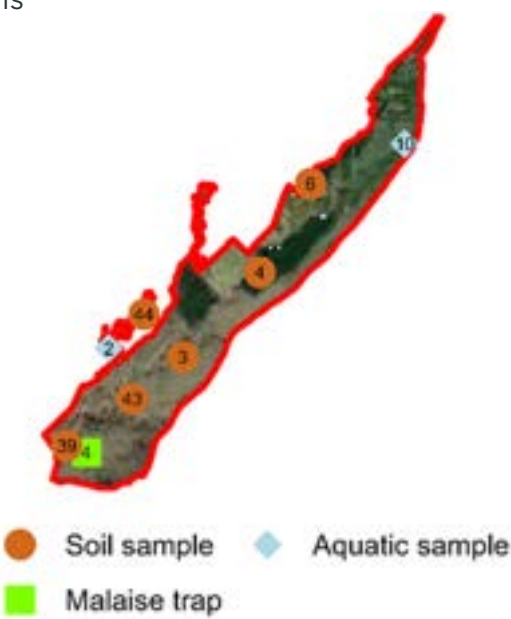
11. Rùsgaich Woods

Figure 16 Rùsgaich Woods maps

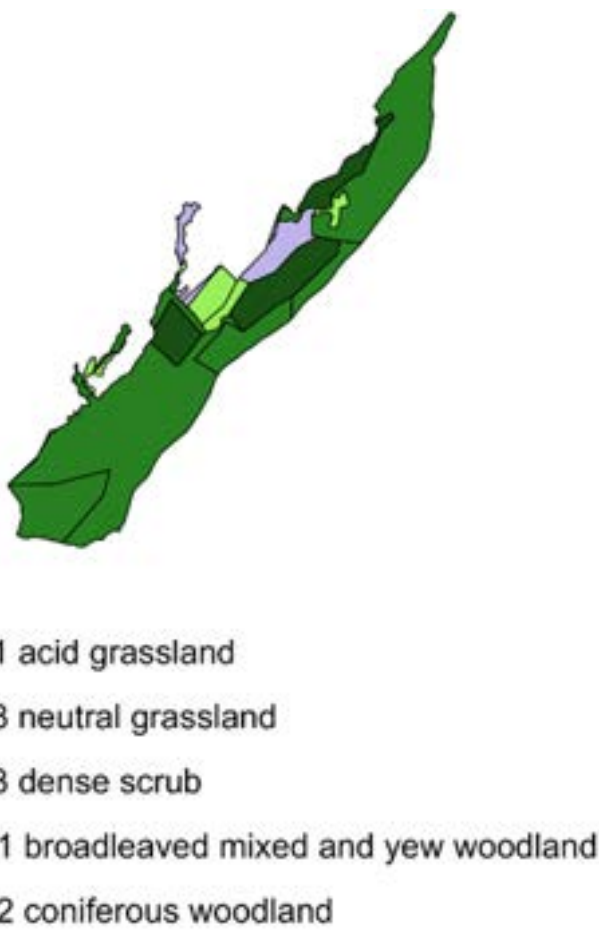
Map showing location within estate



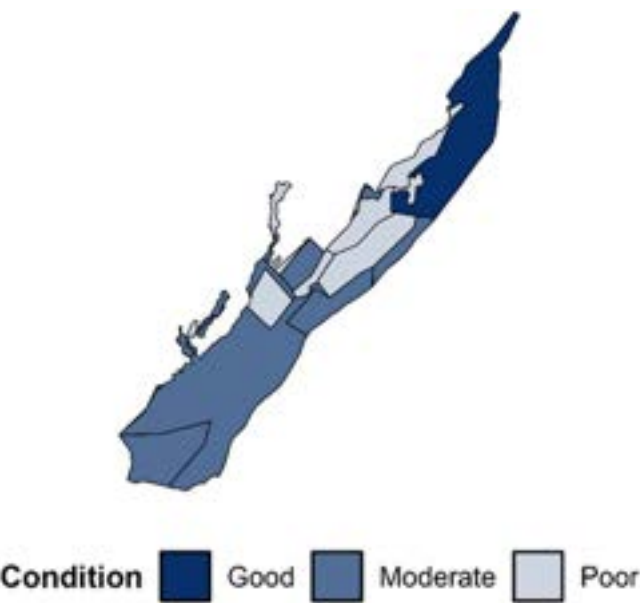
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition





This area of just over 51 hectares is predominantly oak woodland on the slopes down to Loch Ness and is classified as ancient woodland of semi-natural origin. Previous Douglas fir plantations totalling approximately 9 hectares, planted in 1964, were felled in 2022. This clearfelled area is currently classified as a habitat in poor condition but this will improve with sensitive native woodland restoration, through planting and natural regeneration.

The browsing impact assessment showed that browsing pressure here remains high. The oak woodland is dominated by mature individuals with no younger trees to diversify the age structure. Basal, epicormic and lower shoots, when present within a survey area, were highly browsed, occurring mostly on hazel but also on downy birch. No seedlings or saplings were present at any survey point, even in natural clearings, although previous observations have noted oak seedlings – these have evidently not survived their first growing season. Other preferentially browsed palatable species included holly; multiple below-knee height holly shrubs were observed. These individuals appear to be mature but have been cropped and maintained at a small size through browsing. The understorey is composed mainly of moss species, with small amounts of herbaceous species such as tormentil, dog violet, dog's mercury and bluebell, and common heather and blaeberry.

No vines such as honeysuckle or ivy have been found, although these two species do occur on the lower side of the A82 main road by the shores of Loch Ness, where natural regeneration of broadleaf and conifer species is also occurring, which suggests that the road is acting as a barrier to deer movement.

Natural regeneration is also occurring on the root plates of windblown trees; the elevated position puts seedlings and saplings out of reach of browsing animals and the loose soil provides good substrate for seed bedding and germination.

We plan to improve the condition of the oak woodland by increasing deer control in this area, which will allow seedlings to grow and an understorey to develop over time, while maintaining sufficient grazing to keep light levels and structural diversity high. Plantlife also recommended that we consider deadwood and glade creation here, to further increase diversity and create more open old-growth woodland. Existing standing and fallen deadwood has already had these effects in some areas.

More regeneration and structural diversity will also serve to improve the invertebrate diversity at this site, which is currently moderate but not high. The Malaise and pitfalls (ID 4) captured 57 and 29 species respectively and the majority of species were indicative of broadleaved woodland, including the Nationally Rare and Vulnerable spider *Zora nemoralis*, which is found in heather and moss of woodland habitats. There were a couple of deadwood species, a few moths and many flies, including the Nationally Scarce *Fannia ringdahlana*.





12. Lochside strip

Figure 17 Map showing location of lochside strip within estate



This strip of woodland between Loch Ness and the A82 road runs for approximately 2.1km, with a total area of only around 10.5 hectares. It is predominantly a steep, rocky slope down to the loch, with a mix of species including oak, ash, a lot of hazel, willow, rowan and aspen. Scrub dominates near the road, but many older trees are found by the loch, and thanks to the barrier formed by the road, the woodland is very diverse with a complex structure and good condition score. As the only area of the estate with a significant aspen population, this is a possible source for aspen propagation to counteract the current and future effects of ash dieback elsewhere on the estate; aspen, hazel and willow making particularly suitable surrogates for the many lichens found on Bunloit ash trees.

The two aquatic samples taken from Loch Ness yielded results from the eDNA analysis

and showed a high invertebrate species diversity. A couple of Nationally Scarce species were present, including the mayfly *Ameletus inopinatus*, which is associated with fast flowing streams, and the caddisfly *Apatania wallengreni* of wave wash areas. A number of important vertebrates were also present, including the Critically Endangered European eel *Anguilla anguilla*. Freshwater lampreys have also been observed here, where the Grotta burn meets the loch.

DNA from another eel in the Anguillidae family was also found but intriguingly was not assigned to a known species. There were only a few DNA read counts and so it is likely that it also belongs to the European eel, but the presence of another (possibly large?!) eel species in Loch Ness cannot be discounted.



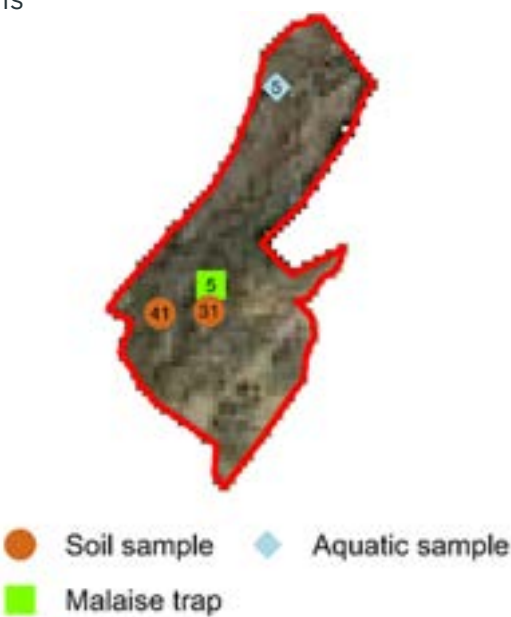
13. Taigh Nellaidh juniper woods

Figure 18 taigh Nellaidh juniper woods maps

Map showing location within estate



Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This 16.5 hectare woodland area is composed of downy birch, juniper and goat willow, with bog myrtle, cross-leaved heath and common heather dominating the dwarf scrub layer. Habitat conditions range from good towards the north, where there is heathland, to poor in the southern areas where there is more broadleaved woodland.

This moderate to poor condition is again likely due to browsing pressure.

The impact assessment showed that bark stripping was varied across the site, with willow, juniper and birch showings variable signs of fraying. Ground disturbance was very low in this area and was mainly associated with well-used large mammal tracks. Epicormic and lower shoot browsing was high, with downy birch showing signs of high browsing pressure. A clear browse line was evident within mature stands.

However, moderate browsing levels here may be desirable in maintaining the juniper woodland by reducing downy birch competition and creating ground disturbance for more juniper establishment.

Juvenile juniper was observed at the site, with no to very low browsing damage, and mature juniper was largely unaffected by browsing pressure.

The Malaise trap in this area captured by far the highest species diversity with a total of 119 species, and the pitfalls captured 39 species. The high species diversity is generated mainly by flies, but there were many different specialists from various habitat niches, including wetlands, indicating a healthy mixed ecosystem. The pitfalls contained the Nationally Scarce caddisfly *Stenophylax vibex* that occurs in unmodified fast flowing streams and fly *Fannia ringdahlana*, which is a damp conifer woodland litter specialist. There were other open tall sward and broadleaved woodland specialists with a millipede, spiders, beetles and a peat bog spider.



Ctenophora flaveolata, a species of crane fly that has rarely been recorded this far north in the UK before, in Taigh Nellaidh woodlands;



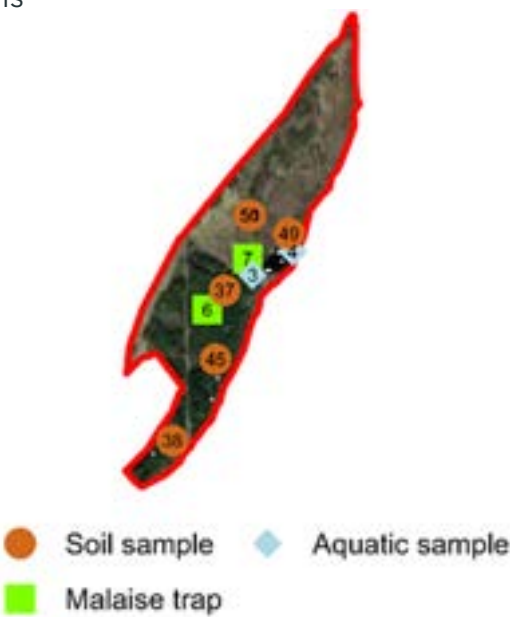
14. Tynaherrick peat and wetland

Figure 19 Tynaherrick peat and wetland maps

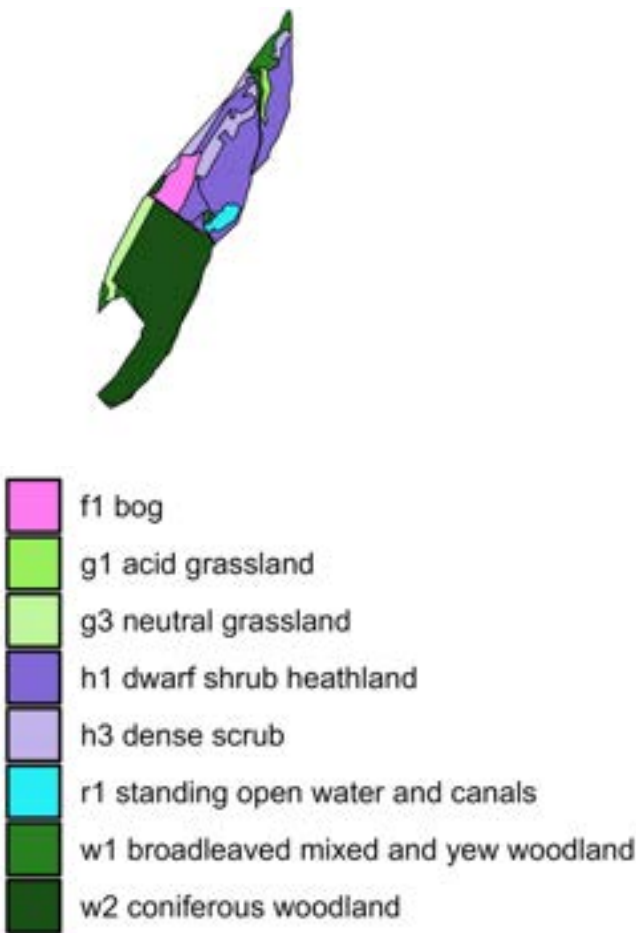
Map showing location within estate



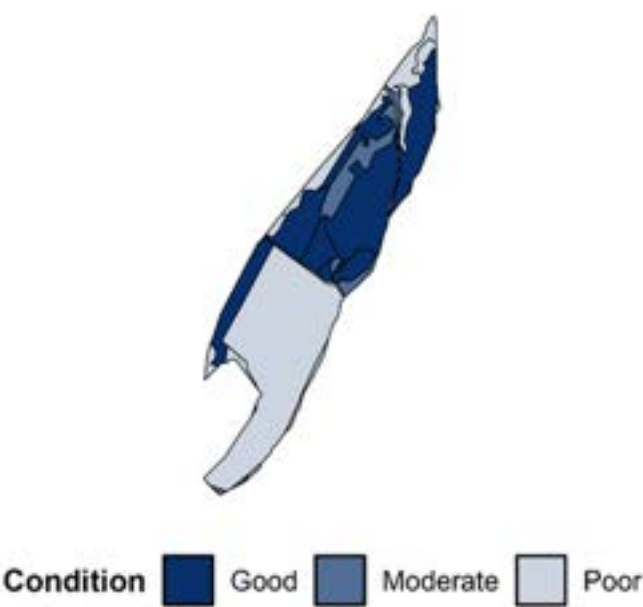
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition





Tynaherrick clearfell and nearby Lochan, with female stonechat (June 2023)

The area is just over 41 hectares and is currently a mosaic of heath, bog, scrub and a large clearfelled plantation. It also contains Bunloit's largest lochan. The aim here is to restore the majority of the area to a healthy peatland to stem carbon emissions and eventually increase carbon sequestration. The 16ha clearfell area to the south was a forestry compartment comprised of Sitka Spruce and Lodgepole pine when Highlands Rewilding took over management.

However, these were planted on an area of deep peat, with an average depth of 1.85m, and were not growing well; they were felled in the winter of 2021 to 2022.

We have been working with Scottish Forestry to get permission to not restock the area with trees, and with Peatland ACTION to plan the peatland restoration with a 'forest-to-bog' project. Recommended restoration methods include stump flipping, where the old conifer stumps are removed from the ridges and used to dam the furrows, and cross-tracking to level the ground surface. Forestry drains will also be blocked. The existing area of bog and heath to the north of the Tynaherrick track will also be restored through drain blocking.

We hope the restoration will take place during the winter of 2023 to 2024.

Throughout the whole area, areas of moraines (higher elevation than the peat bog) will be allowed to regenerate with native species and any non-native species will be removed through annual checks and maintenance.

The Malaise in the clearfell area (ID 6) caught a total of 101 species (75 in the Malaise and 26 in the pitfalls).

Species included the Section 41 moth *Helotropha leucostigma*, a species of damp, marshy woodland and moorland, whose larvae feed on the stems of marshland plants, such as yellow flag iris. There were also some indicator flies; *Medetera petrophila*, associated with birch and decaying wood, and *Sargus flavipes*, which has dung/carrion associations. The pitfalls contained species from open habitats with tall sward scrub, mainly ground beetles and harvestmen.

The Malaise and pitfalls to the north (ID 7), located close to the lochan, also captured a total of 101 species but 68 of these were in the Malaise and 33 in the pitfalls. Species included the Near Threatened moth Autumnal rustic *Eugnorisma glareosa*, which is on Scottish Biodiversity List, and an indicator moth *Elachista alpinella*, which mines sedges.

There were also a number of peat/marsh species and wetland specialists including a stonefly, caddisflies and seepage flies – the latter are part of a unique fauna adapted to this habitat niche. The pitfalls captured a number of spiders, a couple of beetles, flies, bugs and a harvestman, which were mainly marsh and peat specialists, plus open tall sward/scrub and broadleaved woodland specialists.

Restoration of this area to a healthy peatland will boost numbers of marsh and peatland specialists and the nearby mosaics of scrub, heath and woodland will maintain a high diversity.



Beldorney



Overview

Beldorney is a 349-hectare grassland-dominated estate in Aberdeenshire. The eastern edge of the estate is bordered by approximately 2.7km of the River Deveron, which rises in the hills above the Cabrach, to the North-East of the Cairngorms, and has a catchment of 1,266 km². This provides many opportunities for collaboration at the landscape scale, which we hope to develop in the coming months. Beldorney's grasslands were heavily grazed by sheep and cows until March 2021, but then rested

until April 2022, when Highlands Rewilding began our active management of the estate.

Beldorney also has several blocks of conifer plantation and an area of native woodland between Beldorney castle and the River Deveron. There was clear potential from the outset to restore native woodlands, species-rich grasslands and riparian and other wetland vegetation across the estate. The baseline for Beldorney was presented in our [Second Natural Capital Report](#).

Our short-term objectives for Beldorney are:

Wetlands - we will expand and improve wetland habitat, initially through creating new ponds (see Nature Restoration Fund project plans below) to boost biodiversity and increase resilience to climate change.

Grasslands - we will continue to graze the small herd of cattle, owned and managed by Grampian Graziers, across the grasslands. We will establish experimental plots to investigate the effects of regenerative cattle grazing and/or wild grazing on soil carbon and plant biodiversity. We will continually monitor changes.

Tree-planting - we will re-plant the 15 hectare clearfelled forestry compartment with native broadleaves and identify further pockets of the estate suitable for planting.

Forest management - we will manage the remaining forestry compartments sensitively, gradually thinning over time and replacing with native broadleaves, allowing natural regeneration to occur and spread out from the edges. In five years, we hope that wildlife corridors (a combination of naturally regenerated scrub and planted native trees) will connect all areas of the estate.

Agro-forestry - we will plant two grassland areas with fruit and nut trees, to establish multi-functional landscapes that deliver food along with a range of other ecosystem

Peatland - we will restore our small degraded peatland area by removing Sitka spruce regeneration and blocking drains. We will investigate how extensive the peatland area is, potentially removing non-native conifer trees that have been planted on the edges.

Community - we will continue to engage with the local community and develop shared objectives, and will encourage access to the estate through improved signage, a small car park and some marked trails.

Nature Restoration Fund Project

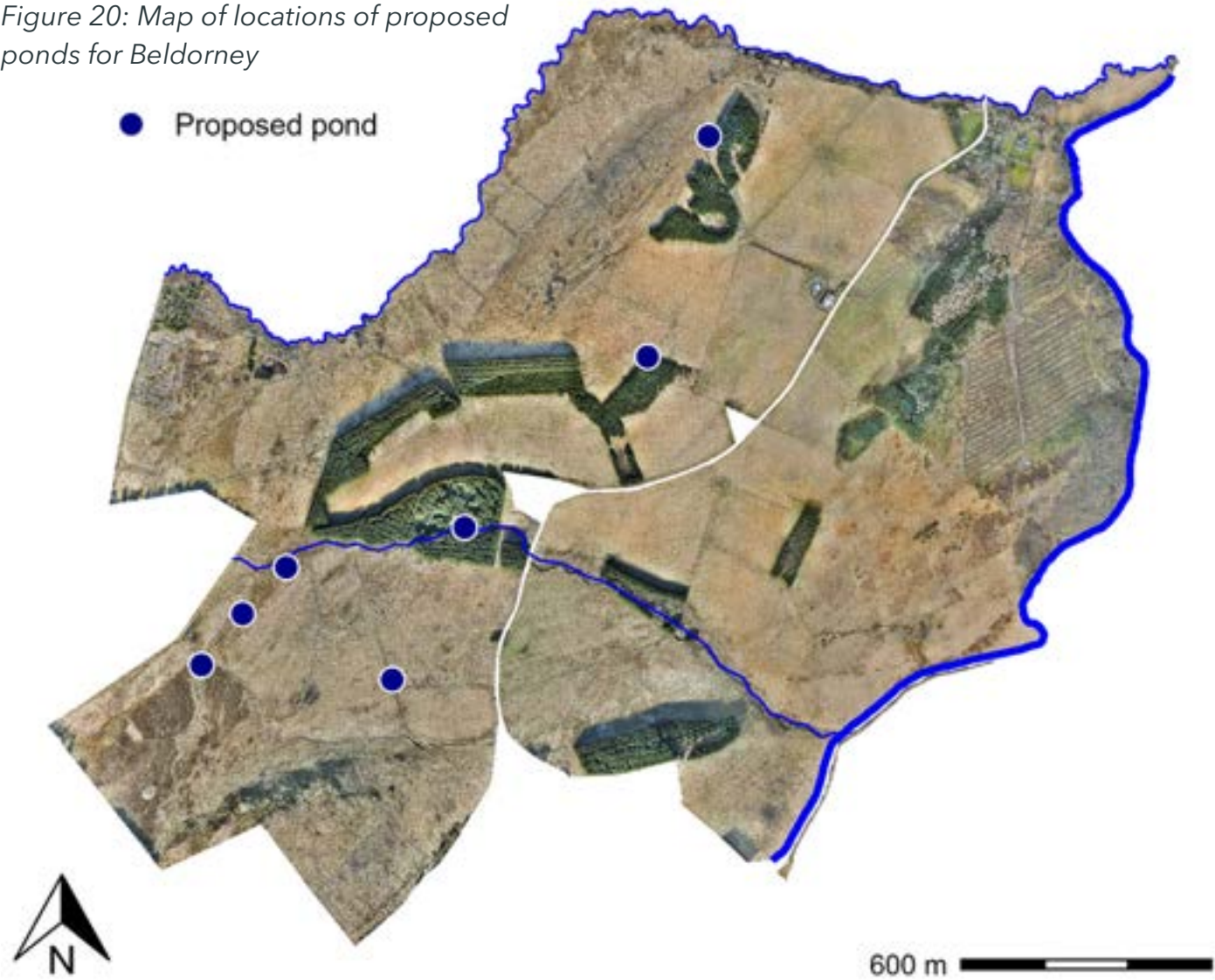
Beldorney Pond Creation for Biodiversity and Resilience to Climate Change

We are delighted to have received funding from NatureScot’s Nature Restoration Fund to create ponds on Beldorney to benefit biodiversity and provide increased resilience to climate change. Pond locations are being chosen carefully based on existing knowledge of the land in terms of water systems, baseline biodiversity data, and advice from SEPA to provide maximum benefit in terms of biodiversity, water

availability, and flood mitigation (see Figure 20).

Ponds act as hotspots for many types of wildlife and plants that rely on wetlands, providing a stepping stone for species as they move across the landscape. Our new ponds will create habitat for newts, frogs, toads, dragonflies and damselflies, and water voles, among many other species. Their creation will also slow the flow of water into the River Deveron in wetter seasons, acting as natural flood management, while also supporting increased water availability for wildlife during drought. This will help to increase water resilience on the estate, protecting against climate change driven biodiversity loss.

Figure 20: Map of locations of proposed ponds for Beldorney



The ponds will also be used for watering livestock through gravity fed troughs. This increased water availability will facilitate wider biodiversity benefits beyond this specific project by enabling further development of the existing strategic planned grazing of cattle, designed to boost biodiversity of grasslands.

The project will enable comprehensive mapping, modelling, and impact assessment of land management changes for pond creation.

We have had initial conversations about the plans with SEPA and, once the scoping and surveying work is complete, we will apply for licences where applicable. We have also discussed our project proposals with neighbouring landowners and there is good potential for this project to contribute to more landscape scale nature recovery in the area. It will also hopefully complement other future wetland creation projects on the estate and we aim to eventually connect existing riparian planting with wetlands and support the natural regeneration of wet woodland.

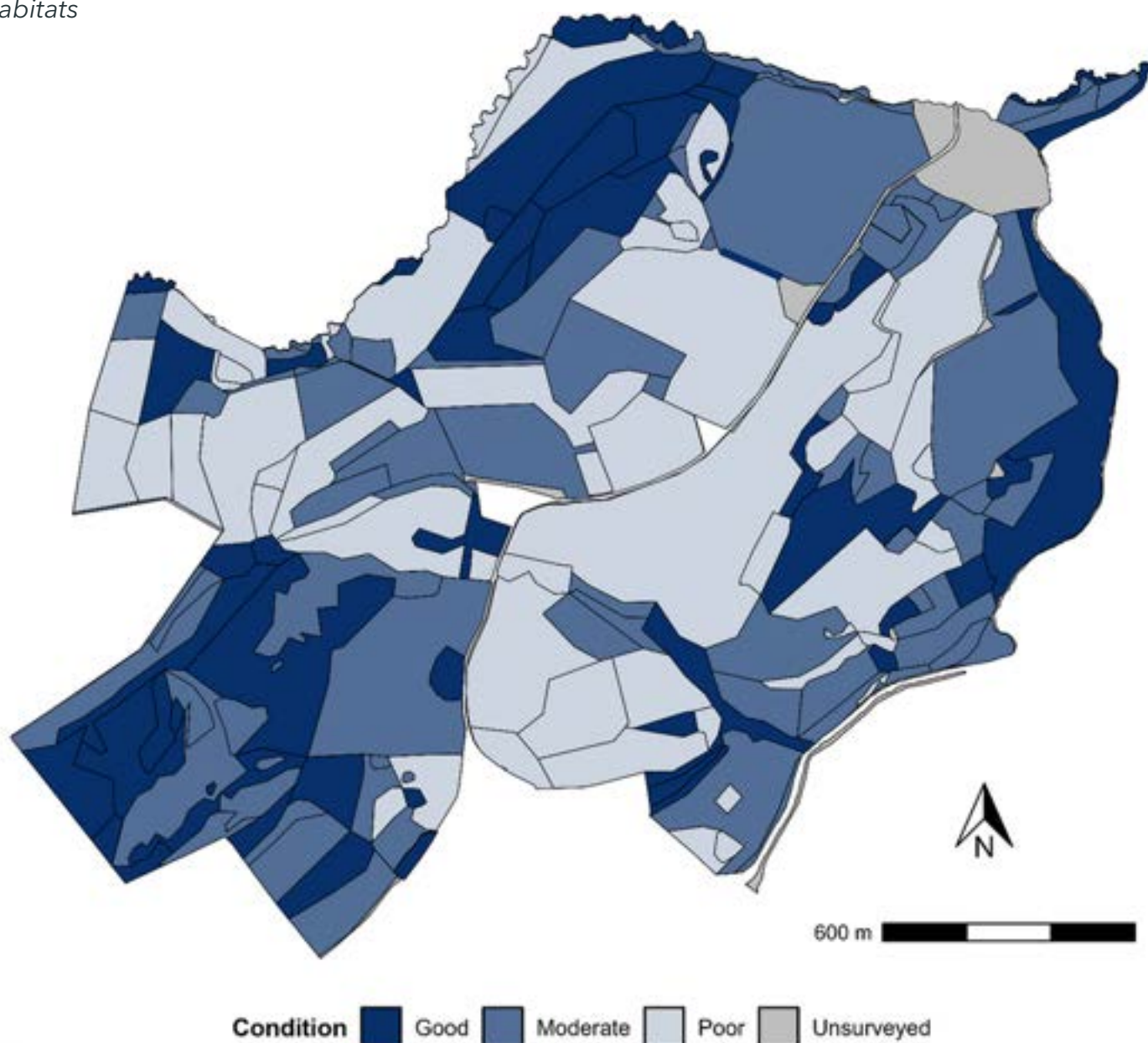


Monitoring

One of our main objectives is to improve the condition of the habitats on the site. In the Second Natural Capital Report we presented the results of the National Vegetation Classification for Beldorney. This provided a useful overview of the habitat types but didn't include condition. In many areas on the estate, the change we are hoping for is not necessarily in habitat type, but an improvement in habitat condition. We therefore commissioned a survey of habitat

condition using the Defra metric, as above for Bunloit. The Defra metric condition survey classifies habitats into three categories: Poor, Moderate and Good. The survey found that 84.8 hectares of Beldorney are in Good condition, 125.6 hectares are Moderate and 132.1 hectares are Poor (10.2 hectares weren't surveyed). Of these areas, just over 11ha of woodland was in Good condition, 5ha was Moderate, and 33ha was Poor. Almost all of the estate's 73ha of acid grassland was in Good or Moderate condition, while almost half of the 180ha of neutral grassland was in Poor condition.

Figure 21 Map of condition of Beldorney habitats



Beldorney's terrestrial invertebrates

During August 2022, we had 15 Malaise traps up across Beldorney Estate, each accompanied by three pitfall traps to survey flying and ground-dwelling invertebrates respectively (as described for Bunloit).

In total, 578 different species were found through analysis by NatureMetrics, although not all of these were identified to a named species due to gaps in the genetic databases.

More information on some of the identified species can be found in the relevant estate sections below. Additionally, the eDNA from 14 aquatic samples were successfully analysed by NatureMetrics for the presence of aquatic invertebrates.

The species lists from the Malaise and pitfall traps, aquatic samples and those from butterfly transects and moth trapping, were analysed by Vicky Wilkins from the Species Recovery Trust, as described for Bunloit.

In total, 26 priority invertebrate species have been identified on Beldorney so far (see Table 3).

An additional 17 priority species have previously been identified within a 5km radius of Beldorney, so there are opportunities to boost numbers on the estate through habitat creation and restoration.

Some further species included in the relatively close Strathspey Important Invertebrate Area that we could potentially attract with further habitat restoration include the moth Kentish Glory *Endromis versicolora* which is found relatively close

to Beldorney and prefers open birch woodland and lightly wooded moorland. Planting Aspen may eventually attract the Aspen Hoverfly *Hammerschmidtia ferruginea*, a priority species located fairly close in the Spey Valley. Its colonisation would be a slow process, however, as the species ultimately requires deadwood from Aspen to allow reproduction; the trees themselves would be generally beneficial as they are an invertebrate-rich tree species. Another possibility is the Golden Net-wing Beetle *Dictyoptera aurora*, which was formerly more common, now thought to be declining and recently known from only a dozen or so sites in Inverness-shire, Moray, Perthshire, Aberdeenshire and Sutherland. It is associated with native Scots pine forests and larvae are known to develop in standing or fallen decaying pine trunks and stumps and so, again, it would be a long-term colonisation.

There are also a couple of priority species on the Scottish Biodiversity List that we might be able to attract through habitat creation. An increase in ponds on site may encourage the Northern damselfly *Coenagrion hastulatum*, which is a very rare species occurring on a range of waterbodies but with a strong association with pine or birch woodland and sedge-fringed lochans with a natural inflow or outflow. There are also records of Northern Brown Argus *Aricia Artaxerxes* within 5km on the NBN Atlas, which require sheltered, scrubby habitats with patches of bare ground and unimproved grasslands, where Common Rock-rose grows in a lightly grazed or ungrazed sward.

Ongoing acoustic bird surveys

In February 2023, we continued our acoustic bird surveys on Beldorney and placed our ten AudioMoths across the estate, each 600m apart. We used this grid set up to get as much coverage across the site as possible and to easily revisit the survey locations in the future to monitor changes. The majority of AudioMoths were actively recording from 1st February - 24th February (some devices recorded for a few days longer or shorter due to battery variation) but unfortunately two devices failed and did not collect any data.

The audio data were analysed by Carbon Rewild and a total of 56 species were identified, including the red listed Skylark, Lapwing and Lesser Redpoll. Species richness identified through these audio surveys were consistently higher than that found on the winter bird transects that were walked in the same period. We are continuing to gather and compare data and considering how audio devices could also approximate bird abundance as well as richness. The results from each individual AudioMoth are presented in the appropriate land management section that follows.

Figure 22 Map of audio sensor locations and species counts



Table 3 Priority invertebrate species identified on Beldorney to date

Taxon group	Species		Status	Species Quality Score	Habitat Associations	Sites
	Latin	Common				
Beetle	<i>Anaspis thoracica</i>		Nationally Scarce	4	Broadleaved only. Larval predator living in decaying wood (red rot), adult nectar feeding	Malaise 3
Beetle	<i>Parabolitobius inclinans</i>		Nationally Scarce	4	Larva and adult both fungivores - feeding from fungal fruiting bodies in broadleaved woodland, with humidity, heavy shade	Pitfall 3
Fly	<i>Dolichopus cilifemoratus</i>		Nationally Scarce	4	Saprophagus larva & predatory adult, inhabiting marshland & running water in the mud/shallow litter of the drawdown zone	Malaise 5, 6, 8, 9, 10, 12, 13, 14, 15
Fly	<i>Fannia norvegica</i>		Nationally Scarce	4	Larva and adult saprophagus in broadleaved woodland, shaded woodland floor	Malaise 8 & 14
Fly	<i>Scoliocentra confusa</i>		Notable	4	Larva and adult saprophagus in broadleaved woodland, shaded woodland floor	Malaise 10
Fly	<i>Orfelia macrocera</i> / <i>Urytalpa macrocera</i>		Nationally Rare; Near Threatened	8		Malaise 11
Fly	<i>Chrysotus femoratus</i>			4	Saprophagus larva & predatory adult, inhabiting marshland & running water in the mud/shallow litter of the drawdown zone	Malaise 1 & 12
Fly	<i>Sciapus longulus</i>			4	Larva and adult both predatory in tall sward, open and damp habitat	Malaise 14
Fly	<i>Symphoromyia crassicornis</i>			4	Larva predatory and adult saprophagous, acid-neutral, wet/damp peat, wetland vegetation	Malaise 5, 4, 6, 9, 11, 14, 15
Moth	<i>Apamea remissa</i>	Dusky Brocade	Section 41 species; Scottish Biodiversity List	1	Larva herbivore, adult nectivore, tall sward or scrub, dry soils and associated with grass	Malaise 3, 6, 9, 10, 11, 12, 14, 15
Moth	<i>Eugnorisma depuncta</i>	Plain Clay		4	Deciduous woodland, larva feed on low growing herbaceous plants	Moth trap
Moth	<i>Graphiphora augur</i>	Double Dart	Near Threatened; Section 41 species; Scottish Biodiversity List	1	Larva herbivore feeding nocturnally on a number of trees and shrubs, including hawthorn (<i>Crataegus</i>) and blackthorn (<i>Prunus spinosa</i>) plus Willow, Birch, Oak, Dock, Elm. Adult nectivore	Malaise 12
Moth	<i>Litoligia literosa</i>	Rosy Minor	Near Threatened; Section 41 Species (research only)	1	Larva herbivore, adult nectivore, tall sward or scrub, dry soils and associated with grass	Moth trap
Moth	<i>Lycophotia porphyrea</i>	True Lover's Knot	Vulnerable	1	Moorland and heathland species, larvae feed on heather <i>Calluna</i> and heath <i>Erica</i> .	Malaise 5
Moth	<i>Phiaris palustrana</i>			4	Heathland with sparse trees feeding on mosses	Malaise 2, 4, 11
Moth	<i>Ochsenheimeria urella</i>			4	Larva herbivore, adult nectivore, larva associated with grass, such as couch grass (<i>Agropyron</i>) and brome (<i>Bromus</i>), particularly short sward	Malaise 6, 11, 13
Moth	<i>Thera cognata</i>	Chesnut-coloured Carpet	Nationally Scarce	4	Larva feeds on Juniper. Habitats include limestone downland, moorland, lightly wooded hillsides and rocky outcrops	Moth trap
Butterfly	<i>Erebia aethiops</i>	Scotch Argus		1	Open tall sward habitats. Associated with moor grasses	Malaise 2
Butterfly	<i>Erebia aethiops</i>	Scotch Argus		1	Open tall sward habitats. Associated with moor grasses	Malaise 2
Butterfly	<i>Boloria euphrosyne</i>	Pearl-bordered fritillary	Section 41 Species; Scottish Biodiversity List; IIA Species	1	Requires violets as the caterpillar foodplant, associated with woodland clearings, well-drained habitats with mosaics of grass, bracken and scrub & open deciduous wood pasture in Scotland. It requires abundant foodplants growing in short, sparse vegetation, where there is abundant leaf litter.	Butterfly transect
Beetle	<i>Hydroporus ferrugineus</i>		Nationally Scarce	4	Larva and adult predatory, grazing marsh and calcareous seepage	Aquatic 14
Fly	<i>Atherix ibis</i>			4	Bankside trees, slow flow, sandy river, coarse woody debris	Aquatic 10
Fly	<i>Paradelphomyia fuscula</i>		Notable	4	Saprophagous larva and adult does not feed, broadleaved woodland in the drawdown zone: mud/shallow litter, neutral/acid seepage, heavy shade, woodland streams	Aquatic 9
Fly	<i>Mycomya trivittata</i>		Nationally Scarce	4		Aquatic 12
Fly	<i>Rymosia armata</i>		Nationally Scarce	4		Aquatic 4
Fly	<i>Dicranota robusta</i>		Notable	4	Saprophagous larva and adult does not feed, fast flow, Coarse wood	Aquatic 4, 7, 8, 11, 12
Mayfly	<i>Rhithrogena germanica</i>		Nationally Scarce	4	Saprophagous larva and adult does not feed, slow flow, unmodified fast flowing streams	Aquatic 8, 10, 15



Land Management Plans

We have split the estate into 13 broad land management areas (not including residential buildings) and will describe each area in more detail below, starting with Craig Dorney in the west of the estate and working clockwise.

Whilst some of the land management work is more advanced, several of the plans outlined below are at initial stages of development, and forestry plans are being drafted for our new 10-year forestry plan, which will then go through the Scottish Forestry approval process.

1	Craig Dorney and surrounds
2	Backside and Tighnaird
3	Craigwatch
4	Chapel Burn grasslands
5	Gallows Hill west
6	Mains of Beldorney grasslands
7	Chapel Burn agroforestry
8	North east spur
9	Main woodland
10	Eastern Grasslands
11	Forest of Hope
12	North Cummerton
13	River Deveron
14	Keepers Cottage
15	Castle, cottages & grounds
16	Mains

Figure 23 Map of the Beldorney land management areas



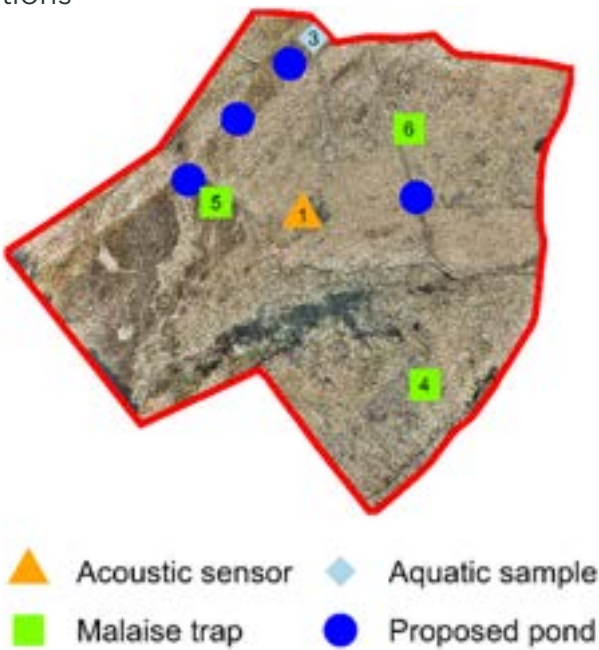
1.Craig Dorney and surrounds

Figure 24 Craig Dorney and surrounds maps

Map showing location within estate



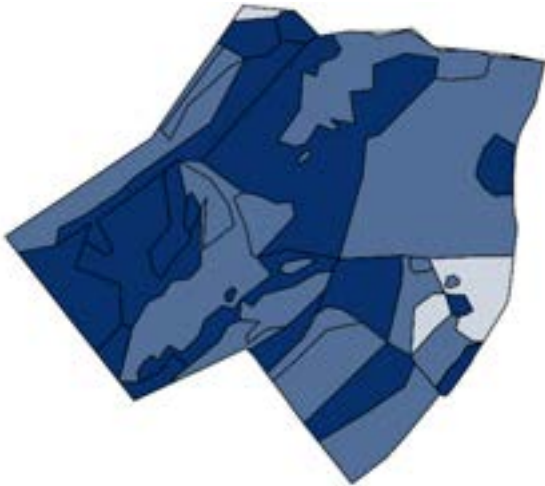
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This area totals 68 hectares and, at 410m, Craig Dorney is the highest point of the estate. This is the site of an ancient hill fort, which was inhabited by Picts in the early Medieval period and is now a scheduled monument. The hill itself is predominantly acid grassland, with patches of heath and the area surrounding it is a mixture of grasslands, fen and blanket bog, with a small patch of good quality scrub by the roadside. The most southerly portion of the area used to be a 4.43 ha coniferous plantation, planted in 1967 and felled in 2013. It has now reverted to grassland and heath of good and moderate condition, but with Sitka spruce regeneration that will eventually reduce the quality of this habitat.

We plan to fell these regenerating, non-native trees before they become dominant and we would like to encourage the regeneration of native Scots Pine trees in this area.

The flat low-lying heaths north of Craig Dorney hill are wetter and grade in and out of blanket bog and swamp in an intricate mosaic. Sphagnum species are extensive and we will maintain this open habitat as it is in very good condition.

We will also help to maintain the good condition of the acid grasslands and heath with light, annual winter grazing when needed and we will expand the wetland habitats through our pond creation scheme.

Four new ponds will be created above Tammie's burn, which will boost biodiversity, particularly invertebrates.

The Malaise and pitfalls (ID 4) located in the previously clear felled site on the southern slopes of Craig Dorney captured insect species indicative of open and woodland habitat, with tall scrub (86 species in the Malaise trap, 25 species in pitfalls). There were some deadwood species of fly and the open areas resulted in some hoverflies and Lepidoptera, including the priority moth species *Phiaris palustrana*, which frequents heathland with scattered trees and feeds on mosses. There were also two interesting spiders; *Pityohyphantes phryianus*, which is associated with spruce plantations and *Zora nemoralis*, which is found in moss and heather in woodland habitats.

The Malaise and pitfalls (ID 5) located in the heathland to the north of the hill captured some interesting species indicative of a mixed habitat, if not a high species diversity (52 species in Malaise trap, 22 species in pitfalls). Species included the Nationally Scarce marsh/water fly *Dolichopus cilifemoratus* (also captured in Malaise 6), an IUCN Vulnerable moth *Lycophotia porphyrea* that feeds on heather and one decaying wood specialist from a pitfall.

The Malaise and pitfalls (ID 6, 51 species in Malaise, 33 in pitfalls) located in the grassland to the east of the hill captured the priority moths Dusky brocade *Apamea remissa* and *Ochsenhiemeria urella*, which is indicative of tall and open grassland. All three Malaise traps in this area caught the fly *Symphoromyia crassicornis*, which is indicative of deadwood or nearby acid wet vegetation. Maintaining and expanding the heathland habitat in this area could bring in more specialist and priority invertebrate species, particularly moths.

An acoustic sensor was deployed from 4th February to 20th February 2023 and located in the centre of this area. Acoustic data was analysed by CarbonRewild and identified 17 bird species, the lowest species richness found in this survey period, potentially due to the exposed location. The highest number of calls (244) were from the crossbill, followed by 66 from tawny owl, 53 from short-eared owl, 51 from siskin and 46 from common buzzard. Excitingly this sensor picked up a couple of calls from a golden eagle, which corroborates occasional sightings of this bird passing over the estate.

We would also like to improve public access to this area and we are exploring the potential to create a small parking area at the side of the road and a footpath to the summit of Craig Dorney. Signage would be designed to explain the history and the current diversity of the area.



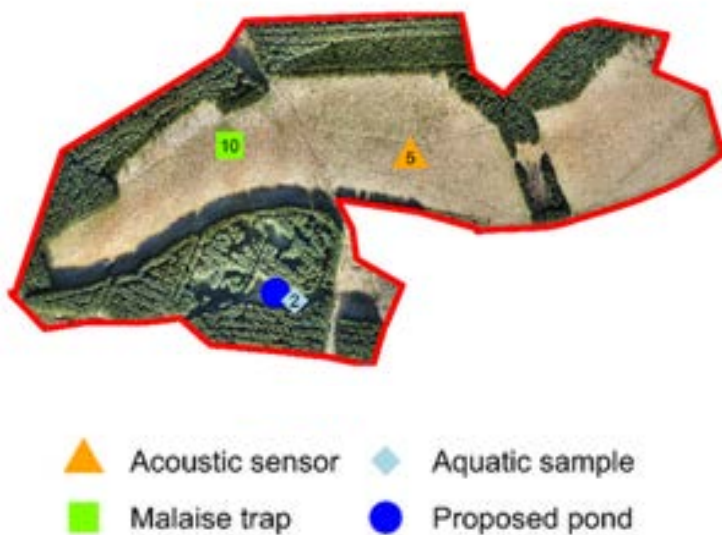
2. Backside and Tighnaird

Figure 25 Backside and Tighnaird maps

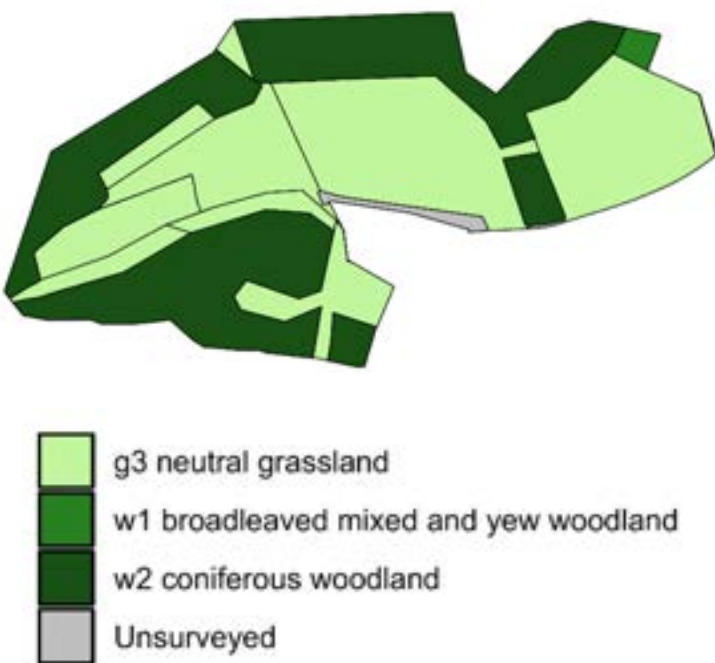
Map showing location within estate



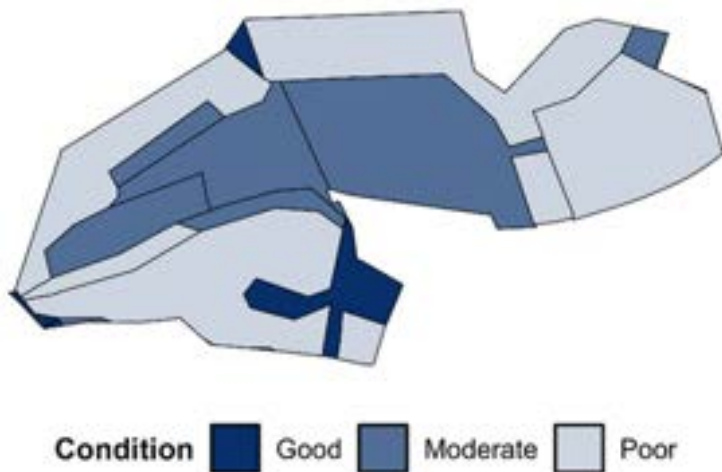
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This area totals approximately 31 hectares and is predominantly coniferous plantations. The majority of trees are Sitka spruce but there are also Norway spruce in the northern block. The compartments to the south were planted in 1980, those to the north in 1972. There is also a small half hectare area of native mixed broadleaves, planted in 1994.

We are planning to thin the coniferous blocks where possible to improve their condition.

There is potential to use the grassland area that is currently sheltered within the plantations for agroforestry and we are investigating options for this. The spruce trees are almost ready for harvesting but the forest currently provides useful shelter on this slope. We plan to plant native tree species around the inner edge of the V-shape, which will grow to replace the shelter of the spruce, once they are harvested in a few years' time.

The woodland in this area was scored as having a poor condition according to the Defra metric, which is typical for non-native plantation woodland. This is because many of the factors that are considered when judging condition of woodland for this metric are minimal or absent. These include the number of different age classes present; the vertical structure; the abundance of dead wood; the number of native species; the number of woodland indicator species in the ground flora; the number of veteran trees and the presence of seedlings, saplings and small trees. Most coniferous plantations have only two or three age classes of trees present and regeneration is usually poor because of the lack of light and space.

Malaise and pitfall traps (ID 10) were located in the central grassy area and captured 90 species and 53 species respectively. These included the Nationally Scarce fly *Dolichopus cilifemoratus*, the priority moth Dusky brocade *Apamea remissa* and another Nationally Scarce fly *Scoliocentra confuse*, which is a saprophagous species indicative of broadleaved woodland. Maintaining some area of open grassland but increasing native broadleaves will boost the insect diversity of this area.

The acoustic device (ID 5) located here from 4th to 24th February, 2023 identified a total of 34 species, which was the highest species richness found in this survey period. This could potentially be due to the sheltered nature of this area, demonstrating the importance of tree cover and supporting our decision not to fell all the plantations until alternative shelter is available. The highest number of calls were from the European robin (1,139), followed by the coal tit (843), common buzzard (602) and tawny owl (367). There were also four red list birds; mistle thrush (51 calls), greenfinch (30), Eurasian skylark (48) and Northern lapwing (3).

The eDNA from the aquatic sample taken from Tammie's Burn here, revealed only five species of aquatic invertebrate, including midges and a very common mayfly, which indicates a low water quality. This was perhaps because the burn runs through the southern coniferous block with little light and ground vegetation.

One of the new ponds is planned for this location and the creation of additional habitat with different water depths will improve the condition and attract more invertebrate species to this area.

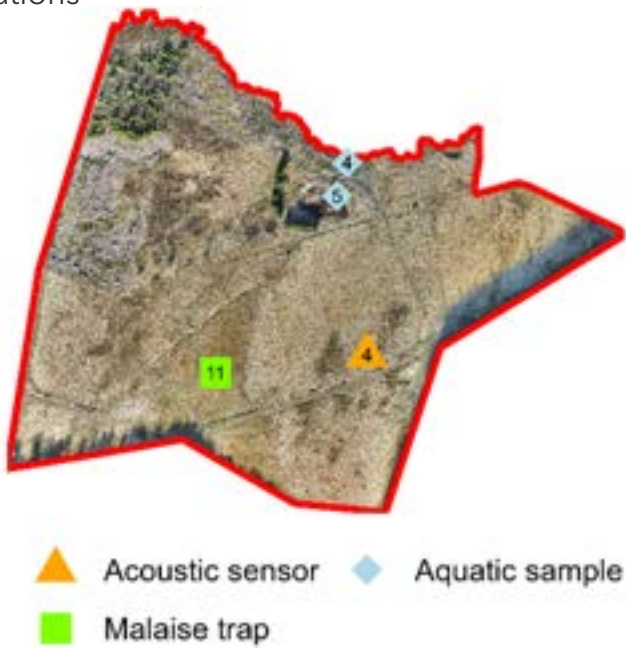
3. Craigwatch

Figure 26 Craigwatch maps

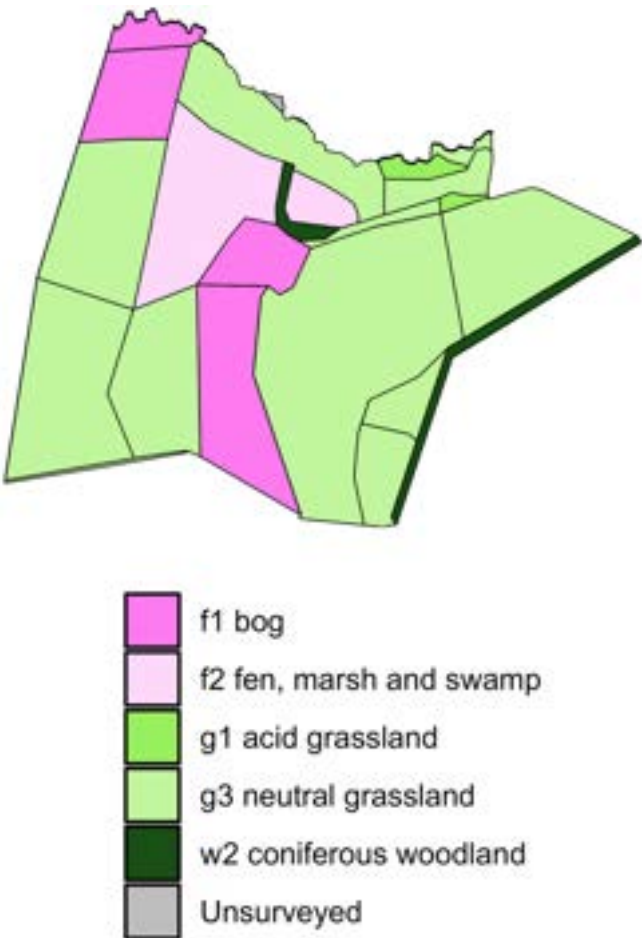
Map showing location within estate



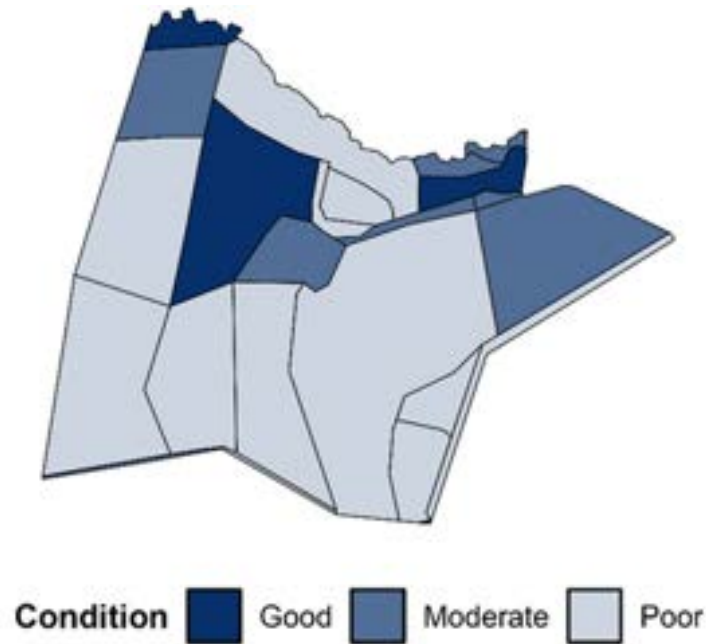
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



Covering an area of around 26 hectares, Craigwatch is currently a mixture of habitat classes and, as described in the Second Natural Capital Report, it includes an area of deep peat. A large portion of the area (14.65 ha) is currently one of the forestry compartments, planted in 2020 before Highlands Rewilding bought the estate. It has predominately been planted with a mix of Norway spruce and hybrid larch, but also with a few mixed native broadleaf trees and Scots pine and, in places, the trees have been planted on peat. This planting was done under the Forestry Grant Scheme, which includes an obligation to maintain the trees for a period of 20 years. However, the Norway spruce are suffering from insufficient nitrogen due to the wet soils and many of the native broadleaves are also showing poor growth. **We are working with Scottish Forestry to agree the best approach for this area, as much of this habitat is not suitable for trees.**

Much of the area was difficult to classify into a habitat type because of the recent planting, but the dominant vegetation over most of the site is *Deschampsia*, hence the neutral grassland classification. This is in poor condition mainly due to the planting and, if an agreement is reached to remove inappropriately planted non-native trees, could be much improved and restored into a larger area of blanket bog. The areas of habitat that are in good condition here, including the fen, marsh and swamp, have not been planted on.

The audio device (ID 4) was in situ in this area from 4th February to 1st March 2023 and captured the calls from a total of 19 bird species. The most common calls were from the coal tit (217), followed by siskin (146), common buzzard (79), crossbill (26) and mallard (22). Restoration of the wetland habitats here could see an increase in bird

species associated with such habitats, such as the golden plover.

The Malaise and pitfalls (ID 11) in this area captured species again indicative of open areas, including the moths Dusky brocade *Apamea remissa*, *Ochsenhiemeria urella* and *Phiaris palustrana*. Also captured were the fly *Symphoromyia crassicornis*, indicative of deadwood or nearby acid wet vegetation and the Near Threatened fly *Urytalpa macrocera*, which inhabits moist deciduous forest. A total of 93 species were captured in the malaise trap and 17 species in the pitfalls. There were also some hoverflies and other species associated with water/wetland, likely to be from the one existing pond on the estate. This pond is becoming over-vegetated and the area of open water is reducing, gradually diminishing its benefits as a still, freshwater habitat. Indeed, the aquatic sample (ID 5) that was collected from this location detected relatively few species (27) and were mainly midges, a common mayfly and marshland stonefly (and also a terrestrial bug, which must have fallen in). Once the new ponds have been created through the NRF scheme, we will consider the options for restoring this pond, thus creating further still water and wetland habitat, which is so important for many species.

In contrast to still water habitats, flowing freshwater habitats are well represented here with the presence of Chapel Burn. The aquatic sample taken from here (ID 4) detected 119 species of aquatic invertebrate, which is one of the best-scoring sites. The species present indicate a good water quality with some coarse, woody debris species, for example, the saprophagous species *Rymosia armata* and *Dicranota robusta*, and also quite a few marshland, mire and seepage species and a number of beetles, mayflies, stoneflies and caddisflies.

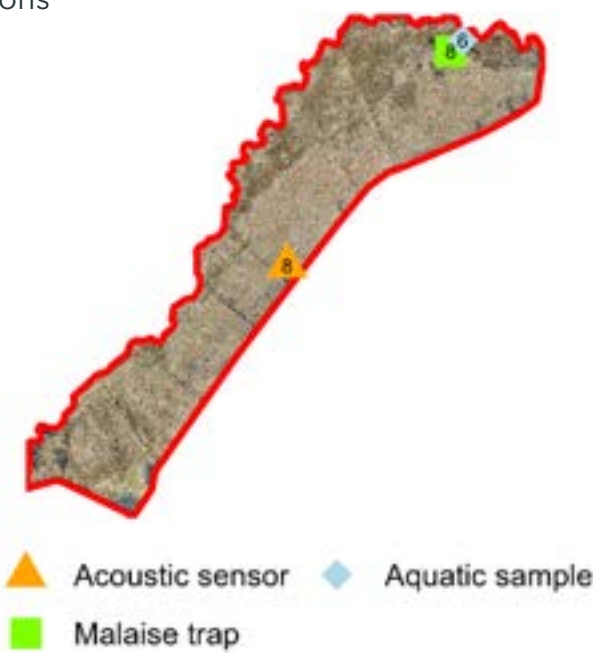
4. Chapel Burn grasslands

Figure 27 Chapel Burn grasslands maps

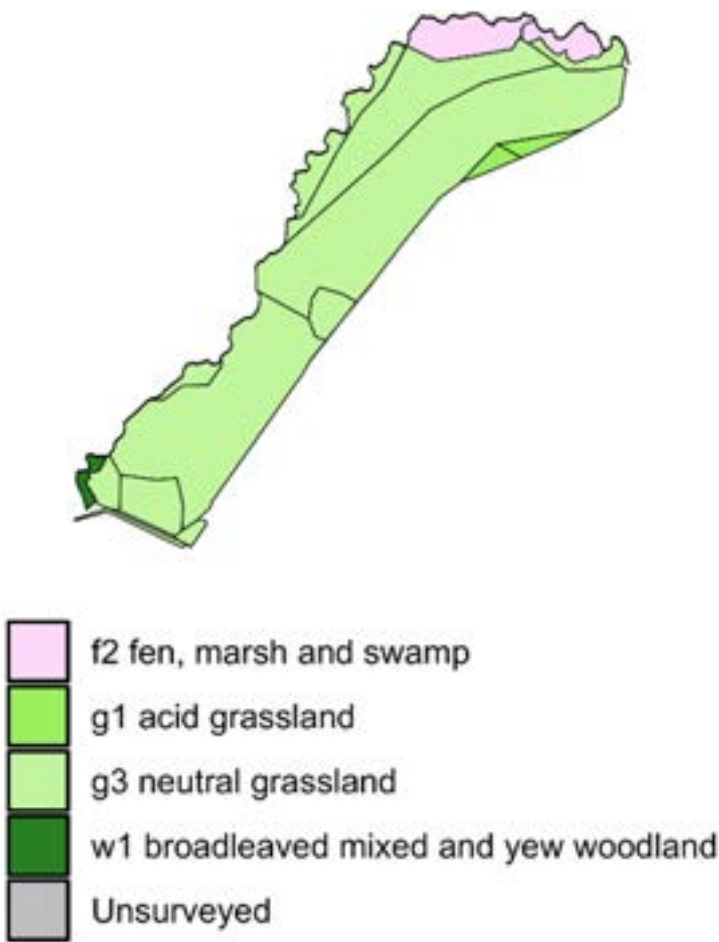
Map showing location within estate



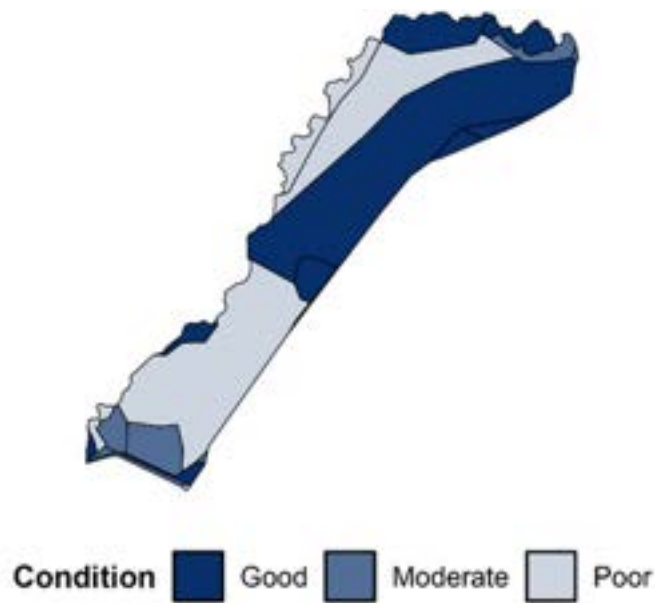
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This is an area of low lying, predominantly neutral, grassland alongside Chapel Burn, totalling 22.4 hectares.

There is also a patch of wetland habitat in good condition, bordering the burn in the north. This area is being grazed from autumn into winter, with no grazing from March to August to encourage nesting curlew, as well as lapwing and skylark. All three species were observed in spring 2023 and this grazing management (alongside the wader management undertaken by the neighbouring estate, Edinglassie) aims to improve feeding and nesting habitats for these birds, as well as maintain and improve the species richness of these grasslands.

The audio device (ID 8) in this area was in situ from 4th to 24th February 2023 and captured the calls from a total of 18 species. Most calls were from the jackdaw (546), followed by the red-listed Eurasian skylark (198), common buzzard (62) and siskin (26). It also recorded the common reed bunting, presumably enjoying the reeds along the burn.

The Malaise and pitfall traps (ID 8) located by Chapel Burn captured a total of 132 species (75 in the Malaise, 57 in the pitfalls), including the Nationally Scarce fly *Dolichopus cilifemoratus*, which is indicative of running water and wetland habitats. There was also the Nationally Scarce fly *Fannia norvegica*, which is a saprophagous broadleaved woodland species but there were not any interesting grassland species, which shows potential for improvement and uplift in this area. An aquatic sample (ID 6) was also taken from the marshy area in the north, which only detected three species, one of which was a midge. This indicates a wetland habitat of low quality - contrary to the habitat condition scoring.

The malaise and pitfalls (ID 9) just south of this area, further up the slope towards Gallows Hill, captured fewer species in total (80 in the Malaise and 40 in the pitfalls) but contained more interesting species indicative of a mixed habitat and better quality grassland. Species included, again, the fly *Dolichopus cilifemoratus* and also the priority moth *Apamea remissa* that requires open areas with grasses and the fly *Symphoromyia crassicornis* from either deadwood or nearby acid wet vegetation.

5. Gallows Hill west

Figure 28 Gallows Hill west maps

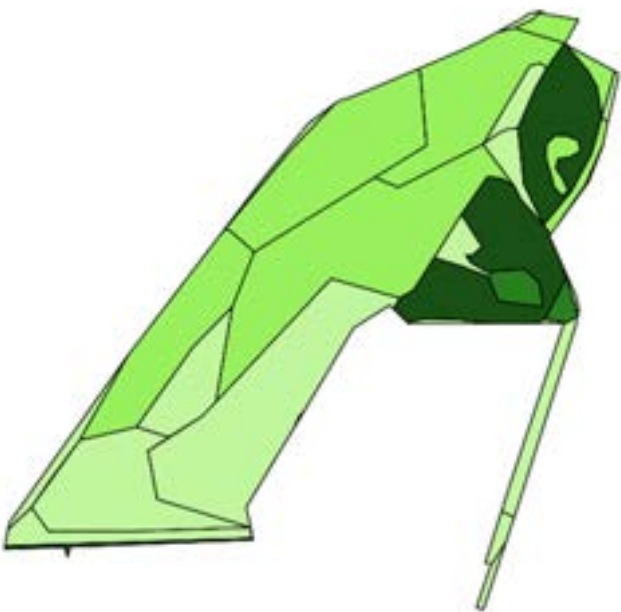
Map showing location within estate



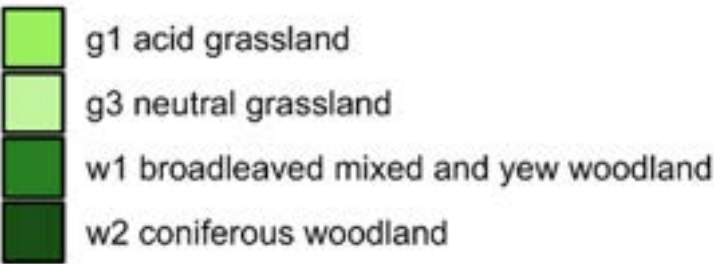
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



The total area of this section of the estate is just over 22.5 hectares and comprises a large area of upland acid grassland on the slopes to the west of Gallows Hill, which is mainly in good condition, and a small forestry compartment.

The good condition of the grassland will be maintained with occasional grazing; this has so far been in autumn and we will continue to monitor and assess whether this is appropriate for the habitat. We will also encourage the regeneration of native trees, including Scots pine, as evidence suggests this area was native woodland in the past. We are investigating temporary Clipex fencing for smaller areas to aid this natural regeneration. This area will also be one of the sites of the planned exclosure plots, to research impacts of grazing on vegetations and soils.

The forestry compartment was planted in 1997 and is a mix of conifers and broadleaves. We have recently received permission from Scottish Forestry to thin some of the Sitka spruce in this block, which will improve the condition by letting in more light. We are investigating the potential for this thinning to be carried out through horse logging – this low impact, traditional method of extracting timber creates minimal disturbance and little compaction of soils.

As this is currently a rather isolated patch of woodland, we plan to eventually link it to the woodland north west of the Mains by planting trees in the spur of land shown on the maps. However, this is under review as part of the new forest plan.

The Malaise and pitfalls (ID 9) on the western edge of this area are discussed above, in the Chapel Burn grasslands. This area also contained a Malaise and pitfalls (ID 7) in the northern forestry block, which captured a total of 104 species (63 in the Malaise and 41 in the pitfalls). The species found were mainly indicative of closed woodland, with a few open habitat and deadwood species, but no unusual or priority species.

Improving the structure and species diversity of these woodland blocks is likely to have positive impacts on the invertebrate communities, boosting species richness and potentially drawing in priority species.

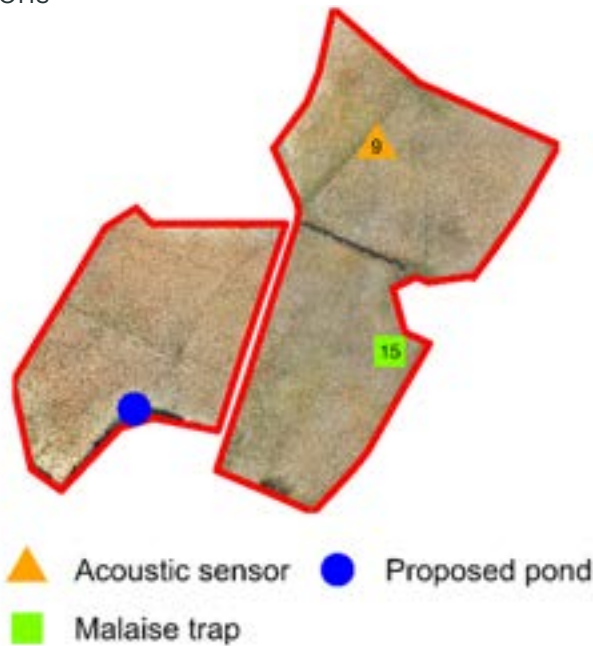
6. Mains of Beldorney grasslands

Figure 29 Mains of Beldorney grasslands maps

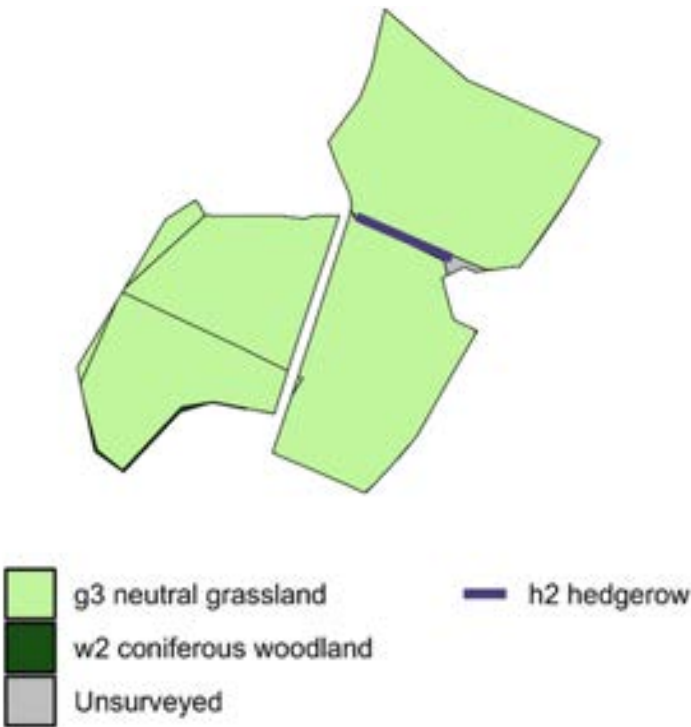
Map showing location within estate



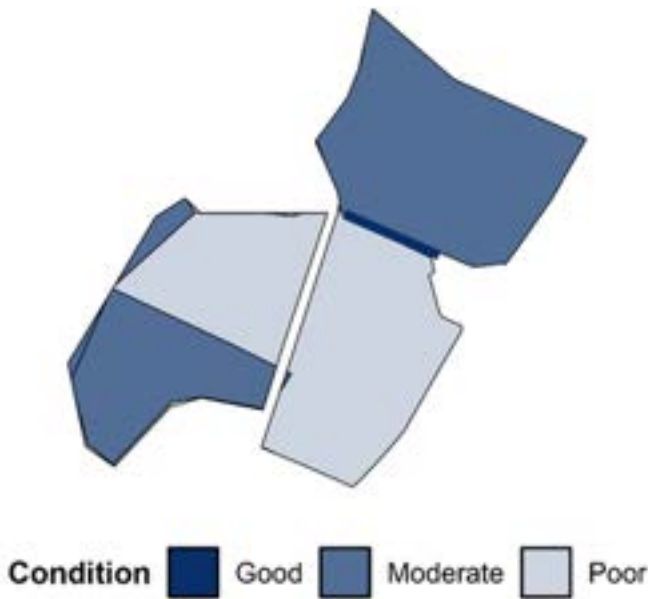
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition





Pasture above Mains of Beldorney (August 2023)

This area comprises the fields around the Mains of Beldorney and covers approximately 26.5 hectares. It is currently all neutral grassland, 14 ha of which is in moderate condition, 12.4 ha in poor condition.

We plan to manage this grassland through continued adaptive multi-paddock grazing (AMP), infrequent and rotational hay cutting and bale grazing, which will improve the condition of the habitat over time and we will also encourage the regeneration of scrub. Species richness is being boosted by bringing in bales of species rich hay, from which the cattle graze in the winter months.

The RSPB reserve at Loch of Strathbeg provided 76 bales in 2022, and approximately 80 bales were brought in from a local species rich grassland site in 2023.

This area also contains the only hedgerow included in the UKHabs assessment, scored as in good condition. It is currently 160m in length and is no longer

maintained as a hedge; the fence containing it on the south side will be removed and we are letting it grow and expand out into the field to extend the habitat.

An audio device (ID 9) was in situ from 4th to 25th February 2023 on the old fence line to the north of the Mains. It detected a total of 33 bird species (the 2nd highest species richness in this survey period). The majority of calls were from the coal tit (2,047), followed by tawny owl (745), siskin (506), jackdaw (202) and buzzard (126). A total of four red list species were also detected; yellowhammer, mistle thrush, lesser redpoll and greenfinch.

Malaise and pitfall traps (ID 15) at this site captured a total of 145 species (95 in the Malaise, 50 in pitfalls), representative of mixed open, wet and broadleaved woodland species including the priority flies *Dolichopus cilifemoratus* & *Symphoromyia crassicornis* and the moth *Apamea remissa*. The pitfalls captured species indicative of a tall sward and there were a couple of carrion and dung beetles, numbers of which we hope to boost through continued regenerative AMP grazing.

7. Chapel Burn agroforestry

Figure 30 Chapel Burn agroforestry maps

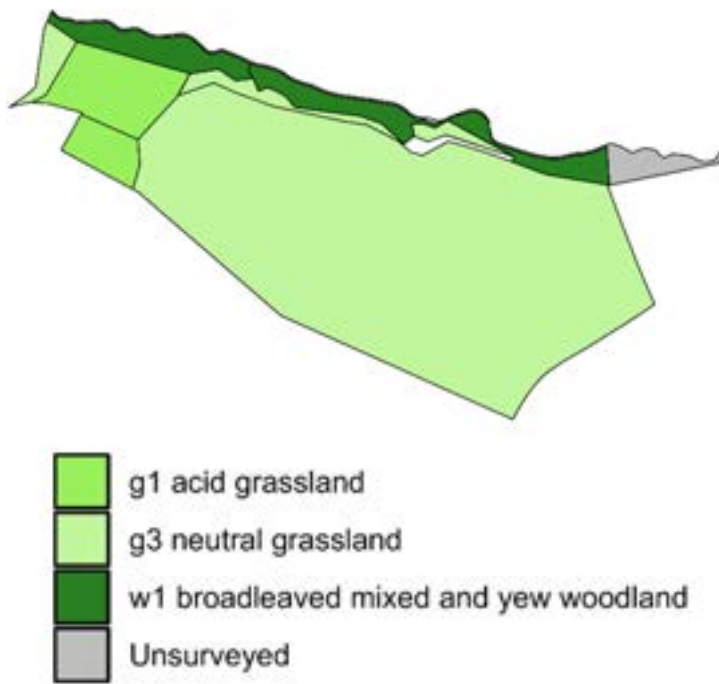
Map showing location within estate



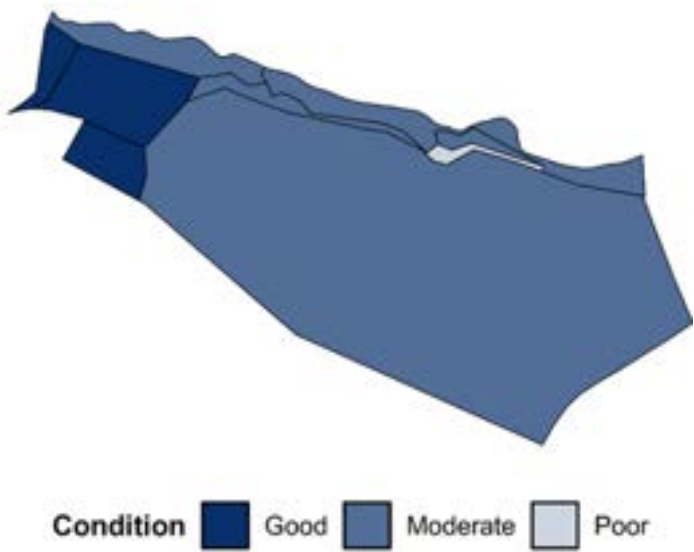
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This 10 hectare area is currently predominantly grassland with some broad-leaved trees growing along Chapel Burn. The majority of the area is neutral grassland in moderate condition, with an approximately 1ha area of acid grassland at the western edge that is in good condition. The strip of broadleaved woodland along Chapel Burn is also in moderate condition.

Management to date has been similar to the fields around the Mains, with adaptive multi-paddock grazing, infrequent and rotational hay cutting and bale grazing. A plan is being developed to use this area for agroforestry, with circular fenced blocks of trees throughout a 5.73ha area of the grassland closest to the road. There will be a total of 34 blocks with a 12m radius and 50 trees will be planted within each.

Higher stature tree species, including oak, birch, walnut and sweet chestnut, will be planted in the centre of the blocks and lower stature shrubs and fruit & nut trees, including hazel, juniper, crab apple and hawthorn, will be planted around the edges.

There were no acoustic sensors or Malaise and pitfall traps in this area. However, one aquatic sample was taken from Chapel Burn here and detected the highest number of aquatic invertebrate species (147), which indicates a very high water quality. There were many coarse woody debris species, for example, the notable fly *Dicranota robusta*, as well as caddisflies and stoneflies. There was, however, a low beetle fauna, so still a potential for uplift.



Electric fences for multi-paddock grazing (August 2023)

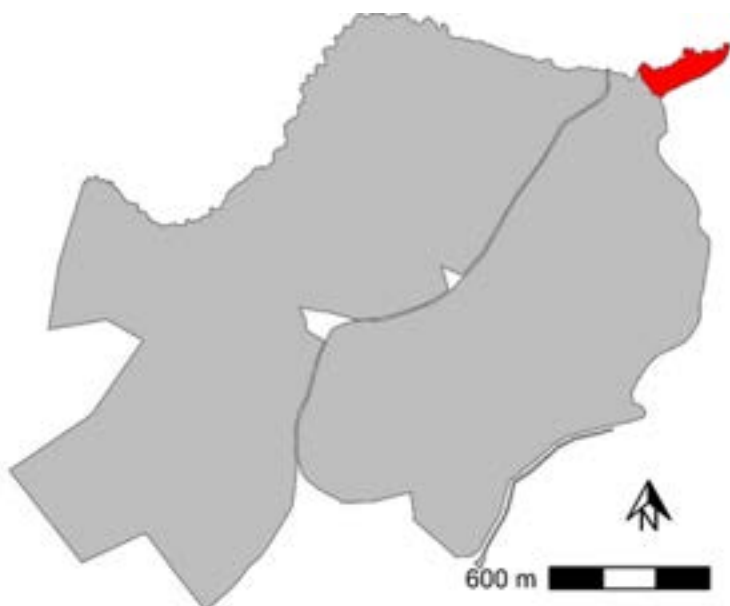


Drone image showing the species rich hay bales spaced out across the field ready for winter bale grazing (August 2023)

8. North east spur

Figure 31 North east spur maps

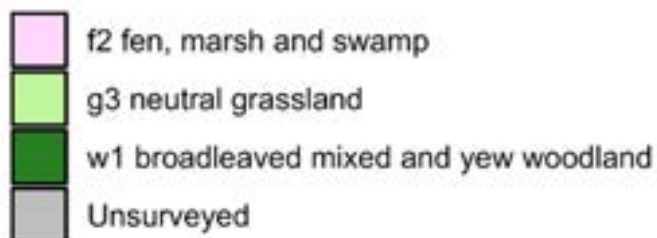
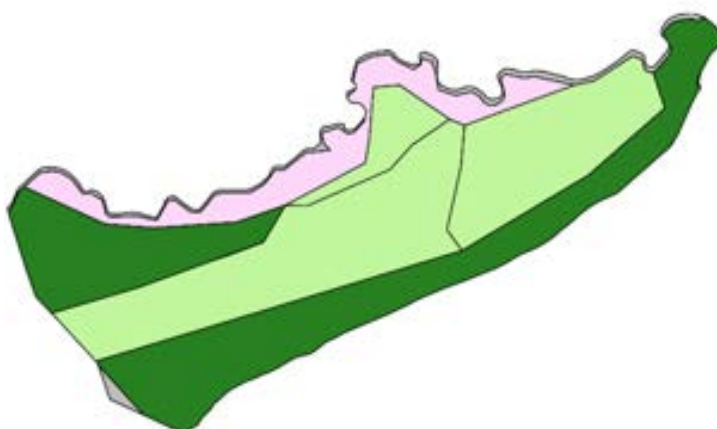
Map showing location within estate



Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



Condition Good Moderate

This small area (around 3 hectares) forms the north-east tip of the estate and is bordered by the River Deveron to the south and Chapel Burn to the north. The broadleaved woodland that runs along the river is in good condition, as is the strip of wetland habitat that runs along Chapel Burn. **The neutral grassland in the middle of the area is in moderate condition and this little-used area could potentially be planted with additional broad-leaved trees to further expand the riparian woodland.**

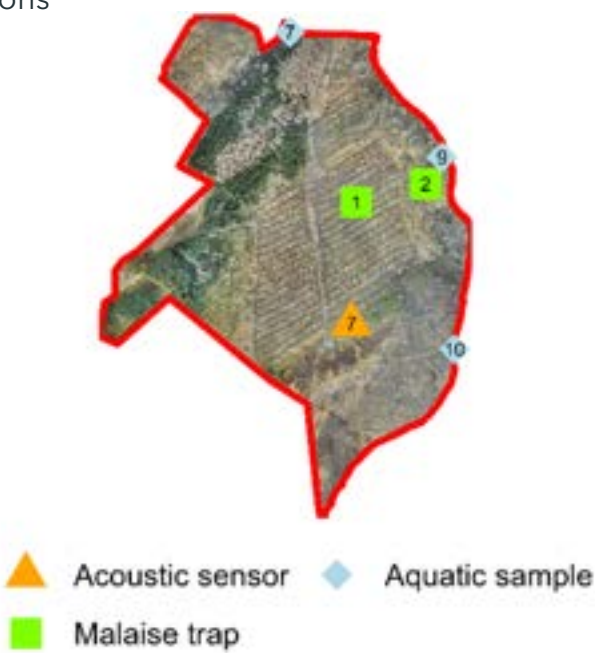
9. Main woodland

Figure 32 Main woodland maps

Map showing location within estate



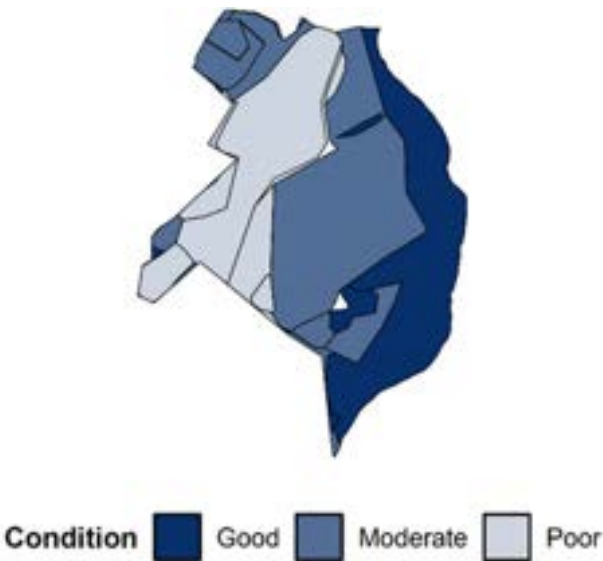
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



- f2 fen, marsh and swamp
- g1 acid grassland
- g3 neutral grassland
- h1 dwarf shrub heathland
- h3 dense scrub
- w1 broadleaved mixed and yew woodland
- w2 coniferous woodland
- Unsurveyed

This predominantly wooded area is just under 41 hectares and includes Tomcur Wood and Cairnhead Wood, both of which are on the Ancient Woodland Inventory. Cairnhead Wood borders the River Deveron and is semi-natural ancient woodland in good condition, classified as such due to the different age classes present, veteran trees and good understorey. Tomcur wood, originally a mix of semi-natural ancient woodland and long-established woodland of plantation origin, now includes the mainly coniferous plantations to the west of this area, which were planted in 1968 and now a woodland of poor quality.

Future management of this area will aim to boost the condition of this habitat through further light thinning and a gradual transition to continual cover forestry.

The 12 hectare area of neutral grassland in the centre is, in fact, a clearfell area - this was a coniferous plantation, which was felled in 2022 after Highlands Rewilding took over management.

The dominant vegetation here is now tufted hair grass *Deschampsia caespitosa*, hence its classification as a grassland under UKHabs, despite being a forestry compartment in the Forestry Plan.

This area will be restocked with native broadleaves, further expanding the ancient riparian woodland and providing good habitat for many species.

The Malaise and pitfall traps (ID 1) located in the clearfell area already captured a high number of species (139 species in the Malaise trap and 30 species in the pitfalls), but this was probably due to the area being surrounded by a number of different good

quality habitats including broadleaved and coniferous woodland and the riparian zone. Indeed, many of the species captured were indicative of closed broadleaved woodland and marshy/running water habitats. Species included the priority fly *Chrysotus femoratus*, a saprophagous species dependent on water, which will have come in from the riparian woodland. Despite the high number of species, there was a notable lack of species representing different niches including deadwood, which indicates that this area has the potential to support higher numbers.

We will ensure that the regenerating broadleaved woodland planned for this area will have high structural diversity and contain good proportions of standing and lying deadwood.

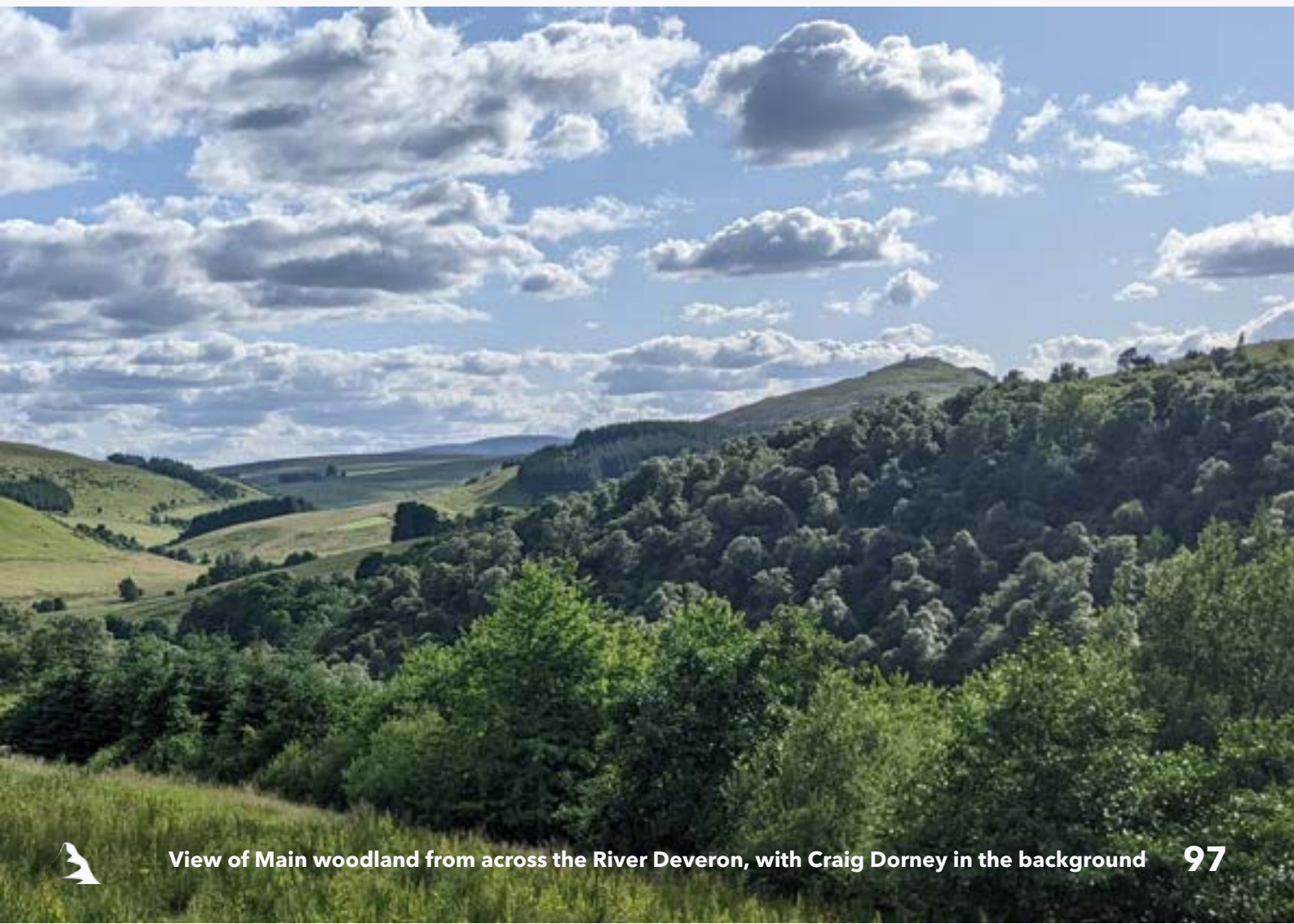
The Malaise and pitfalls (ID 2) located in the ancient broadleaved woodland by the River Deveron captured a good variety of insects, as expected (125 species in the malaise and 34 species in the pitfalls). There were higher proportions of Hymenoptera and Lepidoptera here, including the notable forest moth *Bryotropha galbanella* and the Vulnerable butterfly Scotch Argus *Erebia aethiops*, which is a good indicator species of open woodland edges. However, deadwood associated species were, again, low so there is potential for habitat improvements in this area.

The acoustic sensor (ID 7) was located in this area from 4th to 24th February 2023 and captured 32 bird species, including five red-list species. The highest number of calls were from the coal tit (1,771), followed by wren (663), siskin (407), crossbill (203), robin (156) and goldcrest (137).

An aquatic sample (ID 7) was taken from the burn that runs north out of this woodland

area towards the castle. A total of 97 invertebrate species were detected in this sample, indicating a good water quality (although there were few beetle fauna). One notable fly *Dicranota robusta* was detected, as well as a number of woody debris caddis flies and a few stoneflies giving the site a high conservation value. There were also quite a few woodland flies (not aquatic species) in the sample.

A further aquatic sample (ID 9) was taken from a wetland area in the deciduous woodland adjacent to the Deveron. A total of 82 species were detected here, indicating a moderate water quality and, again, there was a low beetle fauna but a few flies, for example the notable *Paradelphomyia fuscula*, associated with seepages, which is an important niche.



10. Eastern grasslands

Figure 33 Eastern grasslands maps

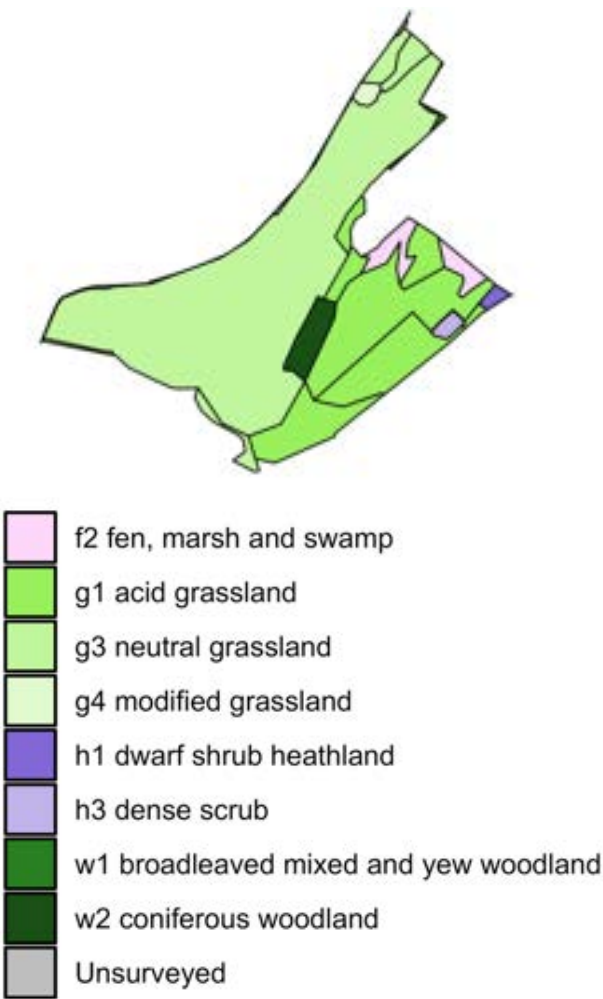
Map showing location within estate



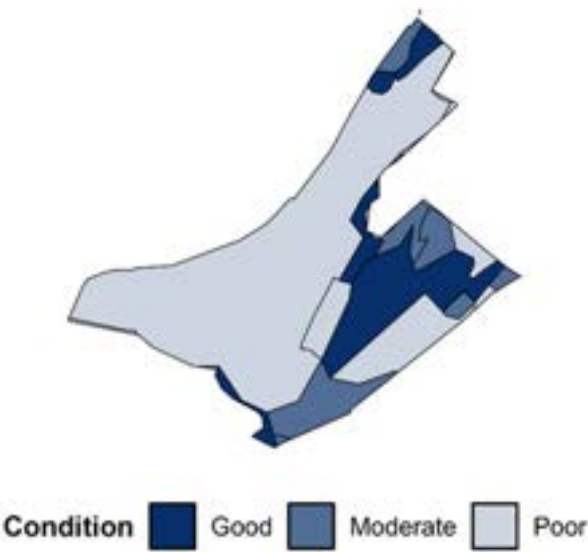
Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This area totals 41.5 hectares and the majority is neutral grassland in a poor condition. Similar to the grasslands to the north of the road, the area is currently being managed with adaptive multi-paddock grazing. There is potential here to plant further broadleaves on the areas of poorer habitat, to provide further connections across the estate.

As well as the neutral grassland, there is a smaller area of acid grassland, which has been assigned Good condition. In fact, this area is very species-rich and the ecologists who surveyed the area are of the opinion that the grassland is worthy of European designation as it conforms to the Annex I category H6230 - 'Species rich *Nardus* grassland on siliceous substrates in mountain areas'.

This grassland type is mainly confined to the Scottish uplands and is more common in the east. However, the Defra metric in its current form does not recognise the significance of such habitats and this is another example of how modifications to this metric are needed to make it fit for purpose in Scotland.

The small forestry block in this area, planted in 1989, is just over one hectare and contains broadleaved trees in the centre surrounded by conifers.

We have recently received permission from Scottish Forestry to thin this block and we are exploring the potential to carry this out through horse logging.

The Malaise and pitfall traps (ID 12) located in the grassland here caught high number of species (131 in the Malaise and 45 in the pitfalls), possibly due to proximity to other habitat niches such as deciduous woodland and scrub. Similar to Malaise 15 on the other side of the road, this trap caught the priority fly *Dolichopus cilifemoratus* and the moth *Apamea remissa*, indicative of marshy and open grassy areas respectively. Also caught was the Near Threatened moth of shrubby woodland, Double Dart *Graphiphora augur* and the priority fly *Chrysotus femoratus*.

The audio sensor in this area (ID6) captured the calls from 29 bird species, including four red list species. Most calls were from the common buzzard (341), followed by coal tit (238), siskin (238), tawny owl (193) and jackdaw (102).

11. Forest of Hope

Figure 34 Forest of Hope maps

Map showing location within estate



Drone image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This area is 26.6 hectares and includes a narrow strip of land to the south of the River Deveron. The majority of the area is the 'Forest of Hope' – an 18.97ha area of new woodland planting, which is described in the Second Natural Capital report. The planted area is indicated with a dotted yellow line in the map above (top right).

The southern grassland area is currently lightly grazed in the winter months, again with adaptive multi-paddock grazing. The small square area of neutral grassland in poor condition is currently being regularly mown and maintained as a deer lawn to aid deer management, which is a priority in this area due to all the newly planted trees.

The Malaise and pitfall traps (IDs 13 & 14) caught 102 species (59 in Malaise, 43 in pitfall) and 154 species (114 in Malaise, 40 in pitfall) respectively, with a mix of species from open, wet and broadleaved woodland habitats. Both Malaise caught the Nationally Scarce marsh fly species *Dolichopus cilifemoratus*. Malaise 13 caught the priority moth *Ochsenhiemeria urella*, which is indicative of tall and open grassland.

Malaise 14 caught the priority flies *Fannia norvegica*, a saphrophagus broadleaved woodland species, and *Symphoromyia crassicornis* from either deadwood or nearby acid wet vegetation.

Planting the Forest of Hope in this area should boost species numbers by attracting more woodland species and, by maintaining adjacent areas of species rich grassland, we will continue to provide habitat for those species dependent on grassland and more open habitats.

An aquatic sample was taken from the small burn that runs down through the centre of the Forest of Hope and a total of 28 species were detected here. This relatively small species list of predominantly flies indicates a low water quality, but there were some wetland-associated stoneflies and the common beetle *Chelifera precatatoria*, which requires exposed riverine sediment and woody debris – two important niches.



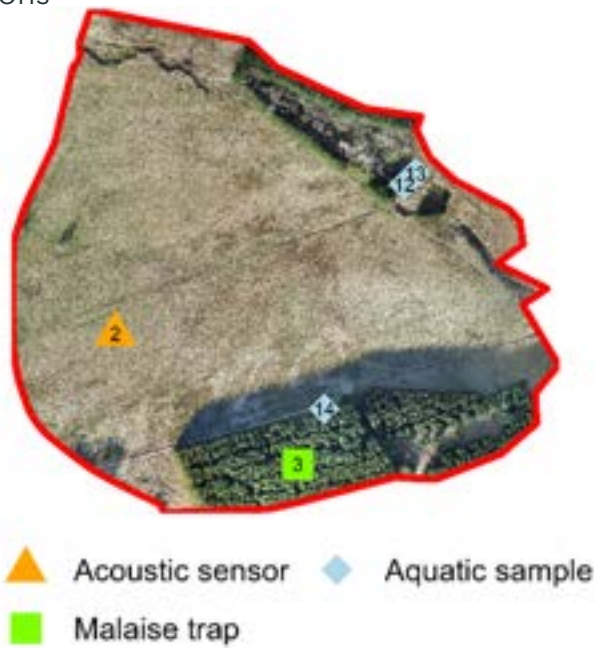
12. North Cummerton

Figure 35 North Cummerton maps

Map showing location within estate



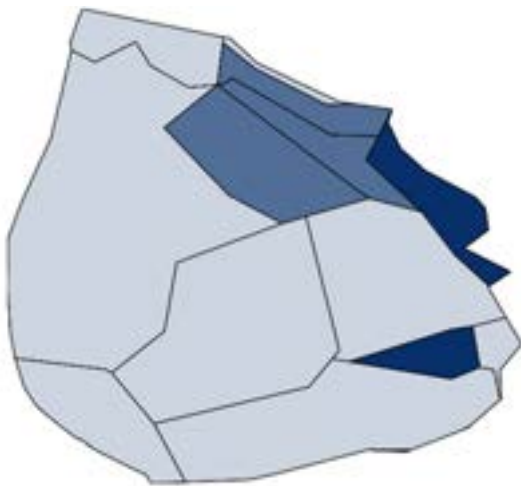
Satellite image of area showing sampling locations



UKHabs level 3 habitat map



Map of habitat condition



This grassland area, bordered by Tammie's Burn and a small plantation to the north and a further small plantation to the south, is 24 hectares.

The neutral grassland, currently in a poor condition, is naturally quite wet and we plan let this area naturally regenerate into an area of wet woodland, facilitated by planting further broadleaf trees, particularly alder and willow, along Tammie's Burn. There is a large field drain and we hope to block this, which would help to rewet the site.

The Malaise trap and pitfall traps (ID 3) located in the woodland block to the south of this area captured a total of 90 species (62 in the malaise and 28 in the pitfalls). There were better deadwood indicator species here, including the Nationally Scarce deadwood beetle *Anaspis thoracic*. The pitfalls also captured another interesting Nationally Scarce beetle *Parabolitobius inclinans*, which relies on fungi. Further beetles were found in aquatic sample (ID 14), which was collected from the agricultural ditch adjacent to this forest block. Some species were found that are indicative of seepage habitats, including the Nationally Scarce beetle *Hydroporous ferrugineus*.

Therefore, although the woodland is in poor condition, the presence of some interesting species shows the area still has potential for restoration and any management activities will need to be careful of disturbing the habitat niches already present.

Two further aquatic samples were collected from the northern edge of this area; one from Tammie's burn (ID 12) and the second from the small wetland area adjacent to the burn (ID 13).

The latter sample did not find many species but the one from the burn indicated a good water quality and included some interesting species including the notable saprophagous fly *Dicranota robusta* and the Nationally Scarce fly *Mycomya trivittata*.

Creating a small (leaky) dam across Tammie's burn in this area would improve the wetland area and create an important wet woodland habitat, which could potentially result in significant species uplift.

13. River Deveron

We have so far carried out fairly limited monitoring of the River Deveron but we plan to expand this over the next year. As a starting point in 2022, three aquatic samples were collected for eDNA analysis and the results suggested moderate to good water quality, with a number of interesting species including the Nationally Scarce mayfly *Rhithrogena germanica*, which is associated with unmodified, fast-flowing streams. Other species include the fly *Atherix ibis*, which is associated with bankside trees and woody debris but there was a notable lack of beetle fauna.

We've since been discovering a lot more about our freshwater invertebrates, through

the “Guardians of our Rivers” project. This partnership project, led by Buglife Scotland, recruits, trains and supports local volunteers who would like to get involved in monitoring the health of their local river. One weekend in August 2023, two of our staff received certified training from Buglife’s qualified Riverfly Partnership trainer, in how to monitor and survey for river invertebrates and how to identify different species.

We will continue and expand this in the spring of 2024, recruiting more local volunteers and creating a group of citizen scientists along the river, which will be a great way to connect to others in the catchment and work together to protect the River Deveron.



Tayvallich (Taigh a' Bhealaich)



Highlands Rewilding purchased Tayvallich (Taigh a' Bhealaich) estate in May 2023. The estate is situated on the Tayvallich peninsula in mid-Argyll and forms part of the stunning Knapdale National Scenic Area. The estate's 1,370 hectares and 40km of coastline contain a mosaic of habitats ranging from coastal, marine, wetlands and salt marsh through to ancient native woodlands and species-rich grasslands, mixed with open sea (the Sound of Jura), sea loch (Loch Sween), inlets (Linne Mhuirich) and lochans, which all have diverse ecosystems varying with the mixture of seabed compositions, tidal flow and currents.

Tayvallich Estate holds exceptional natural capital value and biodiversity uplift potential. Of particular conservation importance are the species-rich fen communities, juniper heath and fragments of Atlantic Temperate Rainforest.

Restoring the Scottish rainforest will be one of our most important priorities.

We are also in discussion with other landowners and groups in the area (including the Alliance for Scotland's Rainforests) about establishing large, landscape-scale collaborations. Additionally, we are discussing how we can support Gaelic language and culture in the area with a local community organisation, particularly by maintaining the use of original place names and exploring the deep links between natural and cultural heritage.

In this first year of ownership, we are focusing on consultation and data-gathering, without making significant changes to existing land management.

Many of our ecological surveys will take place in spring-summer of 2024, so here we give an overview of our activities to date and existing information we hold about the estate.



Community engagement

Community engagement has been a central part of our work at Tayvallich, starting before we purchased the estate. Working with the local community (and the Tayvallich Initiative in particular) we have developed a collaborative approach to estate management, using a number of methods:

- A series of public meetings to discuss management aims and engagement opportunities;
- Individual, face-to-face and online meetings residents, community members and other interested parties for open-ended conversations;
- A professionally-facilitated event to identify desired community benefits from the estate;
- Negotiation with the Tayvallich Initiative, a community body set up to consider options for community land purchase, to agree on shared objectives and a framework for collaboration;
- Agreeing a Memorandum of Understanding for land management to benefit local community and nature. This Memorandum forms an embryonic framework to deliver a unique triple-win partnership for community prosperity, nature restoration and ethical profits for shareholders. The Memorandum contains 24 individual objectives including:
 - Maintaining or, as we have now done, increasing the number of jobs on the estate, in line with also maintaining or building skills in the community;
 - Increased security of tenancies for people living in rented houses on the estate;
 - Sale of land to the community and first refusal on any future sale;
 - Development of further housing and smallholding opportunities, and application of Rural Housing Burdens to these to ensure that they remain in the community in the long term;
 - Establishment of a Local Management Board, collaboratively designed to be representative of community interests, with devolved operational powers for estate management;
 - Definition of a 'community baseline' to capture characteristics that we will seek to improve over time, with regular measurement to check progress.

This collaborative approach has been cited as an exemplar by the Scottish Land¹⁷ Commission amongst others and we plan to further develop engagement processes at Tayvallich and our other estates to establish a transferrable framework for community involvement in nature restoration where outright community ownership is not (currently) possible.





Habitats

Before we conduct detailed habitat surveys, we can learn a great deal from existing published data from a variety of sources. For Tayvallich, two different habitat classifications are available: the European EUNIS classification (used in Scotland) and the British National Vegetation Classification (NVC). EUNIS is a standard and widely-used system that ensures comparability across large scales, while the NVC focuses more closely on the habitats found in the UK, giving specificity and relevance to national schemes. We are currently using both to maximise the relevance of our findings.

Scotland land cover and habitats

Habitat and land cover maps are available for 2020 from a project involving Space Intelligence and NatureScot. This project used Artificial Intelligence to classify satellite data to EUNIS level 2 habitats. For Tayvallich, these data suggest that just over 40% of the area is Mesic grassland, with a further 23% 'seasonally wet and wet grasslands'. Around 15% is broadleaved deciduous woodland.

National Vegetation Classification (NVC)

NatureScot has also published NVC data that include Tayvallich. These data have the advantage of being collected from a ground survey, but this was conducted in 1996 and so is now considerably out of date. Nevertheless, this is a useful comparison to the remotely-sensed classification.



Figure 36 Scotland land cover and habitats map of Tayvallich Estate. EUNIS codes are shown along with habitat types.

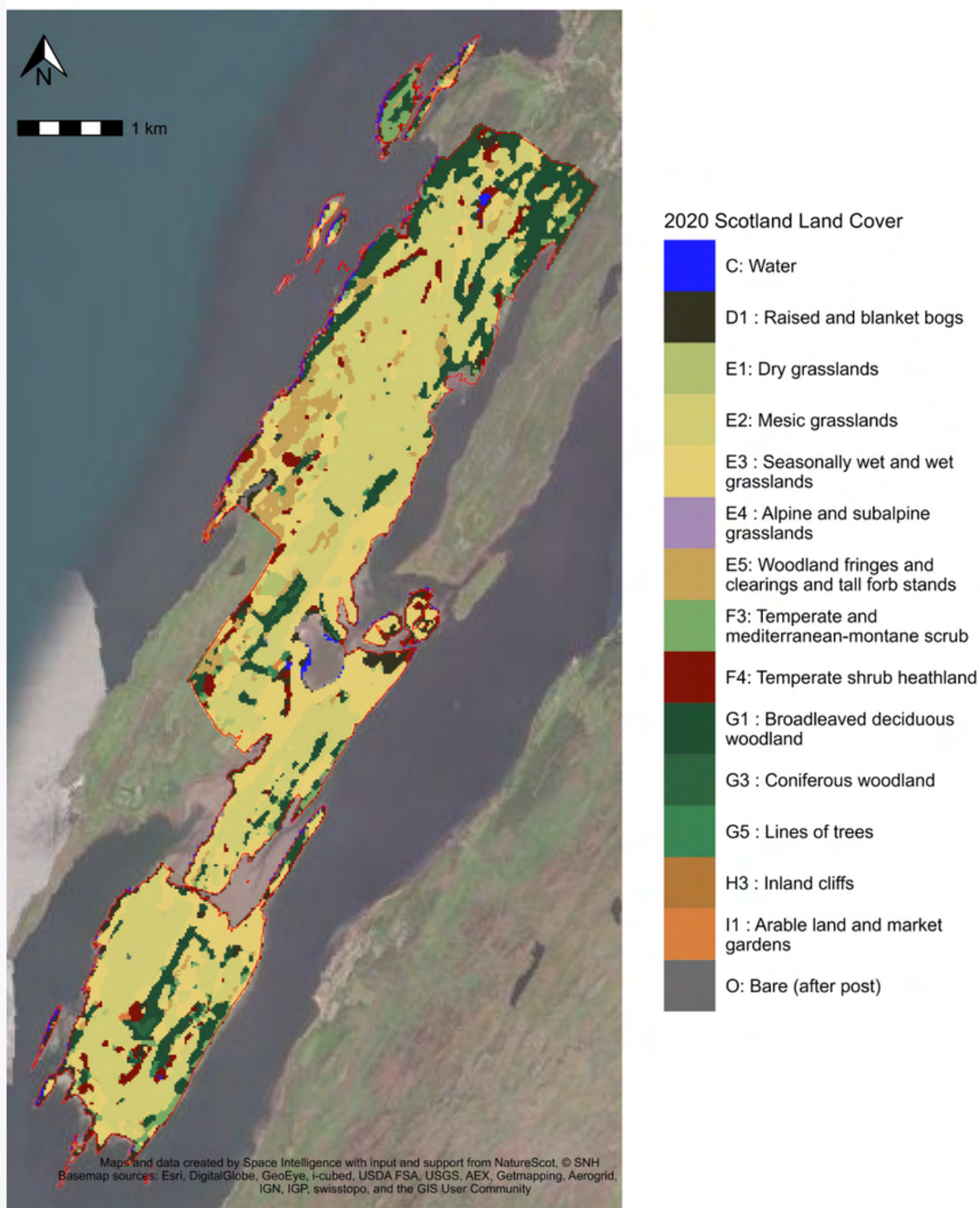
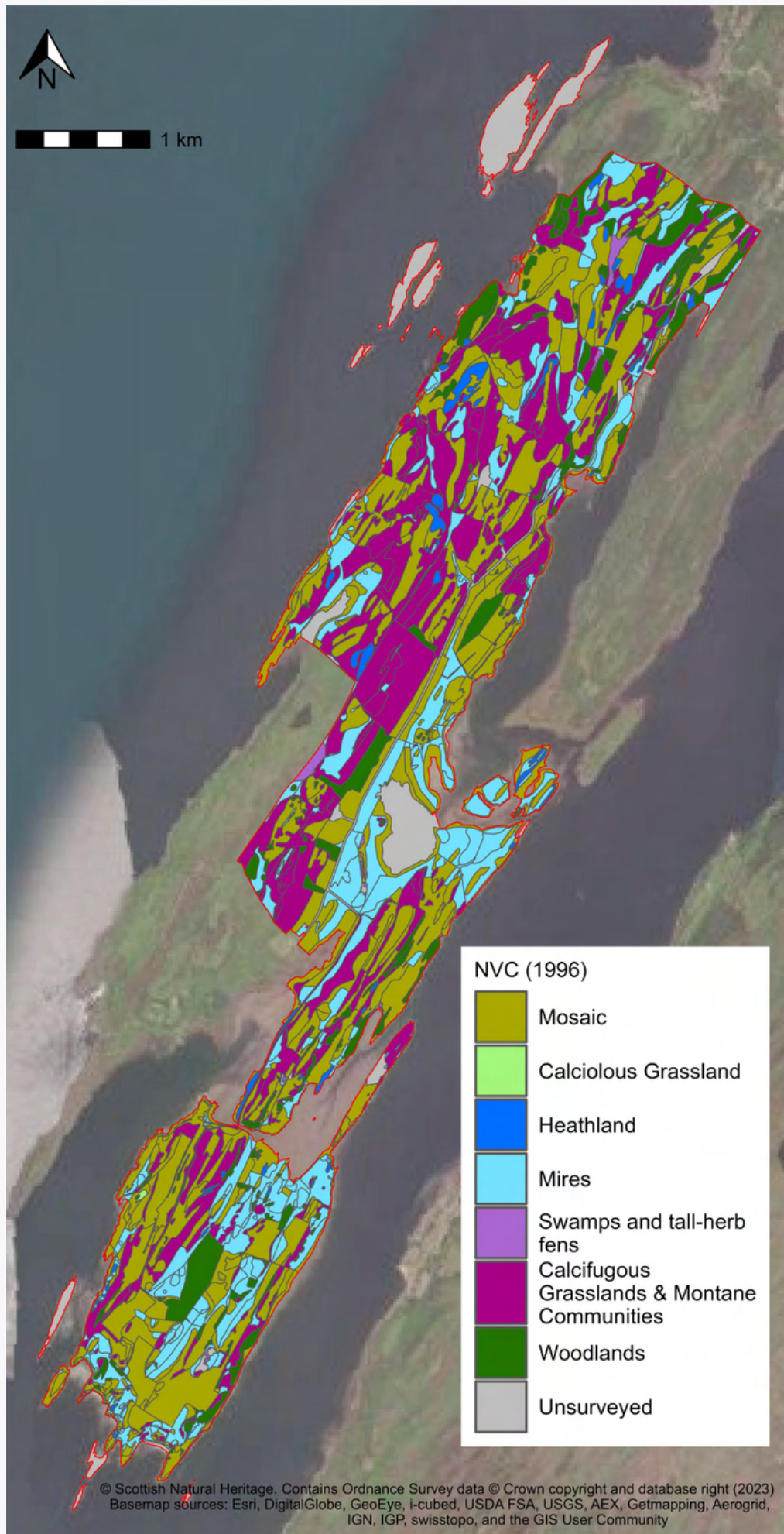


Figure 37 Map of the 1996 NVC data of Tayvallich Estate



The NVC survey covered approximately 1,274 hectares of the estate and did not include the islands. The table below gives a summary of the area of each community.

Table 4 Summary of the NVC communities from the 1996 survey

Community name	Total area (hectares)
Mosaic	521
Calcifugous Grasslands & Montane Communities	352
Mires	258
Woodlands	111
Not surveyed	93.9
Heathland	25
Swamps and tall-herb fens	6
Calciolous Grassland	0

While more than 40% of the area surveyed was classified as Mosaic habitats, the great majority of these are grassland mosaics, especially *Lolium perenne* leys and related grasslands, which covered 110 hectares. Saltmarsh mosaics were also significant, covering 26 hectares. The 258 hectares of mires are made up of 97 hectares of *Juncus effusus/acutiflorus-Galium palustre* rush-pasture, *Juncus acutiflorus* sub-community (M23a), 22 hectares of *Scirpus cespitosus-Erica tetralix* wet heath, *Vaccinium myrtillus* sub-community (M15d), 9 hectares of *Molinia caerulea-Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community (M25b) and many smaller areas of different sub-types or combinations of sub-types.

A total of 111 hectares of woodland were recorded, including 32 hectares of *Quercus petraea-Betula pubescens-Oxalis acetosella* woodland, *Blechnum spicant* sub-community (W11b), 27 hectares of *Pinus sylvestris-Hylocomium splendens* woodland (W18), 11 hectares of *Ulex europaeus-Rubus fruticosus* scrub (W23) and 10 hectares of *Fraxinus excelsior-Sorbus aucuparia-Mercurialis perennis* woodland, typical sub-community (W9a).

Designated areas

The unusual – and unusually mixed – habitats of Tayvallich are recognised in a wide array of designations that cover approximately 85% of the estate. These include Sites of Special Scientific Interest (SSSIs), designated to protect sites that best represent Scotland's natural heritage, Special Areas of Conservation (SACs), designated to protect terrestrial or marine species or habitats listed in the EU Habitats Directive, and Marine Protected Areas (MPAs), designated to protect marine nature. We will manage these areas to maximise their value for their designated qualities, working closely with NatureScot and other relevant parties with expertise and practical knowledge on such management.



Sites of Special Scientific Interest (SSSI)

Figure 38 Map of the SSSIs on Tayvallich Estate



There are four SSSIs within Tayvallich Estate and another (Taynish) on its border¹⁸. These are designated for a range of ecological and geological features, summarised in Table 5. Most of these features are classified as being in favourable condition, with some negative pressures including over-grazing, invasive species and, in some cases, under-grazing.

Table 5 SSSIs on Tayvallich estate and the main features they contain

SSSI name	Features
Linne Mhuirich	Fen meadow, Saltmarsh, Lowland calcareous grassland, Upland mixed ash woodland
Tayvallich Juniper and Fen	Dragonfly assemblage, Juniper scrub, Upland oak woodland, Valley fen
Ulva, Danna and the McCormaig Isles	Bryophyte assemblage, Cormorant (<i>Phalacrocorax carbo</i>), breeding, Greenland barnacle goose (<i>Branta leucopsis</i>), non-breeding, Greenland white-fronted goose (<i>Anser albifrons flavirostris</i>), non-breeding, Lowland calcareous grassland, Lowland dry heath
West Tayvallich Peninsula	Dalradian (geological)



Special Areas of Conservation

Figure 39 Map of Special Areas of Conservation



While Tayvallich estate is bordered by the very large Inner Hebrides and the Minches SAC on one side and the smaller Taynish and Knapdale Woods SAC on the other, our management will primarily be affected by the Tayvallich Juniper and Coast SAC, which covers 1,015 hectares of the estate. This SAC includes the Annex 1 habitat *Juniperus communis* formations on heaths or calcareous grasslands and Annex 2 species Marsh fritillary butterfly *Euphydryas aurinia*, as primary reasons for site selection. The former is the only occurrence of this habitat in the SACs on Scotland's west coast, and is also notable for the mosaic of dry wooded ridges, heathland, grassland and wetland flushes, mires and open water communities within which juniper is regenerating. While these features have been preserved by past management, a number of threats including human activities, grazing and pollution are recorded as threatening the designated features, with others including invasive non-

native species threatening the nearby Taynish and Knapdale Woods SAC.

Marsh fritillary butterflies are a priority species in the UK; they have suffered massive declines throughout Europe and are threatened with extinction. The remaining populations in western Scotland, where the species remains relatively widespread, are some of the most important in the UK and three Special Areas of Conservation (Taynish and Knapdale Woods SAC, Tayvallich Juniper and Coast SAC and Rinns of Islay SAC) have been designated for the species in Scotland.

To start to understand the current population on the estate we commissioned a professional ecologist, Neil Ravenscroft B.Sc. Ph.D. F.R.E.S., to map the distribution and extent of the butterfly's habitat and this was undertaken in September 2023.



Marsh Fritillary caterpillars and larval webs (2023)

The following information is extracted from Neil's full report and we will continue to work from this baseline data and plan management accordingly.

The survey comprised a walkover of the entire mainland area plus Danna and Rubha Bhreatanich but minus all islands with the exception of the Ulva Islands and Eilean nan Uan in south-west Danna. Habitat was mapped and graded according to a scale of suitability for marsh fritillaries and locations of webs of caterpillars observed were also recorded (although the latter was not the primary objective). Marsh fritillaries occur in habitats such as damp acidic grasslands, wet and dry heaths, blanket bogs, rush pastures and valley-bottom mires, that contain their foodplant Devil's-bit scabious *Succisa pratensis*. Light or extensive grazing of grasslands by livestock, especially cattle, or occasional hard, concentrated grazing followed by release, maintains marsh fritillary habitat in areas prone to succession. However, suitable habitat can persist for long periods in the absence of livestock in mires and heaths where succession is slow.

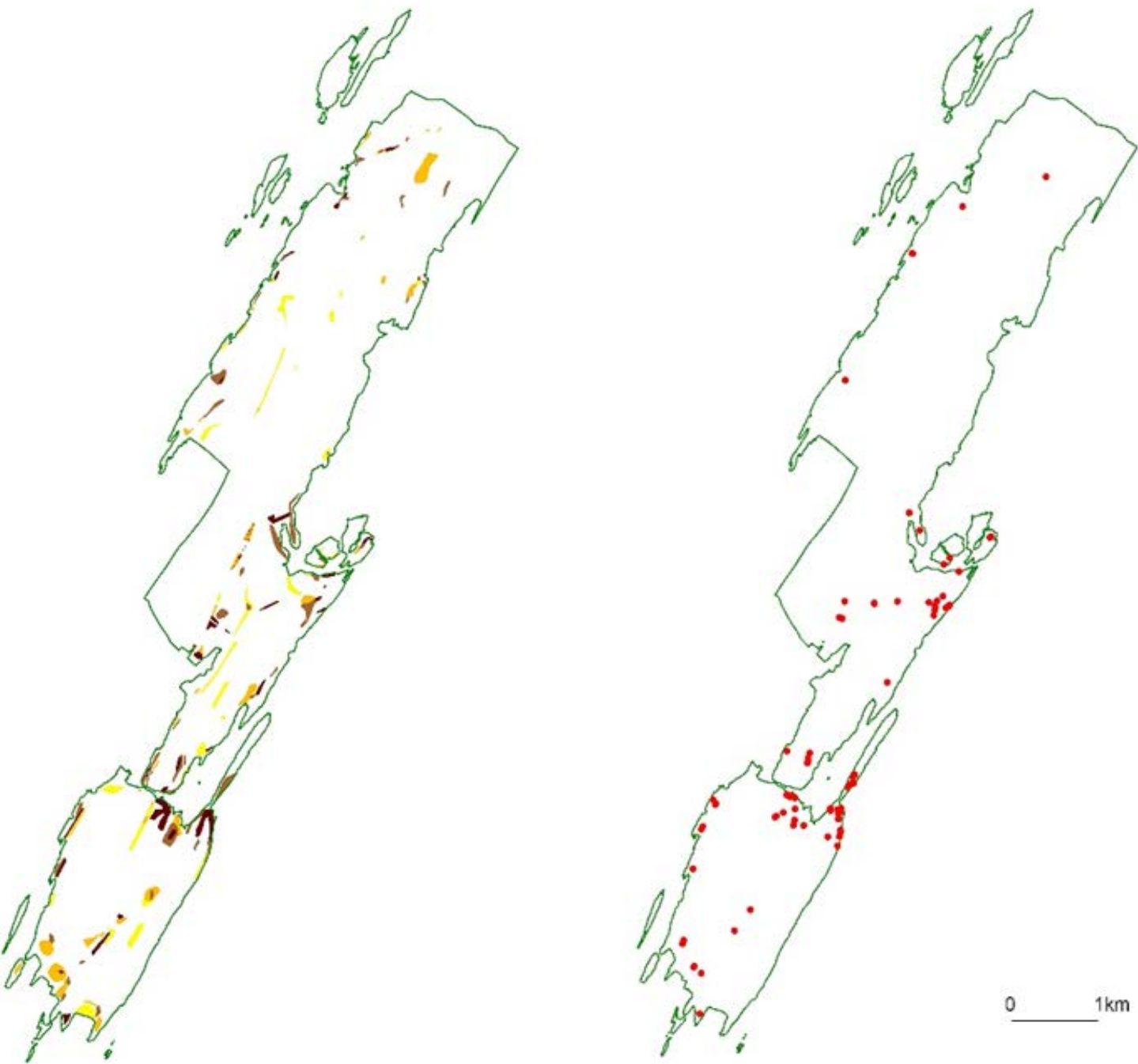
About 65ha of ground containing marsh fritillary habitat was mapped on the estate, representing about 5% of the estate's area and this is most concentrated on Danna and Ulva (both 9%) (see Figure 41). Habitat was graded as poor, good, very good and excellent during walkovers. The grades from good to excellent represent habitat suitable for marsh fritillaries and the differences between them are partly a reflection of the concentration of patches i.e. higher grades contain larger or more frequent and contiguous patches of habitat. The habitat structure is also considered – the best habitat for marsh fritillaries is usually composed of a range of vegetation heights,

including shorter swards and open ground containing Devil's bit scabious. Areas classified as poor were usually tall, dense, wet species-poor mires and rush pastures with scarce Devil's bit scabious, or areas of ground in which species diversity has been reduced by sheep grazing but that have potential with appropriate management. Areas classified as 'good' were usually species-rich habitat that has become marginal through lack of management and succession e.g. tall species-rich rush pastures and dense moor-grass dominated mires, often with small breaks of better habitat. Large areas of poor habitat containing small amounts of very good or better habitat for marsh fritillaries were also included in this category.

The results show that the extent of habitat on Tayvallich is highly favourable for the continued persistence of Marsh fritillaries. However, both the 'poor' and 'good' areas of habitat have the potential to become much more suitable through appropriate management, which will include reduced sheep grazing in some areas and increased cattle grazing in others. It would also be interesting to carry out further monitoring and research into the population dynamics of this butterfly species, which is known to undergo large, cyclic fluctuations. These fluctuations seem to be synchronised over large parts of the range, with peaks recorded at Taynish NNR in 1996/1997, 2006/2007 and 2016 and scarcity noted in 1994, 2002 and 2012 (during surveys of Tayvallich over several days in 2002 no webs were recorded at all). The population is currently resurgent after recent restricted years with the next population trough likely to occur in 2025-2030.



Figure 40 The distribution of ground containing *E. aurinia* habitat on Tayvallich Estate (left) and the locations of webs (right) recorded in autumn 2023.



Marine Protected Areas

Marine Protected Areas around Tayvallich estate are affected by and relevant to our land management. The features of Loch Sween MPA include Burrowed mud, Maerl beds, Native oysters and Sublittoral mud and mixed sediment communities, while the larger Loch Sunart to the Sound of Jura MPA is designated for marine species such as the Flapper Skate.

We are exploring management options appropriate to these designations with relevant experts.



Figure 41 Map of the MPAs around Tayvallich estate

Woodland

In addition to a few small conifer plantations, Tayvallich estate has pockets of Atlantic rainforest. One of our big hopes as part of rewilding the land is to be able to extend the area of rainforest.

The first step is understanding what woodland there is already on the estate, which other areas are well-suited to rainforest expansion, and any factors influencing the establishment of woodland, such as the recognised over-grazing by deer.



Existing woodland

The Ancient Woodland Inventory shows that on Tayvallich estate there is a total of 9.4 hectares of Ancient woodland (of semi-natural origin) and 8.5 hectares of Other woodland (on the Roy maps, ca. 1750).

Figure 42 Map of Ancient Woodland

Assessing the woodland

As mentioned previously, the bulk of the surveying work for the biodiversity and carbon baselines on the estate will be carried out next spring and summer. However, to understand the woodland on the estate lidar data is very useful. In June we took advantage of Arbonaut conducting airborne forestry surveys nearby. They extended their flight paths to cover the Tayvallich estate and captured Lidar data at a minimum of 10 points per square meter, and multispectral data at a 25cm. Having these data across the whole estate allows us to look in detail at tree and woodland characteristics, model the terrain accurately, and compare remotely-sensed data with those gathered by other means.

Whilst airborne Lidar surveying is a good solution for large area coverage, there are advantages of using drone mounted lidar. As part of our research partnership with the Leverhulme Centre for Nature Recovery at Oxford University, we've also gathered very high resolution lidar data by drone across many parts of the estate.

We are currently processing the data from both the airborne and drone surveys, and will carry out a research project to assess the differences in their use for analysing woodland composition, structure and health. Below is a taster of what the data shows.

Rainforest

One of the fragments of Atlantic Rainforest is towards the northern end of the estate (closest to Tayvallich Village). The woodland sits between Linne Mhuirich and the road (the B8025) and this strip has a total area of around 6 hectares.



Figure 43 Aerial image of rainforest fragment

This orthophoto, which was taken alongside the airborne lidar in June, has a resolution of 25cm. The area of the woodland shown is approximately 1 hectare and the image starts to give a sense of the varying age and species of trees.



Plantations

There are five conifer plantations across the estate (four blocks close to the road that runs through the estate, and one block on Danna Island). These contain trees planted between the 1960s and 1970s. The conifers in these blocks are currently ready to be harvested, with an estimated 3,500m³ of timber, and are at risk of windblow if they stay in place much longer due to (non-native) Sitka spruce's tendency to grow too high to be stable in Scottish coastal storms. The five plantation blocks on Tayvallich were not thinned regularly at earlier stages of their growth and so are not suitable for conversion to continuous cover forestry.

This means that we have to consider options for clearfelling the timber, while maintaining the native trees that exist around the blocks.

We are currently reviewing the best solution for harvesting these blocks and using the timber with as little disruption as possible. This will allow us to restock the plantations with native species as a first step towards expanding and connecting rainforest patches elsewhere on the estate.

We can use the data from the airborne and drone surveys to better understand these woodlands. The block of approximately 7.6 hectares closest to Coshandrochaid provides a good example of what the data show.

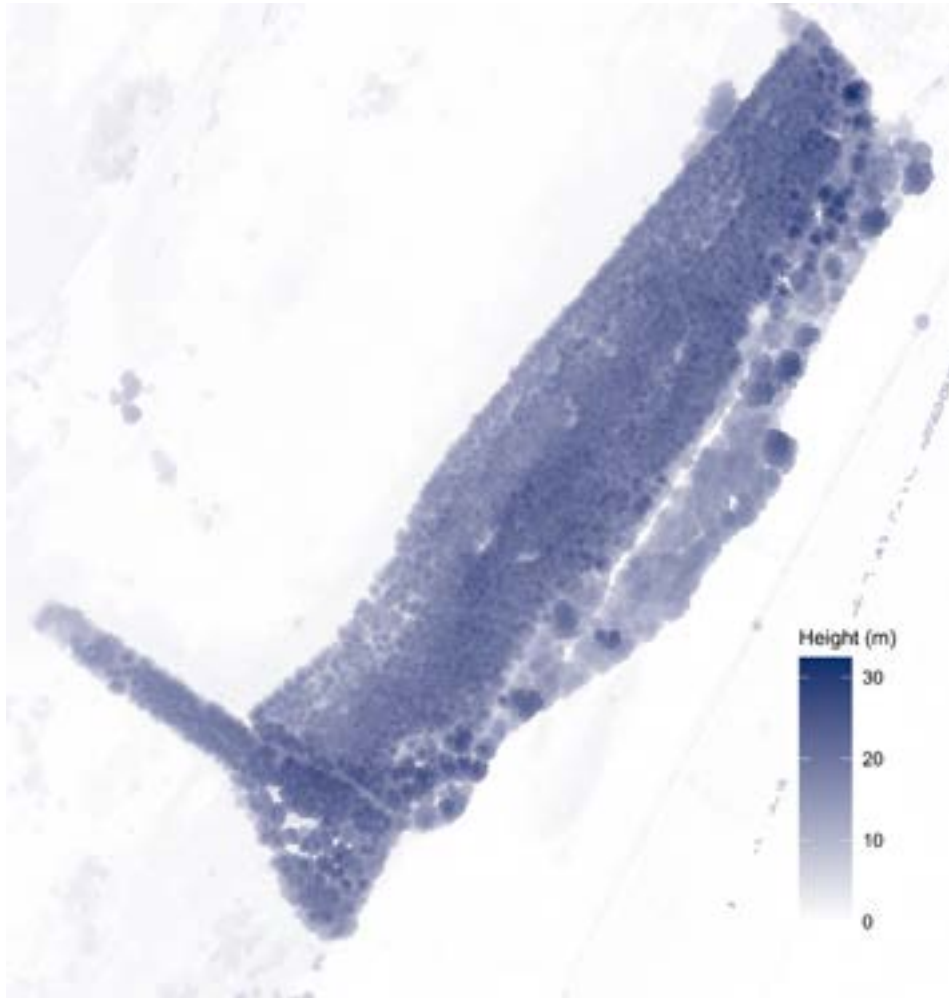
The orthophoto shows the broadleaved outer edges of the woodland, with conifers in the centre of the plantation. The image is high enough resolution to distinguish the individual tree crowns and it is possible to distinguish between broadleaved trees and conifers.



Figure 44 High resolution orthophoto of the forestry block by Coshandrochaid



Figure 45 Canopy Height Model of the woodland nearest Coshandrochaid



From the lidar data we can create a canopy height model which shows the height of the trees. In the image above the darker blue indicates the tallest trees. The tallest tree is on the north-eastern end of the block and is around 32 metres tall. The conifers are approximately 20-25 metres tall.

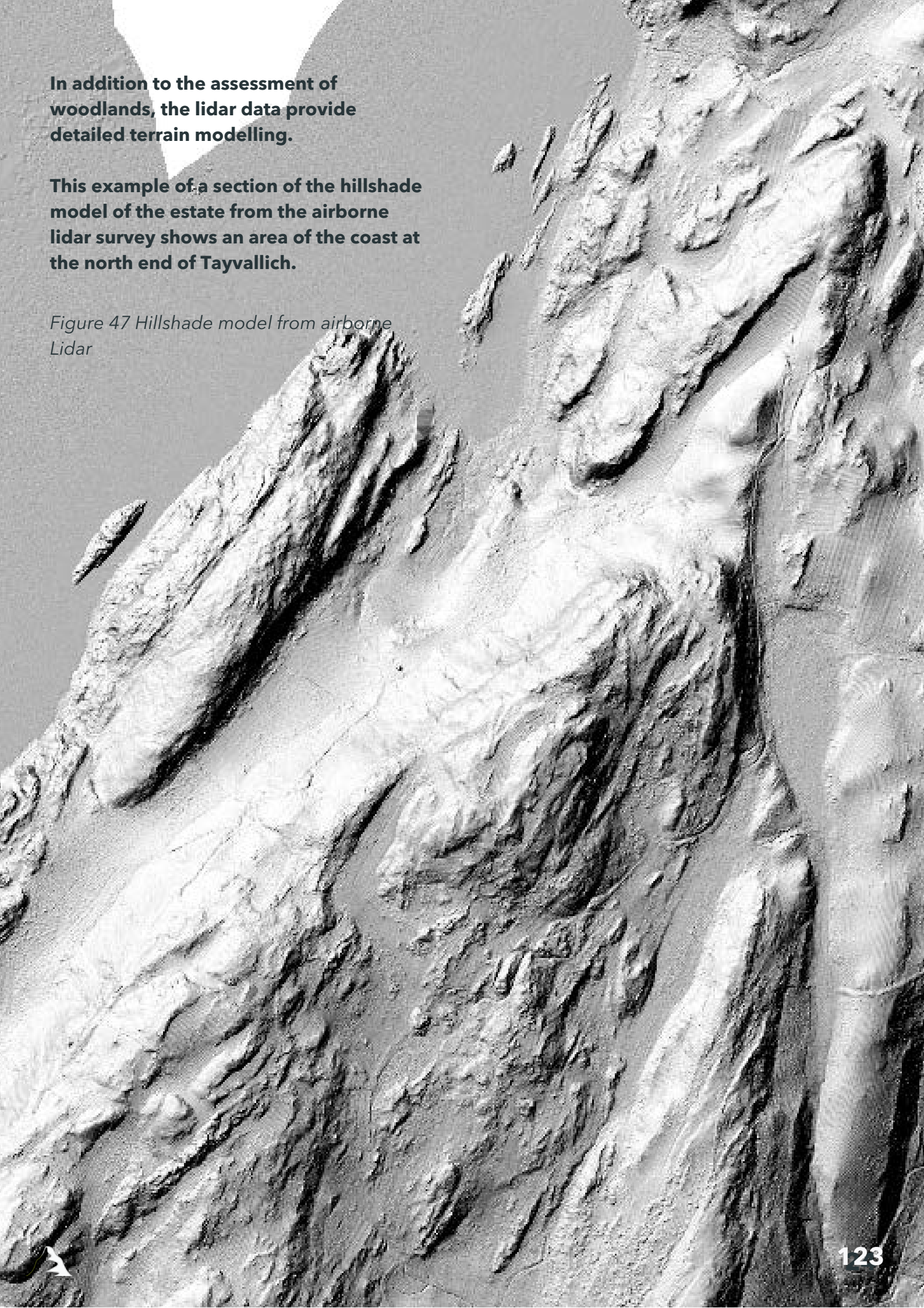
We will be working with the lidar data and images over the coming months and will provide more information alongside the rest of the baseline data at Tayvallich in our next Natural Capital Report.

Our plans include running tree crown detection (to count how many trees there are), and calculating the height of each tree to assess the amount of carbon being stored in the above ground biomass on the estate.

In addition to the assessment of woodlands, the lidar data provide detailed terrain modelling.

This example of a section of the hillshade model of the estate from the airborne lidar survey shows an area of the coast at the north end of Tayvallich.

Figure 47 Hillshade model from airborne Lidar





Management of the land (and sea)

While we do not plan to substantially change estate management in this initial 'baselining' year of our ownership of Tayvallich, there are some issues that we are monitoring carefully. We will take actions such as the management of invasive or over-dominant species. There are small patches of Himalayan balsam, Rhododendron and regenerating Sitka spruce (particularly on a couple of the islands), and in some areas bracken is highly dominant.

We will also look carefully at grazing pressures and patterns. There are currently approximately 1,000 sheep and 65 cattle on the estate. Part of the baselining activity will be to review the numbers needed for the patterns of grazing designed to maintain and improve the habitats.

We anticipate moving towards the regenerative agriculture approach that we have been implementing at Beldorney.

The relationship between land and sea is particularly strong at Tayvallich, and another area of focus is direct and indirect management of the marine environment. We are in the process of recruiting a Marine Rewilding Lead to bring additional expertise into the team and to develop baselining plans for the sea as well as the land, and we will collaborate on these, as ever, with external groups and experts.



Conclusions

After 3 years we have gathered a great deal of evidence to inform our land management of Bunloit and Beldorney estates, and to design our baseline surveys of Tayvallich. By applying a wide range of methods and taking an experimental approach to management, we have been able to identify the most accurate and efficient methods for monitoring biodiversity and carbon dynamics, and the most effective ways to intervene in specific habitats.

In Bunloit and Beldorney we will now focus on modelling the uplift we can expect to generate, implementing planned management, and recording the changes that occur. In Tayvallich we will further develop methods for managing and monitoring ecosystems spanning terrestrial and marine zones, and focus on features already identified as nationally important in designated areas.

While we take these steps, markets to support nature-based solutions are developing rapidly. These markets need to develop in ways that preclude the problems associated with voluntary carbon markets, and identify robust ways of targeting private finance to nature recovery. We are engaging in market development to achieve these ends without selling carbon or biodiversity credits at this point. By taking this approach we intend to develop and share expertise in the design, implementation, verification and funding of nature recovery.

We are working to achieve these aims while becoming increasingly embedded in local communities. Our estate teams are primarily drawn from these communities, and we are developing novel and essential ways of involving communities in restorative land management. Through building skills, employment, education, engagement and agency we hope to increase community capacity.

Meanwhile, by selling land and local housing, agreeing shared objectives and establishing local management boards we hope to direct this agency towards increasing community control and ownership, and ultimately to nature recovery alongside community prosperity.

A great deal remains to be done to identify and scale genuine nature-based solutions in Scotland, and we look forward to another busy year in 2024.



Red squirrel at Beldorney



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