Catkin Ecology and Sarah Watts

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Scottish Seed Stand Project
Summary Report

Contents

Email: info@catkinecology.co.uk
Website: catkinecology.co.uk

WOODLAND TRUST SCOTLAND

1. Introduction

A significant challenge to expanding Scotland's native woodland is the availability of tree seeds for certain species and provenances, particularly for montane species and island / north / west provenances. Seed stands can simplify seed collection for these species by producing large volumes of seed of known genetic origin in an accessible location.

Some seed stands (and clone banks) for montane and pioneer species are already in place or in development – however, as many of these stands are not registered on existing registers, knowledge of the distribution, source locations and use of these stands is currently spread between multiple organisations. To facilitate greater collaboration and meet the rising demand for montane tree species to be incorporated into nature restoration projects, further work was required to map existing seed stands and tree nursery networks to identify current sources of propagation material, as well as potential gaps in supply.

This report summarises the findings of a research project funded by Woodland Trust Scotland into the potential for expansion of Scotland's network of seed stands to contribute to wider availability of local provenance montane and pioneer tree species. This work was carried out by Innes Manders, Julia Stewart (both Catkin Ecology) and Sarah Watts from December 2024 to April 2025.

1.1. Terminology

Definitions of seed stands are variable. In this report, the following terms are employed:

Seed stand: a planted source-identified population which has been established for the purposes of seed collection, usually from cuttings. Although some stand managers refer to their stands as seed orchards, in FRM terminology **seed orchard** suggests a degree of selection for superior characteristics and therefore is avoided in this report.

Accessible planted population: a population which has (either intentionally or not) been planted at a site where seed can more easily be collected than from relict populations, but the main purpose of the population is not seed collection and it is likely to be less managed than a seed stand.

Clone bank: a population of individuals established from cuttings for the purpose of providing cuttings of known origin through clonal reproduction

Wild stand: a well-documented wild population, regularly used for seed collection.

All of the above may or may not be registered on the National Inventory of Basic Material as a "**source-identified stand**".

Montane trees species: Trees and shrubs that predominantly feature at high altitudes, as part of mountain woodland habitats within the treeline; the transition zone (ecotone) between the timberline (below which trees can grow upright) and the tree species line (the highest elevational limit of individual tree establishment). A broad species list has been compiled in the HabMoS remnants dataset[1] and summary report[2]. Montane and sub-montane willows are described in detail by Watts (2024b).

Pioneer tree species: Trees and shrubs with characteristics and reproductive strategies which enable them to effectively colonise areas of open or disturbed ground. All montane tree species could also be described as pioneer species. These species tend to mature after only a few years and produce large quantities of seed. Although the classification of pioneer trees is not rigidly academically defined, a relevant list for this project has been created.[3]

[1] NatureScot (2023a). *See Key References*.
[2] Watts, S. H. (2024a). *See Key References*.
[3] In addition to montane tree species, other native tree species which are regularly classed as "pioneer trees" include: *Alnus glutinosa, Betula pendula, Betula pubescens, Pinus sylvestris, Salix aurita, Salix caprea, Salix cinerea, Salix pentandra, Salix purpurea, Sorbus aucuparia*

1.2. Target Species

This research project has considered the potential for seed stands to contribute to all native pioneer and montane tree and shrub species in Scotland with the exception of aspen (*Populus tremula*)[4] and Scots pine (*Pinus sylvestris*). From this list a subset of priority species has been identified.[5] In some areas, the potential for stands of non-priority species has been considered.

Right: *Salix myrsinites*, Glen Lochay Estate. Although ripe catkins are present in this image, isolated populations and highly recalcitrant seeds make seed collection difficult.

1.3. Why local?

1.3.1. Genetic Diversity and Local Adaptation

> "The overall aim of seed sourcing, from an evolutionary ecology perspective, should be to ensure that planted forests have the capacity to survive initially and continually adapt to changing environmental conditions."
>
> Whittet et al. (2015)

Genetic diversity underpins the survival, adaptation and evolution of a species, and is particularly important under changing environmental conditions. Populations of trees and shrubs tend to have high levels of genetic variation for adaptive characteristics, such as phenology and herbivore resistance.[6] Although the simple view that "local is best" has been justly criticised,[7] there are a number of strong arguments for the use of localised seed sources:

1. Local adaptation:
    a. Seed sourced locally will be better adapted to local environmental conditions.
    b. Seed sourced locally will be more resilient to extreme climatic events (where these have precedent in the area in question).
2. National resilience: the use of local seed ensures high levels of genetic diversity by preventing planting being monopolised by supply from a limited number of restricted sources, thereby increasing overall resilience to threats such as climate change and tree disease.

Although local diversity should be conserved, in general gene flow between populations should be encouraged to minimise inbreeding, particularly since the fragmentation and isolation of populations may be artificial as a consequence of centuries of anthropogenic land-use.[8] Gene flow is best ensured by landscape-scale habitat connectivity, allowing natural processes to determine the extent and direction of gene flow – however, artificial movement of material may be necessary in some areas (see Section 1.3.2.).

1.3.2. Climate Change and Predictive Provenancing

There has already been a significant amount of movement in genetic material across Scotland and Northern England. The direction of travel varies between species, but two general trends can be detected. In general, material from pioneer tree species has been more likely to move from south to north and from east to west due to seed availability. On the other hand, in the case of mountain woodland species such as *Salix lapponum, Salix myrsinifolia, Salix phylicifolia,* and *Betula nana* the general trend has been from material to be moved from the Highlands to Southern Scotland. These trends have largely been driven by easier access to material rather than "predictive provenancing", however, in the case of montane and submontane species in the South of Scotland, there has been an active approach to increasing genetic diversity.

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[4] *Populus tremula* has been excluded due to the difficulties in collecting seed from this species, and the specialist knowledge thus necessary to successfully do so. Trees for Life and Eadha Enterprises are currently propagating *Populus tremula.*

[5] *Betula nana, Juniperus communis* ssp. *communis, Juniperus communis* ssp. *nana, Salix arbuscula, Salix caprea* ssp. *sphacelata, Salix lanata, Salix lapponum, Salix myrsinifolia, Salix myrsinites, Salix pentandra* (lowland pioneer), *Salix phylicifolia, Salix purpurea* (lowland pioneer) *Salix repens, Salix reticulata, Sorbus rupicola*

[6] Whittet et al. (2015). *See Key References.*

[7] Ibid.

[8] Genetic studies have suggested the isolation of *B. nana* populations in Northern England from those in the Scottish Highlands occurred just 230-345 years ago, likely due to human land management (Borrell et al., 2019)

Advocates of "predictive provenancing" suggest that the material used in planting should be derived from current climates analogous to those predicted to occur at the planting site under climate change. However, in general there is no clear benefit to this approach in mountain woodland restoration in Scotland for a number of reasons:

1. There is insufficient genetic material in the South of Scotland and North of England to supply areas further North.
2. The latitudinal climatic gradient is not the strongest climatic factor affecting the conditions where montane species occur – e.g. *Salix myrsinites* populations in the Northwest Highlands are found in warmer climatic conditions than those occurring at higher altitude in the Central Highlands.
3. Factors such as geology and photoperiod will not be impacted by climate change.
4. Long-term resilience to climate change may be better served by retaining adaptative radiation within local populations.
5. Comprehensive predictive future scenario models to guide planting do not yet exist for montane tree species
6. Due to land-use pressures such as overgrazing, montane trees currently persist in refugia which may not represent the full range of conditions these species might potentially occupy. Therefore, "predictive provenancing" models derived from present-day distributions may risk bias towards a sub-set of possible future conditions.

However, where genetic studies have demonstrated a lack of genetic diversity, some assisted gene flow may be beneficial - for example for peripheral populations of *Betula nana*.[9]

2. Current Activity

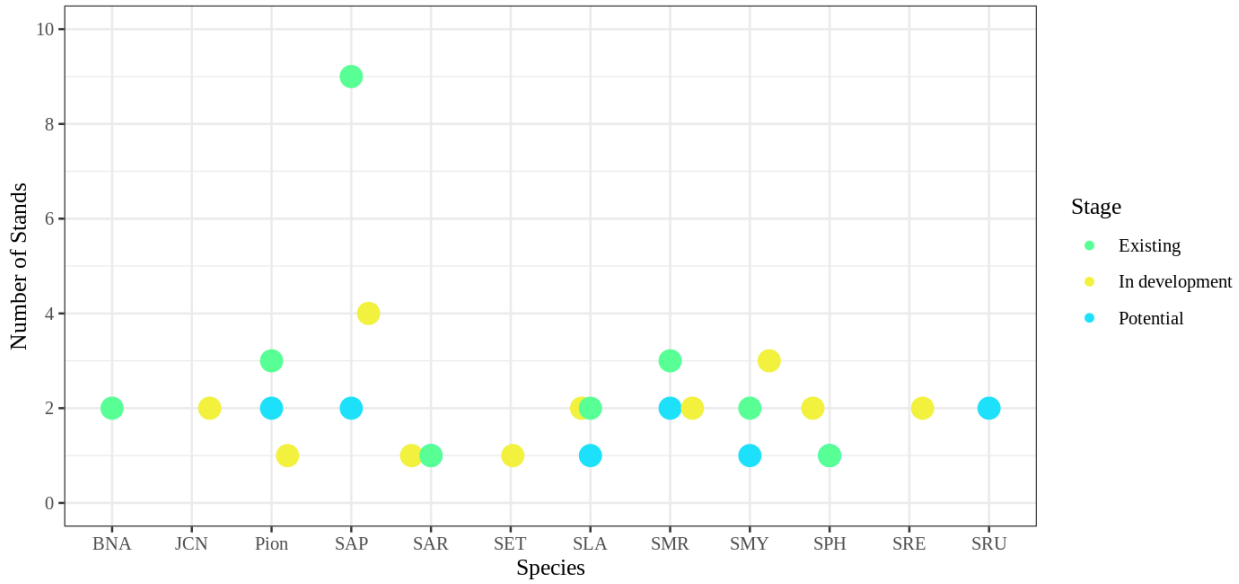


Figure 1. Number of stands (including accessible planted populations and clone banks) for each species. Existing stands (green); stands in development (yellow): potential stands (blue). BNA (*Betula nana*); JCN (*Juniperus communis* ssp. *nana*); Pion (multiple pioneer species, including *Alnus glutinosa, Betula pubescens, Salix aurita,* etc.); SAP (*Salix lapponum*); SAR (*Salix arbuscula*); SET (*Salix reticulata*); SLA (*Salix lanata*); SMR (*Salix myrsinites*); SMY (*Salix myrsinifolia*); SPH (*Salix phylicifolia*); SRE (*Salix repens*); SRU (*Sorbus rupicola*)

A database of current activity has been established by information gathering through outreach on social media, Woodland Trust Scotland website and direct contact with relevant organisations. Seed stand managers were asked to fill out an "Information Gathering Sheet" to provide details of existing stands. PDF maps and excel sheets of the database of existing, planned and potential stands can be found in **Appendix B, Appendix C** and **Appendix D**.

[9] Borrell, J. S., Zohren, J., Nichols, R. A., & Buggs, R. J. (2019). Genomic assessment of local adaptation in dwarf birch to inform assisted gene flow. *Evolutionary Applications*, 13(1), 161-175.

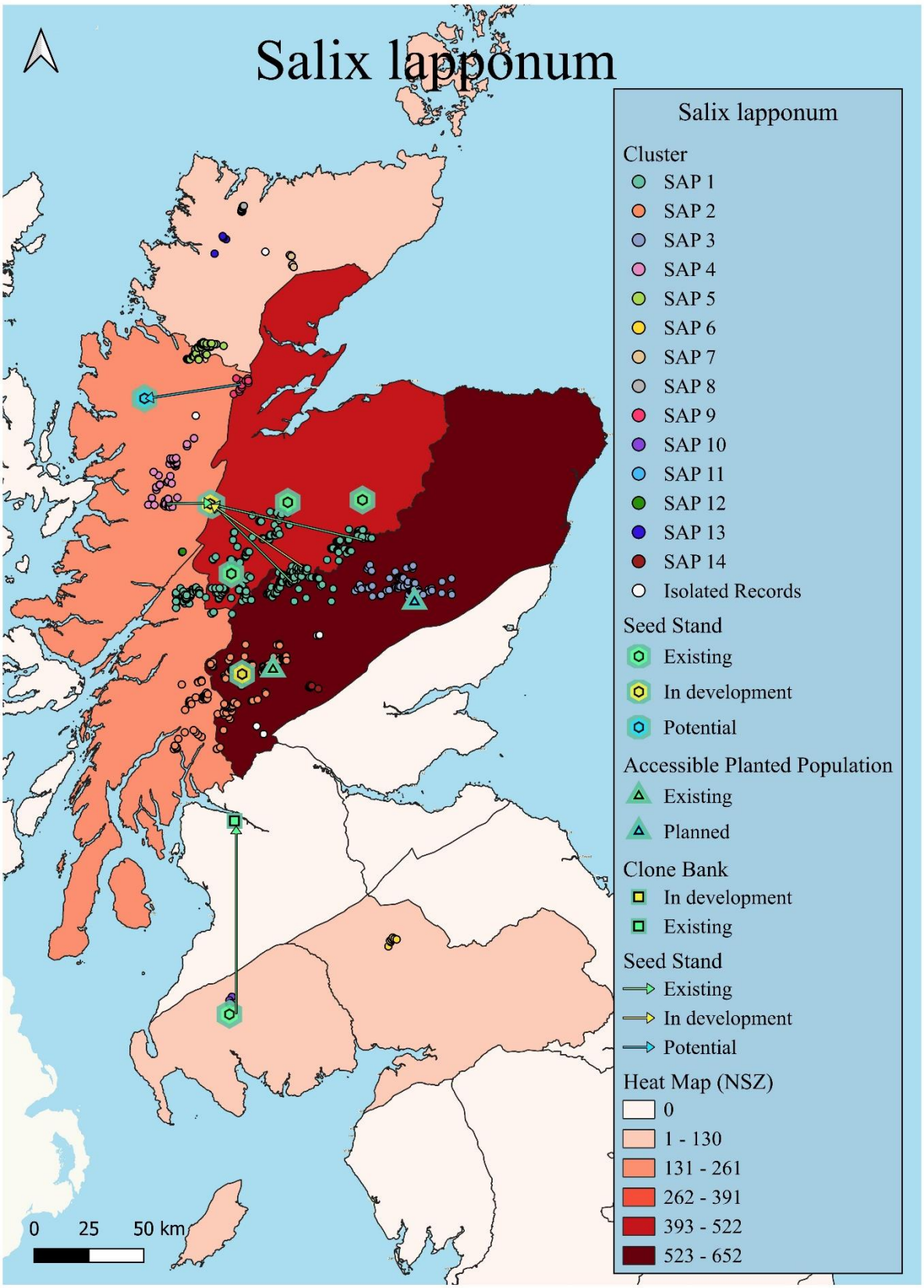


Figure 2. Relict populations (data derived from NatureScot, 2023a; Watts, 2024b) seed stands, accessible populations and clone banks of *Salix lapponum.* Relict points are coloured by localised clusters (see 3.2 Regional Divisions). Seed stands are organised by stage of development: existing (green); in development (yellow); potential (blue). Arrows demonstrate source location for seed stands where these are not located adjacent to source population cluster. Heat map shows the number of relict population records of *Salix lapponum* organised by Native Seed Zone (NSZ). Source: NatureScot (2023a). Replica maps for the other core species covered by this project are shown in Appendix B and Appendix C. [10]

[10] All maps created in QGIS. QGIS.org, %%Y. QGIS Geographic Information System. QGIS Association. http://www.qgis.org

This project has identified 17 seed stands, 3 clone banks, and 4 accessible planted populations which have been established for montane and pioneer species across Scotland by various organisations and enterprises.[11] These sources have biased characteristics, with over-representation of *Salix lapponum* populations in the central Highlands (SAP1) and under-representation of other species and provenances (Figure 1, Figure 2). This is not to suggest there are "too many" seed stands in the Central Highlands – in fact, the presence of nine stands in this area, with four more stands in development, gives an indication of the number of seed stands required to meet demand for mountain woodland restoration. It is important to note that some of these existing stands and clone banks still lack sufficient genetic diversity and should be seen as a strong basis for future work, rather than a fully established seed source for future projects.

This project has also identified 20 projects in development and 20 potential projects under evaluation, including new work by previously active organisations and others.[12] Stands in development include the first stands for *Salix arbuscula,* and *Salix reticulata* (Glen Lochay Estate). These projects will make a significant contribute to addressing gaps in supply, however, to facilitate widespread availability of montane and pioneer species further new work will be necessary.

3. A National Framework for Montane and Pioneer Seed Stands

3.1. Relevant Species

3.1.1. *Salix*

Montane Willows

Seed stands have clear potential to contribute significantly to the availability of local provenance seed from four of six montane willow species: *Salix myrsinites, Salix lapponum, Salix arbuscula,* and *Salix lanata.* Several seed stands exist for *S. lapponum* and *S. myrsinites;* stands are in development for *S. arbuscula* and *S. lanata.* Seed stands for *Salix reticulata* could also be beneficial, and this approach is currently being trialled at one site in Breadalbane. Across most of Scotland dwarf willow (*S. herbacea*) is sufficiently widespread, there is no clear need for "stands" of this species; however, there may be value in conserving material from remnants in the Southern Uplands.

Submontane Willows

The creation of seed stands for the submontane willows, *Salix myrsinifolia* and *Salix phylicifolia*, is complicated by the presence of these species at both low and high altitude. In many areas, even low-altitude seed can be difficult to obtain due to their relative scarcity. It is proposed that seed stands sourced from high-altitude should be established for these species in more continental areas such as Perthshire, the Cairngorms and the Scottish Borders - the threshold of 400m asl used in the HabMoS Mountain Woodland Remnant dataset is suitable for this purpose.[13] In northern and western areas, stands of any altitudinal origin could contribute to wider seed availability.

Other willows that can occur at high altitude

Seed stands for *Salix repens* could contribute to work both at low and high-altitude – however, the threshold of 600m employed in the HabMoS remnants dataset is likely too high for this purpose in many areas outside of the Cairngorms.[14] *S. repens* is also widespread across the country at lower altitudes[15] and may be under-recorded in the uplands.

[11] Trees for Life, National Trust for Scotland, Coignafearn Estate, Corrour Estate, Forestry and Land Scotland, Cree Valley Community Woodland Trust, RSPB, Cairngorms Connect, Scottish Wildlife Trust, Eadha Enterprises, Forestart.
[12] James Hutton Institute-Ripa Gar Foundation Partnership, Woodland Trust Scotland and crofters, Broadford Community Tree Nursery, NatureScot.
[13] NatureScot (2023a). *See Key References.*
[14] Ibid.
[15] Stroh, P. A., Walker, K. J., Humphrey, T. A., Pescott, O. L., Burkmar, R. J. (2023). Plant Atlas 2020. Mapping the distribution of the British and Irish flora (two volumes). Princeton University Press, Princeton.

Seed stands for high altitude *S. aurita* are not necessary in many areas due to the presence of sufficiently large remnant populations which can be used as wild stands, and the risk of gene flow with low altitude populations (see *Betula*); however, in areas where *S. aurita* is uncommon at all altitudes, stands may be beneficial.
Seed stands for *S. caprea* ssp *sphacelata* may also be useful, though particular care should be taken to separate individual plants from those of ssp. *caprea*. This research has found no existing stands of this taxon, which is likely to be significantly under-recorded in the wild[16].

Lowland Willows
Across mainland Scotland, there is no clear need for seed stands of common willows in the lowlands (*S. aurita, S, caprea* ssp. *caprea* and *S. cinerea)* as collection sites for these species are sufficiently abundant, even if seed is not currently available for all areas. However, seed stands for these species could be beneficial for northern and island provenances, particularly NSZ 101, 102 and 103. Local seed stands could also facilitate more widespread use of local stock in the integration of *Salix pentandra* and *Salix purpurea* into woodland creation projects.

3.1.2. *Betula*

Mountain Birch
On consideration and discussion with other mountain woodland practitioners, it has been concluded that seed stands for high-altitude populations of common tree species should not be established at low-altitude until intraspecies genetic variation is better understood. There are a number of reasons for this:

1. Gene flow between planted stands and lowland trees could result in dilution of genetic specificity.
2. Gene flow within stands could result in loss of localised genetics if some collection populations are genetically distinct from lowland populations and others are not.
3. If high-altitude populations are not genetically distinct then establishing stands is an unnecessary use of resources.

This consideration is particularly true of high-altitude *Betula pubescens* (Scottish mountain birch). It is hoped that future genetic work into mountain birch in Scotland may go some way to resolving this concern. The only locations where *B. pubescens* stands have been identified as a priority area are populations on islands – particularly in the Western Isles. However, high-altitude populations of *B. pubescens* which have been established from material collected from relict high-altitude populations (such as from seed collected through the Mountain Birch Project)[17] could offer long-term opportunities for seed collection.

Dwarf Birch
Unlike montane willows, the distribution of *Betula nana* is fairly contiguous across the areas of Scotland where it is found. The need for further seed stands in the central and northern Highlands is not as urgent as for other species, due to the presence of accessible sites where large quantities of seed can be collected from wild stands. On the other hand, where *Betula nana* is being planted, siting a population of plants of known origin in an accessible area, could facilitate easier long-term seed supply. Seed stands could conserve the genetic heritage of relict populations in the North of England; however, these populations may require “genetic rescue” through the introduction of material from larger populations, and genetic studies suggest there is limited value in introducing these genes into populations in Scotland.[18]

3.1.3. Upland Juniper

Juniperus communis populations in upland areas are notoriously difficult to collect seed from, with many isolated populations functionally extinct. It is likely that seed stands could contribute to wider availability of high-altitude provenance seed from both juniper subspecies, and conserve local adaptations, as significant genetic diversity and phenotypic variation exists across Scotland.[19] The major obstacle to seed stands for juniper is the risk of spreading *Phytophtora austrocedri* - however, so long

[16] Ibid.
[17] The Mountain Birch Project – Reforesting Scotland
[18] Borrell, J. S., Wang, N., Nichols, R. A., & Buggs, R. J. (2018). Genetic diversity maintained among fragmented populations of a tree undergoing range contraction. *Heredity*, 121(4), 304-318.
[19] Baker, J. P., Cottrell, J., Ennos, R., Perry, A., A'Hara, S., Green, S., & Cavers, S. (2024). Evidence of genetic isolation and differentiation among historically fragmented British populations of common juniper, Juniperus communis L. *bioRxiv*, 2024-09.

as stands are sited appropriately and strict biosecurity protocols are adhered to, [20,21] seed stands for both juniper subspecies could address an important gap in supply.

3.1.4. Rock Whitebeam

As with the montane willows, the distribution of rock whitebeam (*Sorbus rupicola*) is scattered across Scotland and currently the ability to access sufficient seed is a major restriction on the use of this species in woodland restoration projects. However, the creation of *Sorbus rupicola* stands present some difficulties: trees are often isolated, seed is irregularly produced, and only small quantities can be collected. On the other hand, the apomictic nature of this species means that fewer individuals would be required for seed stand creation. Experimental approaches such as grafting may also provide a route to collecting material from trees which seldom set seed. Therefore, it is proposed that seed stands of *Sorbus rupicola* could make an important contribution to the future of this species in Scotland. Priority areas and potential partners for these stands are shown in Table 1.

3.2. Regional Divisions for the Creation of Montane Seed Stands

The local specificity of forest reproductive material collected in Scotland is typically ensured by classification according to native seed zones (NSZ) of which thirteen are found in Scotland.[22] However, the native seed zones were designed for forestry purposes and are therefore adapted to widespread trees with resilient populations - they are less well-suited to understanding the need for local provenance seed from rarer, montane species. In addition to other critiques of the NSZ system,[23] this research has identified three issues with the application of the native seed zones to montane species:

1. By definition, montane species are more commonly found at higher altitudes. Therefore, they are more often found close to the boundaries of provenance zones, where these are found at higher altitude, for example along ridgelines. Mountains are not the barrier to the dispersal of montane species, but their optimal habitat.
2. Isolated local populations may be genetically distinct as gene flow is more restricted.
3. For some species, such as *S. lanata* and *S. reticulata*, the majority of individuals are confined to a single provenance zone (in the case of both these species, NSZ 202). Establishing a single stand of even 50 individuals from this zone would still lead to a dramatic loss of genetic diversity if this were the main source for all planting projects within NSZ 202.

As recognised by the authors of the report setting out the FRM native seed zones, a superior solution would be genetic or chemical analysis to identify related groups, as occurred with *Pinus sylvestris* and led to the longstanding and widely adopted “pine zone” framework. Future research into high-altitude *Betula pubescens* may be able to facilitate a similar framework for mountain birch. Projects in the Cairngorms have already contributed important insights into the genetics of montane willows.[24] [25] However, genetic research is costly and time-consuming and in the short-term will be difficult to complete for many populations of most species. Therefore, another approach is required to strike a balance between conservation of genetic specificity and the division of populations into meaningful groups which enable the widespread collection of local seed.

The approach set out here employs a species-specific clustering methodology devised from nationwide data of remnant populations.[26] Clustering was carried out using Density-Based Spatial Clustering of Applications with Noise (DBSCAN) which allows for the creation of clusters of varying shapes and sizes and does not require the specification of *n* clusters in advance.[27] The approach taken for each species is summarized in **Appendix A**, and the resulting clusters are mapped in **Appendix B** and pioneer species by native seed zones in **Appendix C.** These outputs are referred to throughout the report as a reference for identifying montane willow populations and to guide a framework of seed stand creation; however, it should be

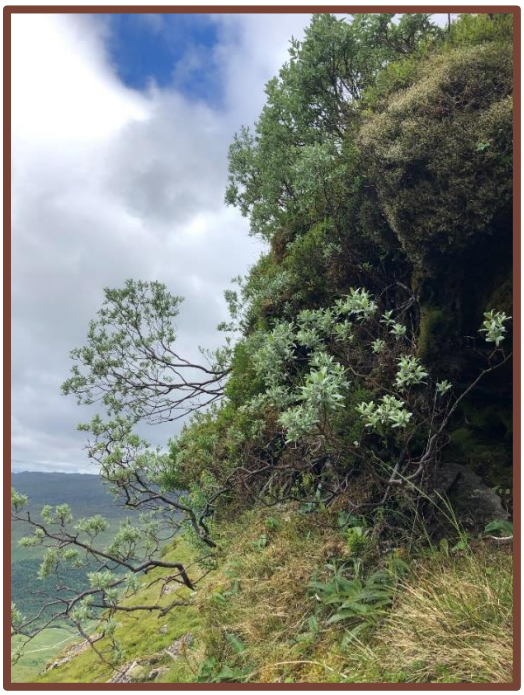
[20] Forest Research (2022a). See *Key References.*
[21] Forest Research (2022b). *See Key References*
[22] Herbert et al. (1999). *See Key References.*
[23] Whittet et al. (2015). *See Key References.*
[24] Finger et al., (2023). *See Key References*.
[25] Stamati K, Hollingsworth P.M., and Russell J. (2007). Patterns of clonal diversity in three species of sub-arctic willow (*Salix lanata, Salix lapponum, Salix herbacea*) *Plant Syst. Evol.* 269 75–88
[26] NatureScot (2023a). *See Key References*.
[27] Ester, M., Kriegel, H. P., Sander, J., & Xu, X. (1996). A density-based algorithm for discovering clusters in large spatial databases with noise. In *Data Clustering: Algorithms and Applications* (Vol. 96, No. 34, pp. 226-231).

recognised that in some instances, aggregation or further subdivision of these clusters may be necessary in the creation and use of local seed stands.

3.2.1. Planting Within Designated Sites

The proposed network of seed stands has been designed primarily for the purposes of woodland creation and mountain woodland restoration outside of designated sites. It is hoped the framework will facilitate the wider use of more local provenance seed than is often currently employed and will make mountain woodland restoration possible at a larger number of sites. In the context of planting within a site designated for Sub-arctic *Salix* spp. scrub (H4080), the best approach may be to establish a stand from site-specific material, unless a clear case can be made that either:

1. There is a lack of genetic diversity in the remnant population OR
2. Insufficient numbers of the remnant population are reproducing OR
3. The origin plants within the seed stand are sufficiently local (10km may be used as a reference distance although this is somewhat arbitrary - climatic and geological similarity should also be considered).



Right: H4080 Sub-arctic *Salix* spp. habitat, just outside Beinn Heasgarnich SSSI. The dominant species here is *Salix lapponum*.

4. Priorities for Seed Stand Creation

4.1. Priority Species

Salix arbuscula

Despite being a nationally scarce species, this project has not identified any existing stands for *Salix arbuscula*, only an accessible population at Ben Lawers NNR. However, the James Hutton Institute - Ripa Gar partnership is currently developing a stand at Glen Lochay Estate. Further stands should be established, particularly for clusters SRB2 and SRB3.

Salix lanata

Although *Salix lanata* is a nationally rare and vulnerable species, the conservation of which has involved large collaborative projects,[28] this project has identified no existing seed stands for this species. This may be due in part to the limited number of suitable planting locations as a result of its highly calcareous soil preferences – however, Trees for Life are currently establishing a stand near Dundreggan. A stand for Caenlochan populations (SLA1) and the Breadalbane area (SLA2) (perhaps building on the existing clone bank), could facilitate planting at appropriate sites. Although the *S. lanata* population at Geal Charn in SLA3 is currently the largest in Scotland with over 1000 plants, this site is notable due to its especially high-altitude location and morphology of particularly low-growing individuals. The population is becoming increasingly threatened by the interacting pressures of climate change and land management, including reduced snow-lie and disturbance by large herbivores[29]. Collecting material for a stand from this vulnerable population would help to preserve local genetic diversity before further losses are incurred.

Salix lapponum

Salix lapponum is by far the best represented species in existing stands (*Figure 1*, *Figure 2*). However, stands for populations in the Northern Highlands (SAP5, SAP7, SAP8, SAP9, SAP13) and Scottish Borders (SAP6) should be a high priority for future work.

Salix myrsinifolia

[28] Marriott RW., McHaffie H, Mardon DK. (2015). Woolly willow. Version 1.0. In *The Species Action Framework Handbook, Gaywood MJ, Boon PJ, Thompson DBA, Strachan IM (eds).* Scottish Natural Heritage, Battleby, Perth.
[29] Watts (2024). *See Key References*.

There are no existing stands for *Salix myrsinifolia*, however, the James Hutton Institute-Ripa Gar foundation is currently developing a stand from high-altitude populations at Glen Lochay Estate (SMY1h), and Forestry and Land Scotland intend to plant populations in accessible locations in Glen Prosen (SMY2h). Eadha Enterprises are gathering a clone bank of high-altitude relicts in the South of Scotland (SMY4h). An accessible planted population is also located on Ben Lawers NNR.

Salix myrsinites
Stands for *Salix myrsinites* populations in Lochaber (SMR2), Breadalbane (SMR3), Caenlochan (SMR5), Assynt (SMR6) and hyperoceanic remnants in NSZ 105 should be a priority for restoration work.

Salix phylicifolia
Only one existing stand has been identified for *Salix phylicifolia* – this is a small population at Coignafearn Estate which would require additional material if being used as a source for future restoration. However, the Little Assynt Tree Nursery are developing a stand for NSZ 102. The low calcareous requirements of this species mean new stands for high-altitude populations of this species could contribute to restoration in many areas. Seed collection direct from wild stands may also be suitable from some larger local populations, such as Corrour (SPH2) and Mar Lodge Estate (SPH1).

Salix reticulata
There are no existing seed stands for *Salix reticulata*, and the authors are unaware of any successful attempts to plant this species in mountain woodland restoration. The James Hutton Institute - Ripa Gar partnership is currently developing a stand at Glen Lochay Estate (SET1). If this work is successful, clusters SET2 and SET4 should also be a priority.

Sorbus rupicola
Seed stands for *Sorbus rupicola* in the Western Highlands or in the Cairngorms could make a large difference to the availability of this species. The difficulties of creating stands for *Sorbus rupicola* means that native seed zones may be sufficiently local, and in the case of NSZ 104 and 105, exchange of material between seed zones may be beneficial.

4.2. Priority Areas

4.2.1. Northern Highlands

Mountain woodland restoration in the Northern Highlands has been comparatively neglected: of 128 mountain woodland restoration sites across Scotland, only two are north of Inverness (both very small exclosures).[30] However, both significant refugia populations and suitable habitat are present, and the area may have greater potential for long-term resilience to climate change. A number of the priority stands identified in Table 1. are located in the Northern Highlands, e.g. SET4, SAP7. Seed stands could also contribute to wider availability of lowland species such as *Salix caprea*, for which the Little Assynt Tree Nursery is already establishing a stand.

4.2.2. Island Provenances

The Western Isles (na h'Eilean Siar) have been identified as a priority area for seed stand creation, including for species where seed supply is unproblematic elsewhere such as *B. pubescens*, *S. cinerea* and a range of non-pioneer species. This work is already being progressed by the Woodland Trust Western Isles team in partnership with local crofters and community groups.

The Northern Isles
Genetic work on Shetland led by Shetland Amenity Trust has already investigated the genetic diversity of relict *Salix* populations. Unfortunately, the "*Salix lapponum"* population on Shetland has been identified as a single *Salix lapponum* x *aurita* clone, and therefore it will not be possible to meaningfully conserve local populations of this species. However, stands of *S. aurita*, *S. repens* and *S. cinerea* could be pursued to conserve the genetic heritage of Shetland's few indigenous trees and facilitate their widespread integration into planting on the archipelago.

Discussions with Woodland Trust Scotland partners in Orkney, suggest sufficient seed can already be collected from remnant populations. However, this project has not been able to ascertain the size and origin of *Salix myrsinites* populations in Orkney (SMR11), which if indigenous would be a priority for conservation.

[30] NatureScot (2023b). *See Key References*.

4.2.3. South of Scotland

Mountain woodland restoration in the South of Scotland has already occurred on a significant scale with organisations such as Borders Forest Trust, Cree Valley CWT (now Cree Valley volunteers), and Forestry and Land Scotland carrying out significant restoration projects. These organisations, along with Eadha Enterprises, are continuing to maximise the use of local material where possible. However, there is also an awareness that sufficient genetic diversity may not be present for all species: BFT have planted *Salix lapponum* and *Betula nana* from material derived from the Highlands.

Appendix D – Database of Seed Stands categorises the priority of stands for each species by cluster or native seed zones.

5. Project Progression

This scoping project has found that seed stands have the potential to substantially improve the availability of local provenance seed for montane and pioneer species across Scotland. Work in this area is gathering momentum as a number of organisations are currently establishing stands, with ongoing work including the first *Salix arbuscula, Salix lanata, Salix myrsinifolia, Salix reticulata* and *Sorbus rupicola* seed stands in Scotland.

However, most seed stand creation continues to be focussed in a relatively narrow band across the Central Highlands, and restoration work in Southern and Northern Scotland remains largely dependent on these sources of seed. We recommend the development and progression of this work by Woodland Trust Scotland, particularly through ongoing work in the Western Isles, Assynt and Gleann Shildeag. However, in many areas it will only be possible to address seed supply through collaboration with multiple organisations.

Ten recommendations are proposed:

1. **Progression of stand creation on Woodland Trust Scotland & partners land.** New best practice guidance for seed stand creation and maintenance has been created (**Appendix E**).

2. **Improve recording and documentation of wild populations of priority species on Woodland Trust Scotland landholdings and** (where suitable) **register wild source-identified stands** on the National Inventory of Basic Material.

3. **Continue to update existing stands in seed stand database (Appendix D – Sheet 2).**

4. Where possible, **use only indigenous local seed of known origin and sufficient genetic diversity in woodland creation projects so that these sources can be used as future collection sites.** This recommendation is almost always undertaken in specialist montane willow restoration work; however, such action will also be important for some more common species including *Juniperus communis*, *Salix pentandra, Salix myrsinifolia* and *Salix phylicifolia*. In some areas, woodlands can be designed to maximise production and accessibility of seed.

5. **Provide support and material to other projects carrying out specialist work** – for example, Shetland Amenity Trust and Broadford Community Tree Nursery.

6. **Encourage collaboration and exchange of local material:**
    a. **Expansion of existing stands** where these lack sufficient genetic diversity**.**
    b. **Development and use of new stands**, including building from existing clone banks where possible.

7. **Promote the use and development of seed stands as part of landscape-scale and regional nature restoration partnerships** involving multiple landholdings.

8. **Explore the potential for further projects to contribute to the long-term availability of non-pioneer species,** such as *Acer campestre* and *Taxus baccata.* **See Appendix D – Sheet 5.**

9. **Support further research** into the evolutionary relationships, genetic diversity, and adaptive potential of montane and pioneer tree species in Scotland.

10. Consider the potential for **a part-time project officer** to lead on Woodland Trust Scotland's approach to delivering the nine recommendations above.

The required funding for most of this work (recommendations 1-6) is modest compared to the cost of many other aspects of nature restoration; however, obtaining funding for some work may be necessary, especially where projects are being led by community organisations rather than large conservation bodies.

Funding for stand creation is perhaps best secured through including seed stand creation in plans for larger projects such as those funded by the Nature Restoration Fund, and/or as part of regional nature restoration partnerships (e.g. Cairngorms Connect and Loch Abar Mòr). Another potential approach would be to draw together stand creation for multiple species and clusters for work in neglected areas and then seek grant funding for these projects. Two potential projects are proposed below.

Potential Project 1. Northern Highlands Collaborative Seed Stand Creation

This project has identified the Northern Highlands as the area where seed stands could have the greatest impact on seed availability for mountain woodland restoration. Key clusters include: SAP5, SAP8, SAP9, SAP13, SMR6, SPH6h, SPH102, SET4, JCN102. Relevant organisations include: Woodland Trust Scotland, John Muir Trust, Scottish Wildlife Trust, NatureScot, Kyle of Sutherland Rivers Trust, Scotland the Big Picture, as well as community organisations and numerous private estates.

A collaborative project could facilitate widespread restoration across the Northern Highlands, potentially through small grant funding for surveys of remnant populations and collections. e.g. Highlands and Islands Environment Fund.

Potential Project 2. Rock Whitebeam Stands

Establishing stands for the Western Highlands (SRU102, SRU104, SRU105, SRU106) and the Cairngorms (SRU202) could have a major impact on the availability of this nationally scarce species. This project could potentially be funded through collaborative work with tree nurseries and woodland consultancies, a number of interested parties having been identified through this work.

6. Key References

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7. Appendices

Appendix A. Local Clustering Methodology

Appendix B. Maps of Clusters and Seed Stands for Montane Species

Appendix C. Maps of Pioneer Species by FRM Native Seed Zone

Appendix D. Seed Stand Database

Appendix E. Best Practice Guidance for Seed Stand Creation and Maintenance