

Habitat Assessment for Proposed Black Hills  
Regeneration Project:

Linking deer fences to enable deer density  
and impact reductions for landscape scale  
nature restoration.

KNOYDART FOUNDATION AND ASSOCIATED  
PRIVATELY OWNED GROUND

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## 1. INTRODUCTION

Alongside ongoing woodland re-establishment projects on the Knoydart Peninsula, the Knoydart Foundation are proposing the completion of a strategic deer fence across the western range of the peninsula. The proposed fence would connect existing fenced and planted areas to create a continuous deer-proof boundary from Inverguseran to Inverie (c. 30km<sup>2</sup>). The plan within the project area is then to reduce and maintain deer numbers at very low levels to the west of the fenceline to facilitate the natural and active restoration of the full range of coastal and upland habitats. The current pattern of landuse includes four coastal crofts with sheep grazing (one of which grazes cattle), and smallholdings with agricultural and land regeneration aspirations. These account for c. 300ha with minimal sheep grazing outwith fenced parks or of the moorland above the 150 to 250m contour. The landuse mix includes significant recent (<25yr old) areas of woodland.

This report is a compilation of existing and new habitat information to provide a complete, baseline assessment of the relative importance of habitats within the proposed fenced area and of how they will be affected by the proposed reduction in herbivore impacts.

Existing information includes data from a previous Phase 1 survey (Bob Black 2000), an assessment of the condition of open and afforested peatlands (Colin Wells 2018), NVC survey and the current ground truthing of existing survey information (Dayton 2022, this report). The scope of this survey and assessment is limited to botanical aspects and the other key wildlife are not covered.

### Rationale

We know from historical records that Knoydart was previously more heavily forested and that native woods have declined or disappeared in the past as a result of livestock farming and felling for industry and charcoal.

However, upland woodlands can:

- store carbon – in the trees, in timber products, in peat and in the soil
- enhance the aesthetic quality of a diverse landscape
- protect soil from being eroded by rainfall into watercourses
- reduce the risk or impact of floods by slowing surface water run-off
- support biodiversity

The proliferation of woodland in upland areas can cause concerns, for example the planting of non-native conifers, such as Sitka spruce and lodgepole pine, across the blanket bogs of the Flow Country in the 1980s caused the degradation of large areas of peatland in the Flow Country, some of which are now under restoration. The present-day policy in Scotland and the UK is to accelerate afforestation of the wider landscape with native woodland, productive broadleaves and commercial conifers in appropriate locations (Scottish Forestry).

These appropriate locations include farmland and moorland/upland open habitats where key carbon storage/sequestration and biodiversity features are not compromised. These constraints on open ground include:

- the botanical importance of internationally recognised upland habitats such as heather moorland, flushes and bogs, plus their associated bird and other wildlife
- the landscape value of Scotland's upland moorland, which includes the evolution towards natural treelines or scrub.

- coexistence with and adaptation of other management objectives – e.g. sporting (grouse & deer) and livestock management to meet the restoration objectives.

As part of landscape scale ecosystem restoration new woodland regeneration or planting should therefore consider habitat and landscape, be of an appropriate scale and fit with a wide range of interests and needs (Jepson & Blythe 2020).

## 2. DESK STUDY

Data from the existing survey information was gathered and pertinent information collated within a single GIS format. The areas highlighted for new or refreshed botanical surveys included:

- Privately owned areas, as yet not surveyed.
- Habitats sensitive to changes in herbivore management.
- The identification of habitats unsuitable for woodland creation such as deep peat or montane areas.
- Areas & routes for ground truthing existing data sets and future monitoring priorities.

### 2.1 Areas as yet not surveyed

Habitat survey to Phase One level (Black 2000) was carried out on the Knoydart Foundation lands. However, there are seven private landownerships within the area proposed for exclusion, as well as the recently acquired KF Millburn property, and these have had limited habitat information collected. This project aims to complete habitat surveys for the remainder of the unsurveyed ground within the proposed fenceline (where landowner consent allowed\*). Areas selected for survey as part of this project included:

- Inverguseran farm – all areas to the west of the Guserein River
- Sandaig & Torr na h'Innse
- Torr Mor/Reidh an Daraich
- Glaschoille House
- Scottas
- Millburn to Beinn Bhreac

Some of the privately owned land at Aior\* (c. 430ha) has not been included in this survey<sup>1</sup>.

Refer to Fig 1.

### 2.2 Baseline habitats sensitive to changes in herbivore management

The habitats within the Knoydart peninsula comprise a suite of hyperoceanic upland vegetation communities typical of the Scottish West Coast (see Maps 2a & 2b) and Appendix 1. The soil is predominantly acidic with abundant peat over impervious metamorphic and igneous rocks (Lower Morar Psammite Formation & Lewisian Complex). There are relatively few basalt and microgabbro dykes which raise the pH and add a variety of minerals to surrounding soils. The area proposed for deer exclusion extends from sea level to just over 400m at Roinne na Beinn which is dominated by wet and dry heath vegetation and blanket bog with associated grassland and flush habitats.

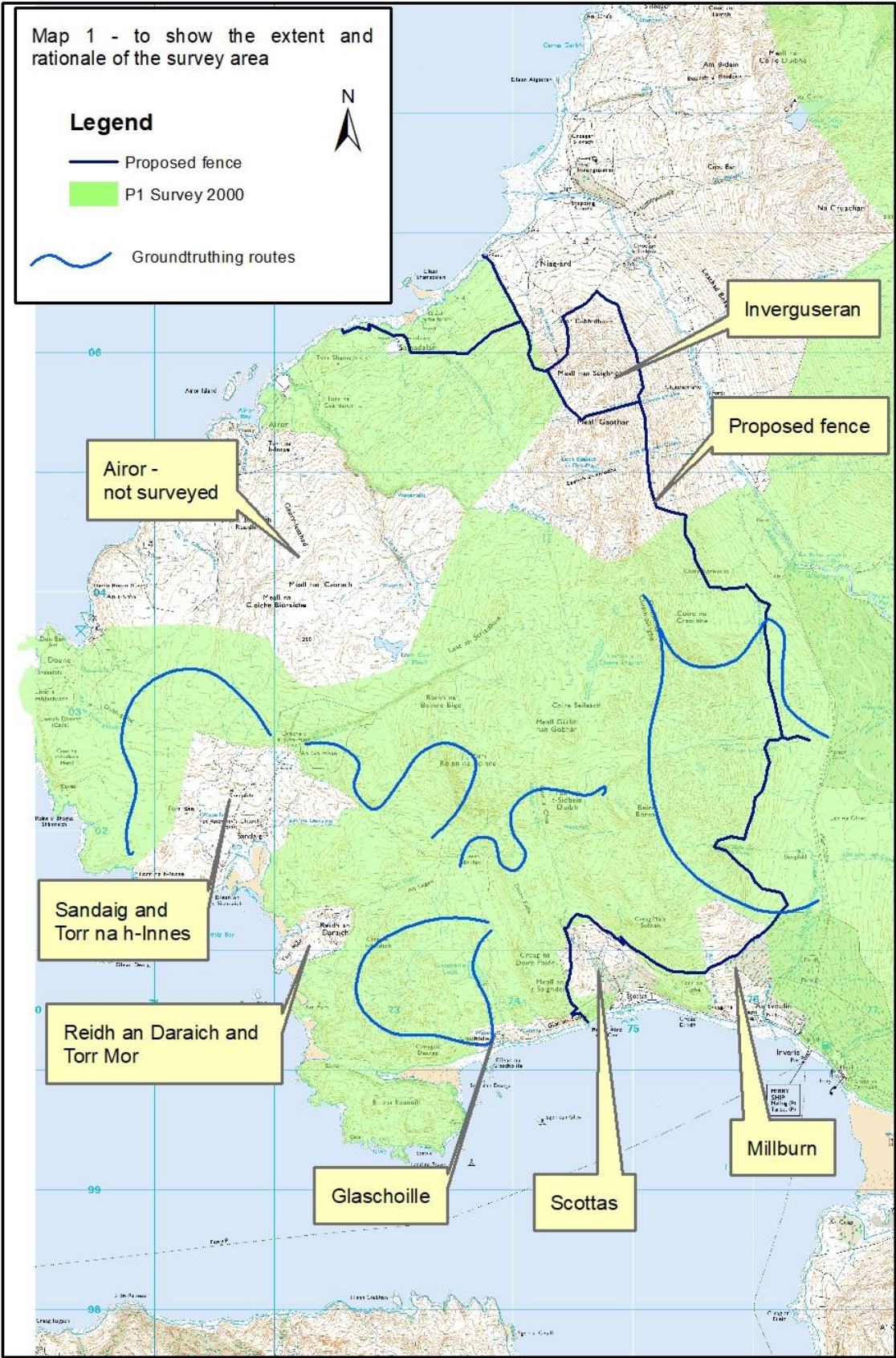
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<sup>1</sup> Aior is therefore not included in subsequent constraints maps. (i.e. blank features here do not mean it lacks key features and is unconstrained).

**Woodland:** There are existing wooded areas throughout the peninsula. The largest wooded areas are around Inverie, Scottas and Airor. These are mainly planted woods, with some stands of mixed conifers, Scots pine and planted broadleaves such as lime, beech and sycamore. Stands have been fenced and planted with native broadleaves along Glen Guseran, at Airor and Sandaig. There are native broadleaves such as alder, birch, rowan, aspen and oak as bands of woodland running along small burn ravines and around the coastal fringe.

There are also frequent scattered trees throughout the peninsula, on the heath covered banks of burns, around the crags on Roinn na Beinne and other hills, such as Coire na Craoibhe. These include stands of the riparian woodland (W7 *Alnus glutinosa-Fraxinus excelsior* woodland), more upland types (W11 & W17 *Quercus petraea-Betula pubescens* woods) and *Ulex* scrub (W23).

Browsing on sapling trees by deer (and/or sheep) is a strong limiting factor in the regeneration of woodland in the uplands and saplings accessible to browsing will show signs of persistent off-take, with clipped growth forms common. Seedling trees present in late summer are generally completely removed by mid or late winter. As throughout the Highlands most trees outside fenced areas within the Knoydart survey area are restricted to inaccessible locations such as crags and riverbanks. The incidence of native trees within the uplands across the Knoydart peninsula is relatively high and this survey highlighted signs of natural regeneration. Hence there is a significant local seed source that would proliferate with reduced deer numbers.



## Heath

Wet dwarf-shrub heaths, in which species such as *Calluna vulgaris*, *Erica tetralix* and *Tricophorum cespitosum* are frequent, form the dominant habitat type over most of the peninsula, mainly on a peat-based substrate 10-50cm deep. Within this habitat, drier heaths dominated by *C. vulgaris* with *Erica cinerea*, are common over steep hillsides, crags and rocky summits with a mineral soil. *C. vulgaris* and *E. cinerea* are relatively palatable year-round and *T. cespitosum* is an important spring forage. Within this habitat sapling trees are rare, but it is notable that, where stands have already been deer-fenced there is quite rapid regeneration of trees such as birch *Betula pubescens*, rowan *Sorbus aucuparia* and alder *Alnus glutinosa*. Outside of bog or on exposed ground above the tree-line it is expected that there will be the replacement of heathland by woodland (in some sectors gradually) across this part of the Knoydart peninsula with reduced browsing pressure.

## Blanket bog

The survey area includes abundant pockets and larger extents of blanket bog. This habitat occurs on deep peat which can be from 50cm to several metres deep. The peat depth survey carried out by Wells 2020 found peat near to Sandaig and Doune over 5m deep. Blanket bog is a nationally and internationally important habitat type (EU 7130 Blanket bog) and should be preserved wherever possible.

Browsing on heather and other woody species is typically lower on blanket bog than drier heath but, even where browsing is low, trampling impacts can be high on blanket bog where deer pass through to access more palatable browse. Trampling impacts tend to cause the disruption and loss of Sphagnum species and to the spread of cotton grass and an increase in associated bare peat areas. As has been demonstrated elsewhere in the Western Highlands a reduction in herbivore pressure will halt these impacts to the mire habitats often with rapid recovery.

## Flushes

Flushes can experience locally higher grazing and trampling pressures than their surroundings and this is evident within the Knoydart survey area. Their openness makes them easy access routes within taller heather moorland and they often support a local frequency of palatable sedges and grasses. They also support a diversity of less common species such as *Saxifraga aizoides* and *Carex dioica* plus more diverse bryophyte communities. These alkaline flush habitats are of National priority and are listed as Annex 1 habitats in the EU Habitats Directive (7230).

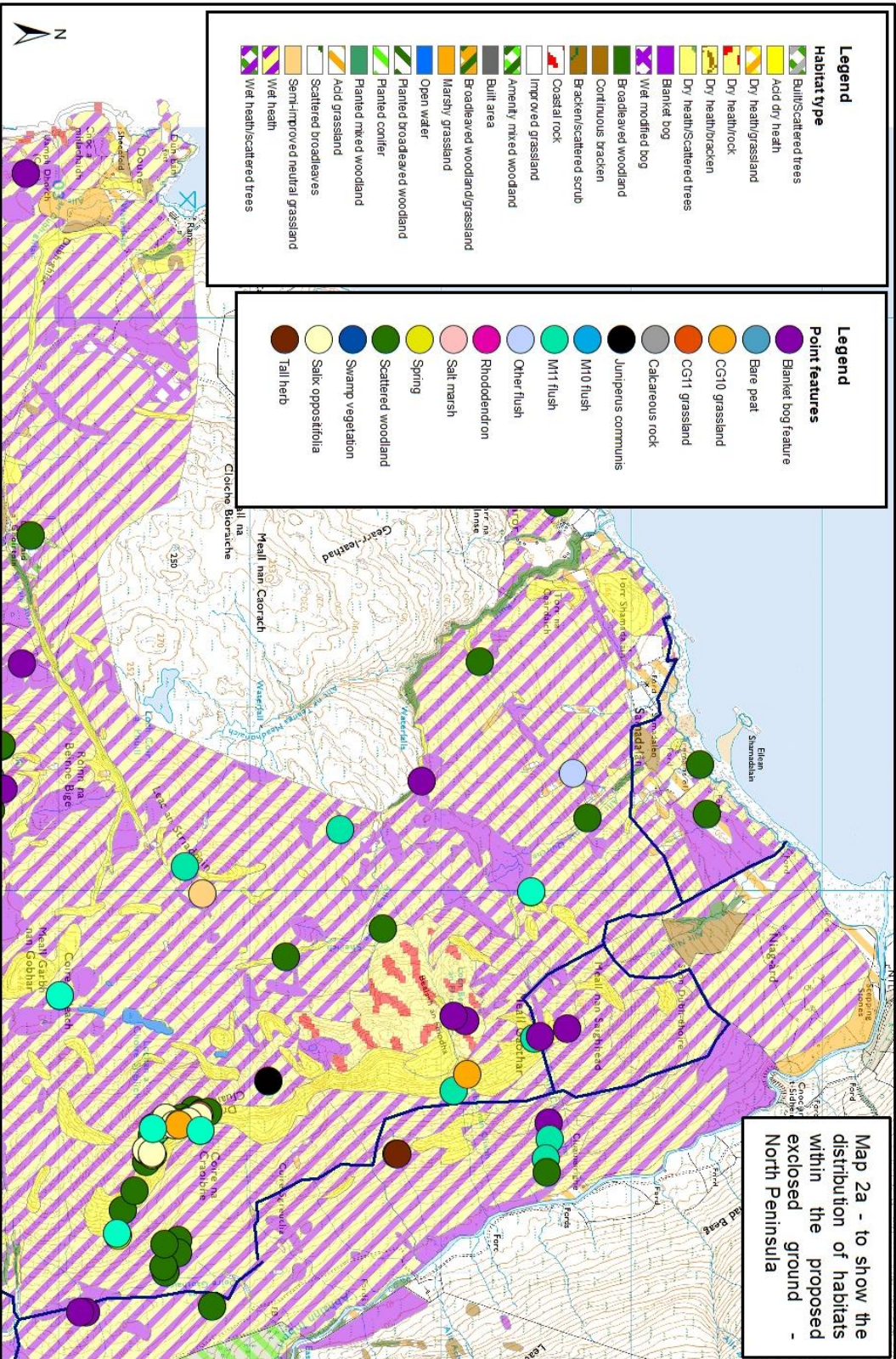
These flushes can be all but destroyed by heavy trampling and grazing impacts but, where still in reasonable condition, can recover rapidly with a reduction in herbivore pressure (Dayton 2014 HIA Meall na Samnha & Beinn Heasgarnich). They are also susceptible to changes in composition when there is a reduction in grazing pressure. The typical, low-growing species of these habitats can be over-shaded by surrounding dwarf-shrubs and grasses and/or outcompeted by taller herbs, giving rise to an expansion in tall-herb habitats such as U15 or U17 (Dayton 2014 HIA Ben Lawers).

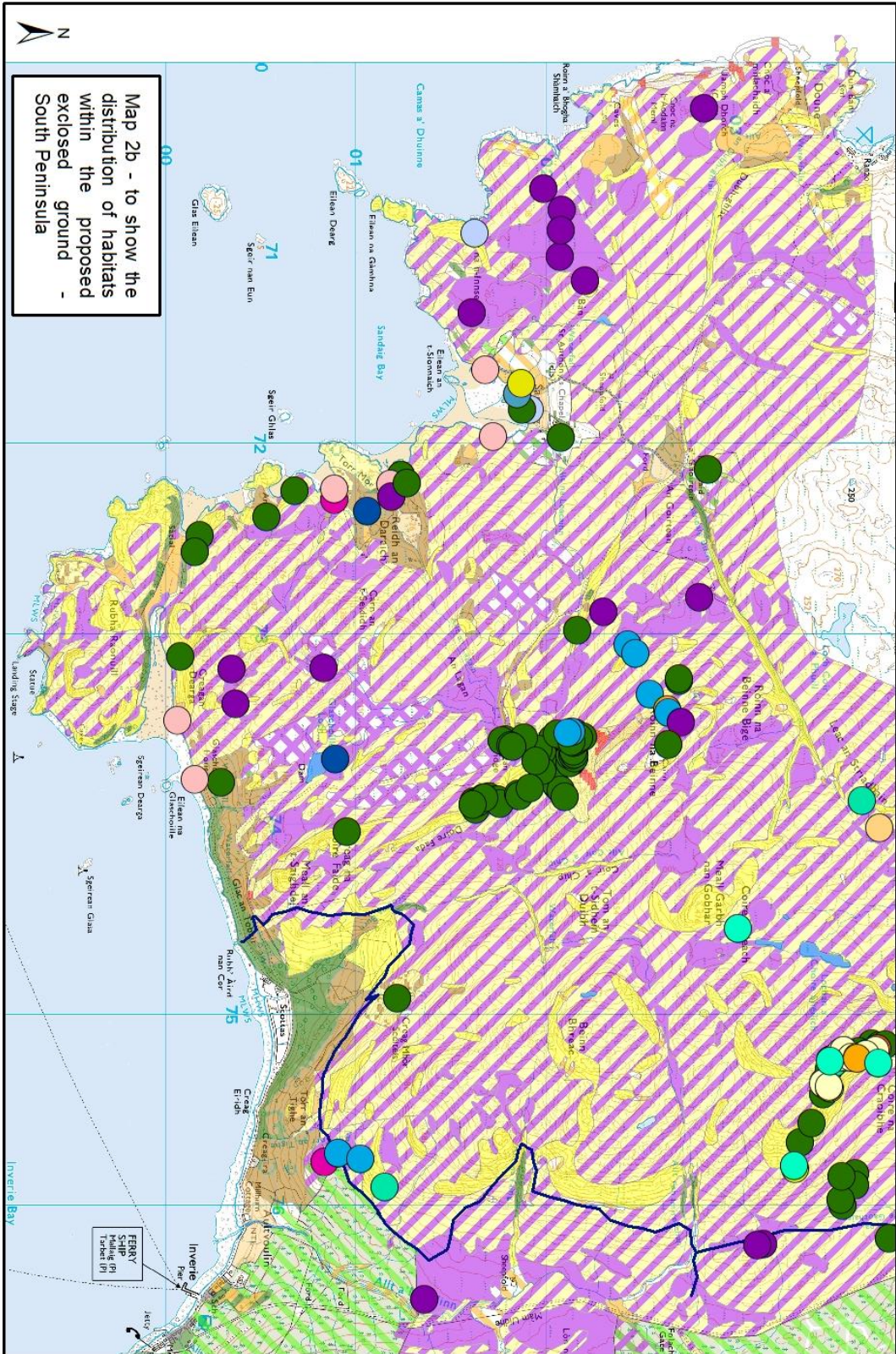
## Grassland

The grasslands across the Knoydart hills are predominantly fescue dominated acid grasslands (U4) which support a range of palatable and less palatable species and on the higher slopes, mat grass dominated grassland U5. This habitat is dominated by *Nardus stricta*, which is quite unpalatable for most of the year. There are scattered pockets of more

calcareous grassland (CG10 & CG11) in which low-growing species such *Thymus polytrichus*, *Alchemilla alpina* and *Campanula rotundifolia* are frequent and these tend to be preferentially grazed where they occur due to their high palatability. These are effectively point locations in Figures 2a and 2b and vary in size from a few square metres to c. 0.2ha.

A reduction in grazing pressure is known to have a greater impact on grasslands in which palatable species are most prolific. Calcareous grassland is particularly susceptible to a reduction in the frequency of its typical low growing species under low/no grazing pressure as these are out competed by taller grasses.





## **2.3 Constraints to woodland creation**

### **Deep Peat**

Although very wet bog will restrict the growth of most tree species, the growth of even stunted trees on deep peatland tends to dry out the peat, allowing it to oxidise and therefore stimulating peat loss. As peatland is an important planetary carbon store, the destruction of peat is now prevented wherever possible. FCS guidelines restrict new, grant-funded planting on peat deeper than 50cm.

As highlighted above, blanket bog is a nationally and internationally protected habitat.

As a general rule, blanket bog type vegetation is found on peat with a depth of greater than 50cm. The peat depth survey carried out in 2020 by Wells *et al* (areas highlighted on fig 3) shows stands of peat with a depth of greater than 5m.

By combining the results of the peat depth survey and the current NVC/P1 survey data for blanket bog distribution at Knoydart, Figure 4 highlights those peatland areas where woodlands (planted or naturally regenerating) are not recommended.

### **Calcareous flush and grassland habitats**

Flush and spring habitats are all typically low growing and directly sensitive to trampling impacts which can disrupt sensitive moss mats and uproot small, procumbent species with delicate rooting systems. They also provide loci for many the less common species found within the uplands.

Woodland creates heavy shading and this impacts on these habitats leading to changes in their species composition and structure. It would be expected that many of the mosses, smaller, low growing and scrambling species typical of these habitats would be out-competed in a transition to scrub or eventually closed canopy woodland. However, it is also clear that ancient native woodland mosaics include nutrient rich springs and flushes of similar plant assemblages.

### **Higher altitude habitats**

The area of search includes habitat from coastal saltmarsh and cliffs to the tops of a range of hills to about 450m on Roinn na Beinne.

Trees are unlikely to grow well in exposed locations and there is likely to be a natural 'tree-line' especially to the prevailing west or south-westerly slopes and summits, where a natural transition from woodland to dwarf shrub heath would be expected. It is policy from Scottish Forestry that afforestation of skyline within upland landscapes is not encouraged.. The existing forestry within this sector of the Knoydart peninsula also all lies below 300m asl, though remnant individual native trees do survive within niches on these hill tops.

Natural regeneration of native species will occur where environmental conditions allow and this should be accepted as part of the project (refer 3<sup>rd</sup> paragraph 3.1 below).

## **2.4 Areas and routes for ground truthing**

As a result of the above considerations, the following areas were selected for ground truthing of existing Phase One survey information (Black 2000) (Map 1).

- An Goirtean to Roinn na Beinn – including Roinn na Beinn Bige and Meall Garbh nan Gobhar. Upland habitat rising to the highest point on Roinn na Beinn and including areas of base-rich flushing (M10) previously identified.

- Beinn Bhreac to Coire na Craoibh – exposed summit communities along the top of the crags.
- Coire na Craoibh - steep, east-facing crags supporting tall herb ledge and other calcareous communities.
- Tom an t-Sidhein Dubh and Bheinn Breac, suite of typical upland habitats.
- An Goirtean to Doune – lower lying sub-montane habitats and coastal rock and cliff.
- Glaschoille Loch to Cable Bay, upland and coastal habitats

### 3. RESULTS

#### 3.1 Existing Woodland

Map 3 shows the location and extent of existing wooded areas within the proposed fenced area, including planted and native stands, conifer, mixed and broadleaved trees.

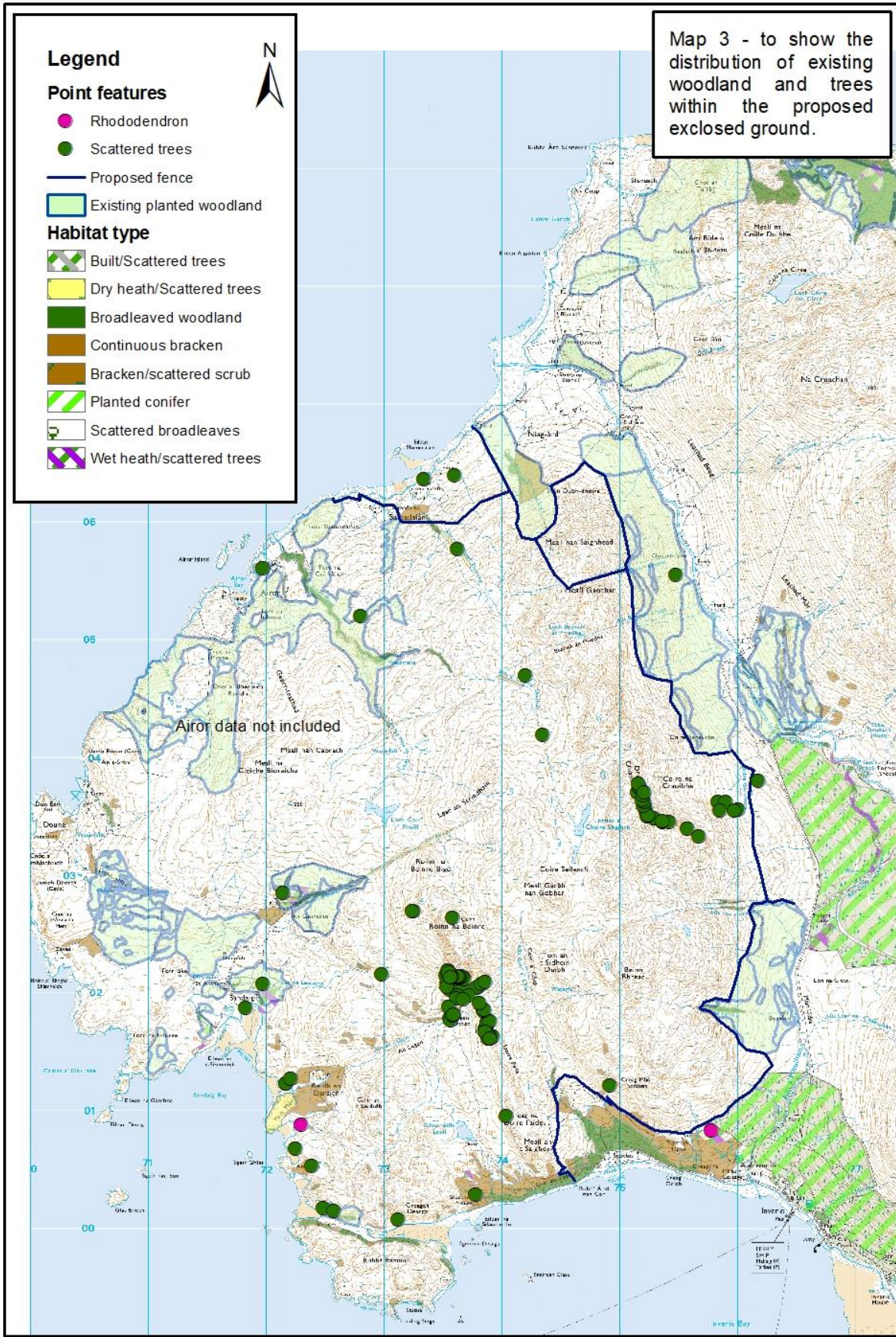
The main areas of native broadleaved woodland are: a narrow strip along the Airor Burn, a broader band of coastal woodland between Glaschoille and Creag Ira and a strip along the crags to the north of Rubha Raonuill. All of these are well established and listed as Ancient/Semi-natural in the Ancient Woodlands Inventory, which means that they have been wooded continuously for over 400 years. There are also several narrow riparian woodlands and scattered trees along some of the upland burns, predominantly alder with some alder and birch.

Around the summits of Beinn na Roinne and Coire na Craoibh are stands of scrubby, sub-montane woodland, dominated by eared willow *Salix aurita*, birch and rowan. There are mature and sapling trees found even near the summits of these hills, especially in the lee of prevailing winds and less exposed locations and where crags and other features make them less accessible to grazing animals.

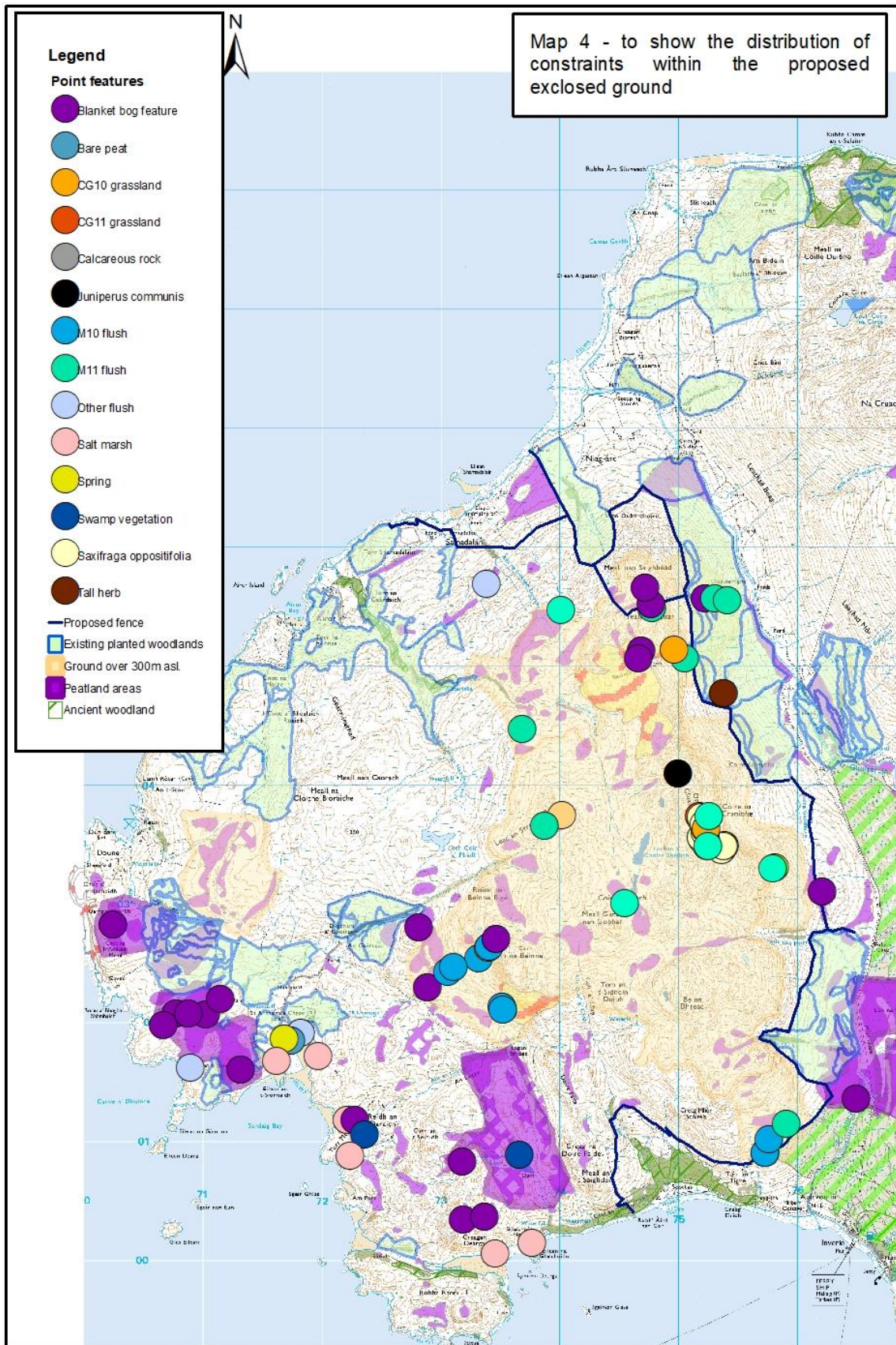
In the open moorland there are a surprising number of small and sapling trees scattered across the wet and dry heath vegetation. These are most common around rock outcrops and small crags where browsing is less accessible but there are also stunted trees even out on the open heath. Where there have been fences already erected, natural regeneration of trees is evident, including within areas that have been planted.

To the east of the fenceline, there are already large blocks of planted conifers, predominantly pine, with pine, fir and spruce near to Inverie. Along Glen Guseran, to the west of the river the slopes have been planted with a variety of native broadleaves including birch, rowan, alder, willow, cherry and pine.

There are therefore established native woodlands that will provide sources of seeds and existing trees scattered throughout the peninsula. It would be expected that there would be rapid expansion of woodland by natural regeneration in the surrounding heaths with a strong reduction in grazing as proposed.



### 3.2 Constraints



### 3.2.1 Deep Peat Habitats

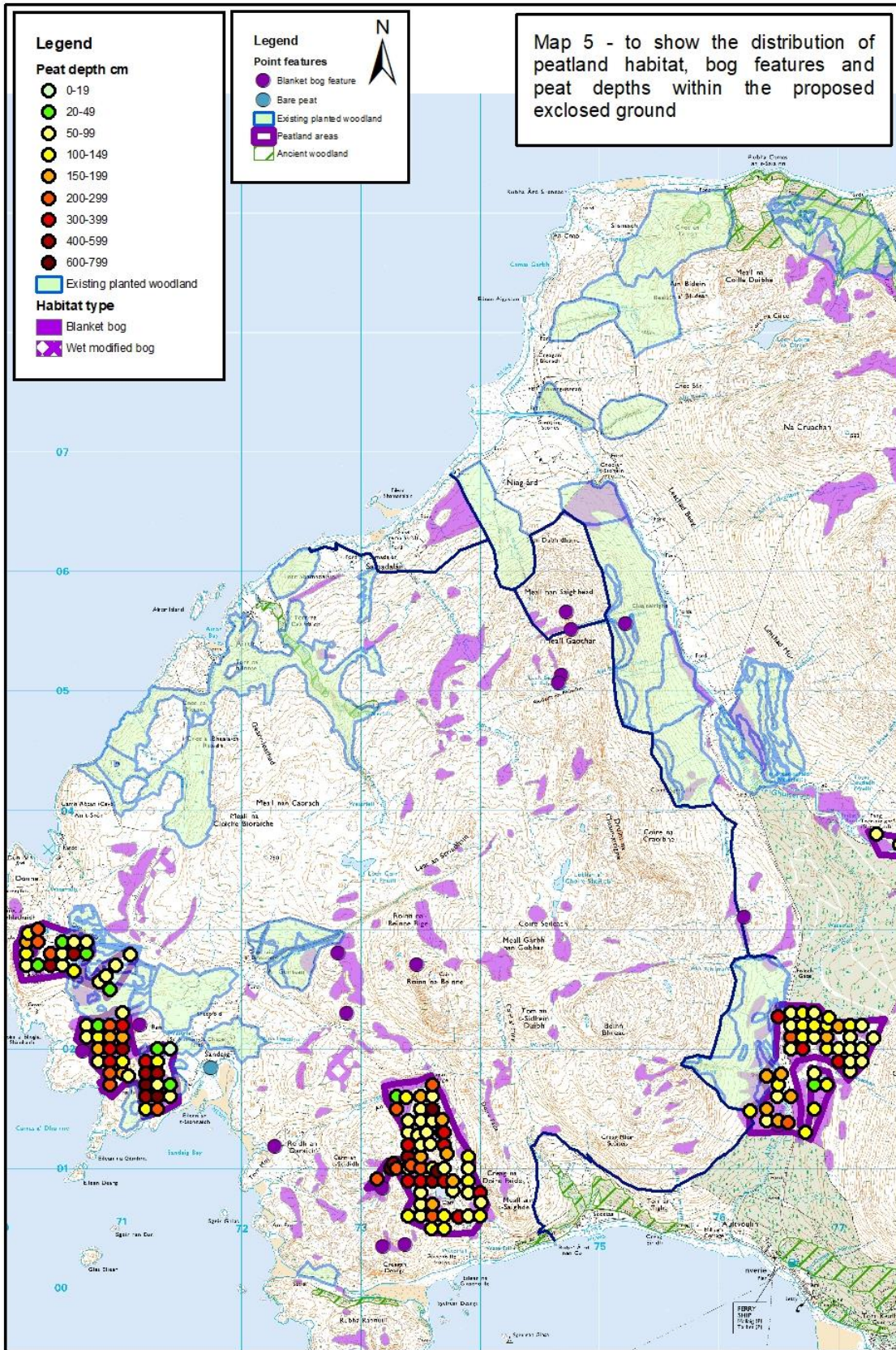
Map 5 highlights all areas of blanket bog including the more extensive stands to the west of Sandaig and at Doune as well as smaller pockets and areas of wet modified bog with peat depth assessed as of 50cm or greater.

The blanket bog within this survey area typically supports species such as *Eriophorum vaginatum* and *Sphagnum papillosum*, sometimes *S. magellanicum*, all of which are peat building species. Typically blanket bog occurs on peat that is over 50cm deep and often over 1m. Within the survey area there were signs of peat banks mainly in proximity to the crofting dwellings plus associated access tracks (e.g. north of Sandaig Bay Figure 4). In addition some peat areas were drained during agricultural improvements in the 1970's although the majority as north of Sandaig Bay are now in-filled. Elsewhere small deposits and basins of peat are generally undisturbed.

In 2020, Wells *et al* undertook a peatland survey of some of the larger stands of blanket bog at Sandaig and at the far west, near Doune, as well as within some of the larger forested blocks. In all stands, very few measured depths were less than 50cm (green points) and many were over 2m, with the deepest stands indicating over 7m depth of peat. As part of this survey a peat pole of 2m length was used to assist with the identification of peat habitats and random samples were taken from blanket and wet modified bog throughout the area. Aside from the larger stands measured by Wells *et al* in 2020, 95% of all samples within the areas shaded purple on map 5 were between 50cm and 2m depth.

The related target notes show where there are features associated with good quality blanket bog such as bog pools and hummock hollow topography and other features indicating good condition including a range of less common bog species such as *Schoenus nigricans* and *Listera cordata*. The pool systems noted generally support species such as *Drosera rotundifolia* and *D. anglica*, and in places there are stands of *Menyanthes trifoliata* and *Rhynchospora alba* in pools and peat depressions which is another important Annex habitat (7150, depressions on peat substrate of the *Rhynchosporion*).

The overall assessment of blanket mire habitats demonstrated that the majority of the 212ha resource is in moderate to good condition for active peat accumulation.



### 3.2.2 Habitats and species of International importance to Nature Conservation

The suite of upland habitats present within the Knoydart peninsula includes many that are of national and international importance to Nature Conservation. These include the following habitats that are listed in the EU Habitats Directive (2000) as of international importance to nature conservation. There is therefore a presumption in favour of conserving and enhancing these habitats. It is theoretically probable that their combined and extensive distribution on the western end of the peninsula would meet the criteria of SSSI status.

#### **Code 4010 Northern Atlantic wet heaths with *Erica tetralix***

M15 *Trichophorum cespitosum*-*Erica tetralix* wet heath

Wet heath occurs extensively throughout the peninsula. It is mostly in good condition, though lightly to moderately browsed and often occurs in mosaic with blanket bog and dry heath.

#### **Code 4030 European dry heaths**

H10 *Calluna vulgaris*-*Erica cinerea* heath

H21 *Calluna vulgaris*-*Vaccinium myrtillus*-*Sphagnum capillifolium* heath

Stands of dry heath occur over exposed summits, steep slopes and other thin soils.

#### **Code 7130 Blanket Bog (active)**

M17 *Trichophorum cespitosum*- *Eriophorum vaginatum* blanket mire

There are large stands and pockets of blanket bog in mosaic with wet heath throughout the peninsula. The larger stands to the west, near Sandaig and Doune, are in good condition and have associated bogpool systems, some with very deep peat 2-7m.

Associated habitats include

M1 *Sphagnum denticulatum* bog pool community

M2 *Sphagnum cuspidatum/fallax* bog pool community

M3 *Eriophorum angustifolium* bog pool community

#### **7150 Depressions on peat substrates of the *Rhynchosporion***

High quality intact bog pool systems with *Rhynchospora alba* were recorded within the M17 blanket bog, south of Doune.

#### **Code H7230 Alkaline fen**

M10 *Carex dioica*-*Pinguicula vulgaris* mires

Flushes of this type were frequent along soaks in the wet heath, mainly around the summit of Roinne na Beinn.

M11 *Carex demissa*-*Saxifraga aizoides* mires

Frequent around the summits of Meall Gaothar, Beinn Bhreac and above Coire na Croaibh, mainly low, stony flushes, sometimes on trampled ground adjacent to flowing burns.

### **Code 91A0 Old sessile oak woods with Ilex and Blechnum in the British Isles**

W17 *Quercus petraea*-*Betula pubescens*-*Dicranum majus* woodland

Scattered on higher slopes, the banks of upland burns and crags.

### **Code 91E0 \* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior***

W7 *Alnus glutinosa*-*Fraxinus excelsior*-*Lysimachia nemorum* woodland

Around the coast from Millburn to Glaschoille, and along burn-sides throughout the peninsula.

#### 3.2.3 National importance:

The following habitats present on the site are subject to national Biodiversity Action Plans (BAPs) including priority habitats: upland heathland (M15, H10), blanket bog (M17, M1, M3), alkaline fen (M10, M11) upland woodland (W7, W17).

The woodlands along the Airor Burn and around the coast from Glaschoille to Millburn are also listed in the Ancient Woodland Inventory for Scotland as ancient semi-natural.

These habitats should be retained and protected with no loss of extent or quality, and enhancements made wherever possible.

#### 3.2.4 Local importance

The habitats above are also of local and regional importance. Species of local sensitivity include *Juniperus communis*, *Saxifraga oppositifolia*, *Arctostaphylos uva-ursi* and *Rhynchospora alba*. The habitats supporting these species should be retained and protected with no loss in extent or quality and enhancements made wherever possible.

On the summit of Coire na Craoibhe there are occasional low growing juniper bushes that are consistently heavily browsed and stunted to form prostrate mats. With a significant medium term (5-15 years) reduction in deer browsing these bushes will be able to grow in a more open structure and should extend their surface cover.

*Saxifraga oppositifolia* is frequent around the crags at Coire na Craoibhe both in accessible and inaccessible locations mainly above 300m asl. Here it is locally frequent whereas it was not recorded from elsewhere on site. These locations coincide with the basalt and microgabbro dyke (or dykes) (Section 2.2) which are relatively scarce within the western end of the peninsula.

*Arctostaphylos uva-ursi* was recorded from one location on thin soil on the rocky top of Rubha Raonuill.

*Rhynchospora alba* was recorded from two of the large stretches of blanket bog.

#### 3.2.5 Ground Water Dependent Terrestrial Ecosystems (GWDTE):

The NVC methodology relates to the wetland habitats specified in LUPS GU4 and the SNIFFER report 2009. The extent and type of wetland habitats identified are shown in Map 6 using the broad categories as described in the SNIFFER report.

The following NVC types found within the peninsula are classed as GWDTE's under SEPA wetlands classification.

These are M6 acid flush, M10 basic flush, M11 basic flush, M15 wet heath, M25 marshy grassland, M32 and M38 springs .

Of these the M10 & M11 flushes, and the M32 and M38 springs are of high priority. These habitats are considered highly ground-water dependant and vary in size from a few square meters to c. 0.3ha. Areas where these springs and flushes occur should be avoided for the woodland establishment machinery/transport phase and designed with significant buffers (20-150m) in the design phase for new planting.

There are frequent base-rich flush, spring and calcareous grassland habitats spread across the peninsula, predominantly around the upper slopes of Roinn na Beinn, Meall Gaothar and Coire na Craoibh to Beinn Bhreac and Coire an t-Searraich. The M32 and M38 springs are located near top of Coire na Craoibh.

M6 acid flush vegetation is also classified as highly ground water dependant but occurs very commonly across disturbed areas of the hillside and in drains (both natural and artificial) and soakways. It can also receive a significant surface water input, so in places it can be moderately ground water dependent. Botanically it can be species poor and willow and alder/birch regeneration can be allowed to develop as part of the habitat restoration.

Wet heath and *Molinia* dominated grassland (M15/M25) are less ground water dependant and often occur as part of the suite of bog communities. They are largely in good condition at this site.

### 3.2.6 Landscape Considerations

On the constraints map 4 it is also evident that many of the habitats and species of nature conservation importance occur above 300m asl., on the summits, exposed areas of the higher hills and along steep, inaccessible crags such as along Coire na Craoibhe. The majority of M10a alkaline flushes are found around Roinn na Beinn and there are frequent M11 *Saxifraga aizoides* flushes around the top of Meall Gaothar and along the Black Hills ridge to Beinn Bhreac. M32/38 spring habitats were recorded from above Coire na Craoibhe and *Saxifraga oppositifolia* was frequent along those crags.

*Juniperus communis* was recorded from the summit above Coire na Craoibhe and there were other species found in these higher altitude and exposed areas, i.e. over 300m asl.

The modern-day landscape character of the Knoydart hills is accentuated by their distinctive skyline form (note that 400-600 years ago it would have looked different). To preserve as much of this quality as well as many of the habitats and species of importance as possible the ground above 300m asl. should be considered as of high priority and only low density sensitive planting of appropriate species in selective locations should be permitted.(map 4). It is however expected that scrub and woodland regeneration will eventually form its own natural tree line and change the landscape and visual appearance over the long term, and that should not be not be discouraged<sup>2</sup>.

## 4. RECOMMENDATIONS

The area of the Knoydart peninsula west of the proposed fence-line lies between sea-level and just over 400m asl. with upland habitats dominated by wet heath vegetation, dry heath and bog. There are frequent existing planted and native woodlands and scattered trees along burns, crags and around the coast.

The proposal is to link up existing deer fences across the peninsula and carry out significant deer reduction cull within this area, and then subsequently manage the browsing/grazing

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<sup>2</sup> A transition from the sheep and deer-scalped profile to an unkempt, shaggy appearance.

impacts over the medium to long term. This survey's results show that there is a significant tree resource within the project area but that there are also habitats of national and international importance that would be affected by the reduction in herbivore pressure. There are also landscape and land-use considerations.

A complete audit would be achieved by inclusion of the Airor farm unit and this should be a priority of the project.

#### 4.1 Carbon store

The expansion of the existing woodland could have a range of possible benefits. Trees form a carbon store which is an important consideration in the current climate crisis. However, the predominant substrate of relevance to carbon sequestration on the Knoydart peninsula are the peat or peaty gley soils.

Blanket bog habitat is typically found on peat that is 50cm deep or more and, within Knoydart, stands have been found that are up to 7m deep. Deep, saturated peat does not support abundant tree growth, as was found in the attempts to afforest parts of the Flow Country in the 1970s.

Map 5 shows the extent of the blanket bog resource (212ha) within the area of search and the peat depths within the areas for which this information is available. In total this accounts for a surface coverage of c. 7% within this western sector of the Knoydart peninsula (excludes Airor). The largest areas of blanket bog are found around Glaschoille Loch, to the west of Torr na h'Innse and between Sandaig and Doune. These stands all include areas of peat from 5-7m depth. The large stand of blanket bog at Torr na h'Innse includes frequent large pools and stands of *Menyanthes trifoliata* and *Drosera anglica*, and the stands between Sandaig and Doune have frequent depressions with *Rhynchospora alba*.

However, other peat or peat-rich deposits across the peninsula are mainly smaller and on slightly sloping ground and therefore less waterlogged (purple on map 5). The non-systematic peat depth samples taken during this survey indicate typical depths of between 0.5m and 2m within these kinds of stands. The other dominant habitat within these hills is wet heath on thinner peat or peaty gleys, which are typically between 20cm and 50cm. It would be expected that natural tree regeneration would occur readily on these stands with woodland types such as birch dominated W17 and W4.

On the wetter, deep peat stands, even around the margins of boggy ground, some willow, birch and alder will grow. On peat, trees can cause local drying and oxidation of the substrate. The growth of trees would lead both to the moderate loss of peat by decomposition over the long term, resulting in a net increase in carbon dioxide production and an increase in the capacity of the ground to support further trees as it dries.

There is therefore a trade-off between the carbon store predicted within the new woodland and the loss of the existing carbon store within the peat. The Forest Scotland guidance recommends that no tree planting should be carried out on peat deeper than 50cm and this should be adhered to at this site. Where possible, all areas shaded purple on map 5 should be excluded from active tree establishment.

It is, however, impossible to restrict natural woodland regeneration in the absence of browsing (or very low browsing rates) except by the manual removal of saplings. This has been done elsewhere (e.g. on the Moine Mhor, Argyll) but is an expensive and arduous process and not part of this regeneration project's principles. The initial, effective removal of deer from this area will facilitate the natural regeneration of native trees throughout the

peninsula and this will result in some loss or encroachment of peatland and blanket bog habitat. It is advised that a carbon budget be carried out to assess whether the proposed carbon store created by the new woodland is large enough to justify the potential marginal loss of the carbon store already held in waterlogged peat.

#### 4.2 Biodiversity

Woodlands support a large range of associated species, iconic mammals, nesting birds, invertebrates, woodland flowers and lower plants. The West of Scotland is of high importance for bog woodland, upland oak/birch woodland and hazel woodland, the latter primarily for the abundance of bryophyte and lichen species that it supports (Averis and Coppins 1998). However, the open upland habitats that it would replace are also part of the suite of Annex 1 protected habitats listed in the EU habitats directive, including the blanket bog, wet and dry heath vegetation, basic flushes, tall-herb ledges and stands of calcareous grassland. These habitats support species such as *Salix oppositifolia*, *Juniperus communis*, *Arctostaphylos uva-ursi* and *S. aizoides*.

Together these habitats are important refugia for other associated species. The upland grasslands, wet heath and bog habitats that cover most of this area are important hunting grounds for golden and sea eagles, hen harrier, merlin and there are likely to be golden plover, greenshank, dunlin and other nesting waders.

To create a more biodiverse landscape, existing open habitats could be enhanced by sensitive planting of appropriate low density montane and scrub woodlands. The additional cover would promote increased prey species populations for raptors, whilst maintaining open hunting ground and could lead to increased ranges and recruitment rates especially of golden eagles.'

It is also probable that under the proposed open planting that existing red and black grouse populations will expand.

There are multiple otter ranges around the coast plus freshwater habitats within the area and there are local records for badger, bats and pine marten. The habitat requirements of, plus unrestricted access by, protected species needs to be taken into account when planning new planting and natural regeneration, with appropriate corridors left or provided within the enclosed peninsula.

Any increase in the number of associated woodland species must therefore be considered alongside the loss/modification of other habitats of importance to the conservation of biodiversity.

Wet and dry heath habitats and blanket bog are extensive and are well represented both in the West of Scotland and within Knoydart. The minor reduction in the total extent of these habitats would therefore be considered balanced by the resultant increase in the less extensive upland woodland types. Within Natural Heritage Zone 8 native woodland cover is currently very low, a rough estimate suggests c. 2-3%. The nature restoration aims should include the spread of scrub habitat, in particular Juniper on free draining soils where the local seed source is absent. Similarly, blackthorn and hawthorn scrub can be established at the lower altitudes (for example on acid grasslands) which will act as the precursor to oak or birch-dominated native woodlands.

Of greater significance are the base-enriched habitats, the flushes (M10, M11) springs (M32, M38), calcareous grasslands (CG10, CG11) and the tall herb ledges and crags (U15, U17) as these are limited habitats and require specific conditions in which to grow, including

ground-water dependency and local base-enrichment. The location and distribution of these is shown on maps 2 & 5. These habitats are also sensitive to changes in herbivore pressure. Even in the absence of trees, the reduction in grazing pressure is likely to allow taller grass, rush and herb species to proliferate which will result in the potential loss of smaller annual species and lower plants. This alters the character of these base-rich flushes and flushed calcareous grassland, but should be part of the transition/evolution to a new balance of habitats. As such, targeted monitoring here is advised in order to adjust future grazing management.

On map 5, it is evident that the majority of these base-enriched habitats are found along the higher summits from Meall Gaothar to Coire na Craoibhe and around the upper slopes of the Roinne na Beinn (mainly above 300m asl). The surveys characterised the current grazing impacts as locally moderate/high although many examples are ungrazed as on inaccessible ledges.

These localised habitats should be excluded from any new planting and marked out by an ecologist during the planning phase of any new woodland creation (some of which are below 300m altitude). The key upslope sources of base-enrichment should also be included in these marked zones. However the majority of the moorland above 300m altitude (c. 70-80%) is outside these particularly valuable habitats. It is recommended that care be taken when planting any selective low density native species above 300m asl. (which includes Juniper scrub –Section 4.2 above).

However, the reduction in herbivore impacts will stimulate natural regeneration of trees throughout the peninsula (within the edapho-climatic constraints). Thus, some expansion of trees into the higher ground will occur and is a key part of the landscape scale, ecosystem restoration aims. It is expected that low growing species typical of exposed locations that includes ground lichens such as *Cladonia* spp and clubmosses such as *Huperzia selago* will alter in distribution and surface cover as they are shade-intolerant.

#### 4.3 Landscape and land-use considerations

The high ground areas also form the main skyline of Knoydart (refer section 3.2.6). For example, Beinn Bhreac forms the main hill view from Inverie and Roinn na Beinne is the main profile from Sandaig or offshore.

Hill walking and climbing are also some of the main reasons that guests come to Knoydart, with the open hills creating a range of accessible walks. The replacement of open hill land with the perceived 'less accessible woodland' could restrict/alter access to this part of the peninsula.

It is therefore recommended that the proposed new woodland planting be predominantly designed below the 300m altitude, leaving the higher ground, mainly open with natural regeneration. Well established paths with multiple gates through the deer fences would also encourage walkers to access the upper slopes and summits.

#### 4.4 Ongoing management

As discussed above, the change in deer management will potentially have indirect impacts on deposits of deep peat plus the associated mire habitat modification or loss. However, the restoration of bog woodland is also a key biodiversity aim. Negative impacts are also predicted for the calcareous vegetation communities. The recommendations outlined above aim to mitigate these effects, but the control of natural regeneration in the absence of large herbivores (or large herbivores at very low density without natural predators) is outside of the

project's current scope.. The end aim is to restore a mosaic of open, upland habitats with a significant cover of scrub and woodland.

Large herbivores have an important role in the uplands, with some value in the moderation of fire risk, maintenance of the low and open structure to some key habitats as well as prey and carrion value to raptors and some of the mammals.

It is recommended that the long-term plan for the area includes proposals to reintroduce large herbivores after 10-15 years, once the trees have become established. As elsewhere in Europe, the preference under rewilding principles would be generalist grazing species such as takhi/native ponies, native breeds of cattle or aurochs in the form of bison/Tauros.

## **5. SUMMARY**

- The proposal to manage deer with a reduction cull on this sector of the peninsula would encourage the natural regeneration of native trees throughout the area, except on very exposed or boggy ground. One of the primary aims is to retain and expand all the existing native woodland.
- Blanket bog is an important habitat and existing carbon store. Peatland habitat over 50cm deep should be excluded from any planting schemes. It is advised to undertake a carbon balance budget (Section 4.1).
- The land above 300m asl. includes many of the habitats highlighted as of particular importance to conservation including flushes, springs, calcareous grassland and tall herb habitats. This also includes the most exposed ground and the important landscape and visual features. It is advised to manage this area sensitively, allowing natural scrub and tree regeneration to form new treelines.
- The habitat requirements of other species such as protected mammals and nesting birds should be taken into consideration. As part of advancing the scientific knowledge base for large-scale restoration projects it is advised to survey and audit the starting baseline populations.
- Adherence to non-disturbance of bird nest sites (or otter holts, pine marten dens) during land management operations is required under legal guidelines.
- Base-enriched flushes and their sources of enrichment on and around the 300m altitude and deep peat areas should be identified, marked out and excluded from active tree planting.
- To control ongoing natural regeneration in more sensitive areas such as bogs and higher altitude communities, deer should be allowed to re-colonise the area at appropriate densities once the trees/scrub have become established.
- Access to the open upland areas above 300m should be retained through wooded areas by provision of multiple deer fence gates/stiles and creation of footpaths.
- Ideally the final privately owned unit at Airor should be surveyed to strengthen the cohesion of this project.
- Botanical monitoring plots for the key habitats are advised to verify the predictions of this survey and assessment. These should include measures of both plant species cover and diversity as well as standard grazing impact quadrats.

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