Restoring ecological richness at Birchfields – the Natural Capital Laboratory

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Ecological richness

Ecological richness comes from **WILDNESS**. It is an expression of the variety of **ECOSYSTEM PROCESSES** present, as evident from the characteristic **INTERACTIONS** between specific species. Often the greatest impact comes from **HIGHLY INTERACTIVE SPECIES**, based on the presence and **EFFECTIVE ABUNDANCE** of those species

The presence and abundance of species is dependant on the prevailing **BIOPHYSICAL** (biotic and abiotic) conditions, such as **TROPHIC INTERACTION** (carnivores, omnivores, insectivores, detrivores and decomposers) and the growth of **AUTOTROPHS** (plants, algae, some bacteria) based on the underlying geology, soil characteristics, hydrology, elevation, aspect and orientation, and climate, those conditions overlaid by land use history

Restoring ecological richness – ecological network design

Restoration of ecological richness at any location has to be seen in a wider context to ensure **CONNECTIVITY** and limit **ISOLATION**. Networks to capture and sustain **REGIONAL DIVERSITY** are the basis of the origins of rewilding, a **WILDLANDS NETWORK DESIGN** being a spatial mapping approach to identify components of the Network based on the habitat needs and mobility of **FOCAL SPECIES**. The set of focal species are chosen on the basis that their needs capture and sustain that regional diversity. Steps in a WND:

- identify key species that could be present in the landscape, their habitat requirements and mobility
- map existing populations and determine existing **CORE AREAS** of key species
- opportunity map for expanded or new core areas based on habitat suitability or potential and probable **WILDLIFE MOVEMENT LINKAGES** between them
- set out goals for accomplishing a connected wildland network, including any restoration of landscape cover or species needed
- identify evolutionary and ecological processes such as natural disturbance and biotic interaction and seek to remove barriers to their operation
- establish land use activities permissible in each component of the Wildlands Network Design, including areas of **COMPATIBLE USE** around core areas as buffer
- consider legislative, regulatory and compliance issues with proposed Wildlands Network Design
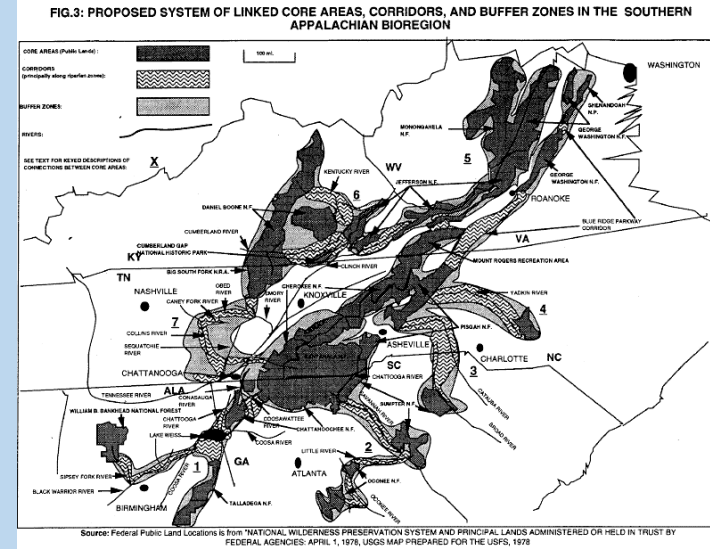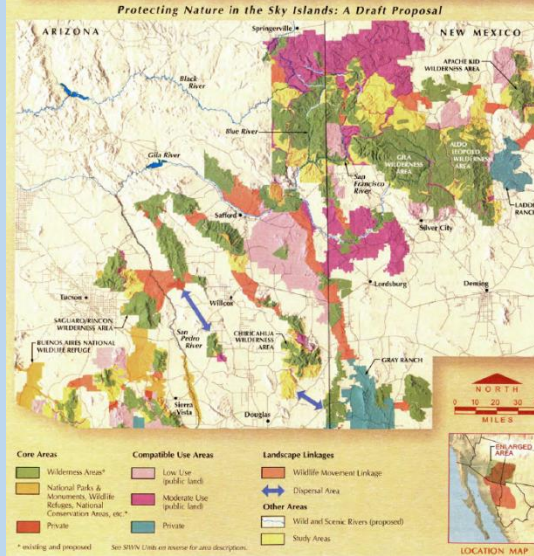
Early Wildlands Network Designs
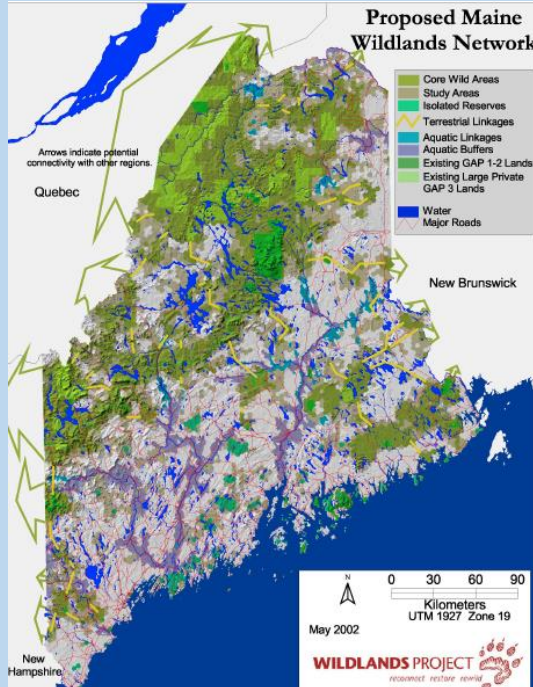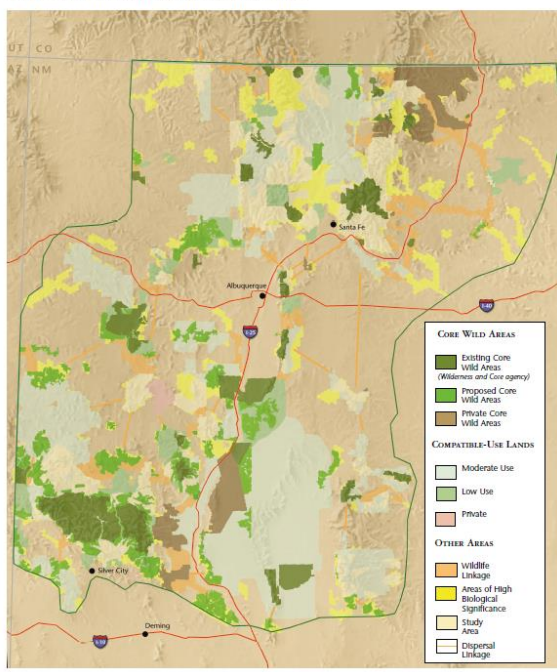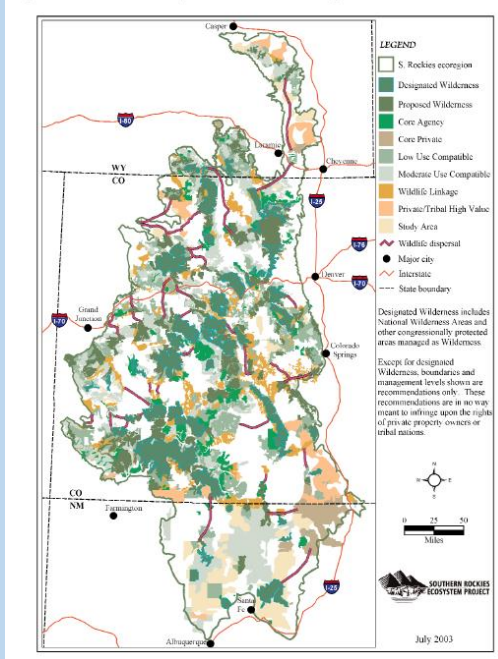
Restoring ecological richness – the importance of connectivity and available area

Given a fixed location and available area, such as at Birchfields, **CONNECTIVITY** becomes the critical factor in restoring **ECOLOGICAL RICHNESS,** the connectivity facilitating **IN-MIGRATION** and **PASSAGE** of species as restoration proceeds

The **AVAILABLE AREA** and its context in the wider landscape determines whether the location can be a **CORE AREA** in any meaningful sense, or is better seen as a **NODE** of a particular subset of ecological richness, ensuring that this richness is sustained BUT which is also connected to other potential **NODES** or **CORES** by way of **WILDLIFE MOVEMENT LINKAGES**

The **HOME RANGE** of species determines whether the **AVAILABLE AREA** can support a population of the species **wholly within its location**, a **NODE** for that species, or whether the species utilises the location as **part of its home range**, or is just **passing through**
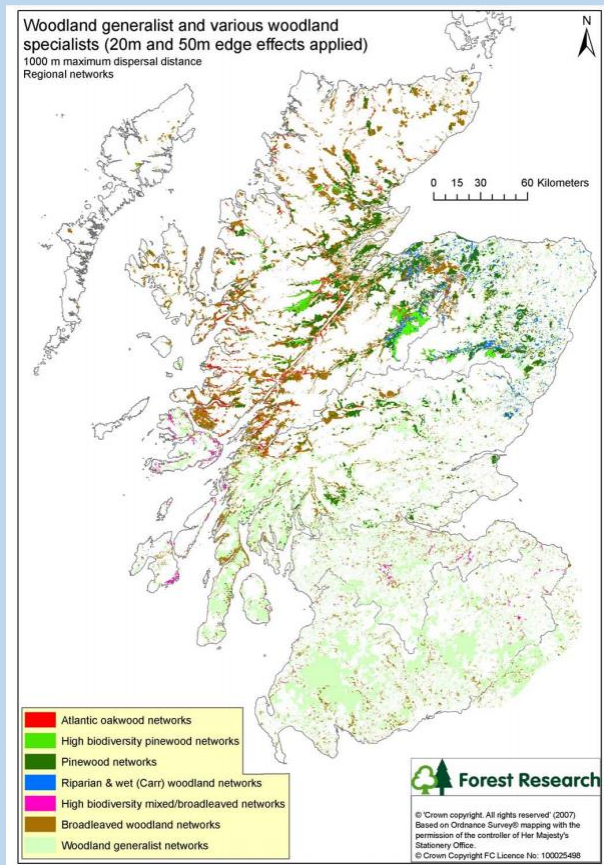
Connectivity for ecological landscapes through Habitat Networks

HABITAT NETWORKS are an established strategy to reduce and overcome the barriers or resistance to movement of wild nature, and include:

- **FIELD MARGIN STRIPS** of un-ploughed land with native plant cover, networked with other land covers of lower resistance, such as unimproved grassland, or which link in to existing patches of semi-natural habitat such as heath, scattered trees, scrub or woodland
- margins are an important approach to **RIVER CORRIDORS**, where fencing off livestock from river edges would allow more varied landscape cover, and prevent erosion and silting into the river course
- **RIPARIAN COURSES** are routes for connectivity in themselves, as many plants and trees distribute themselves by shedding seed into water courses, or bits of root breaking off and lodging further down stream
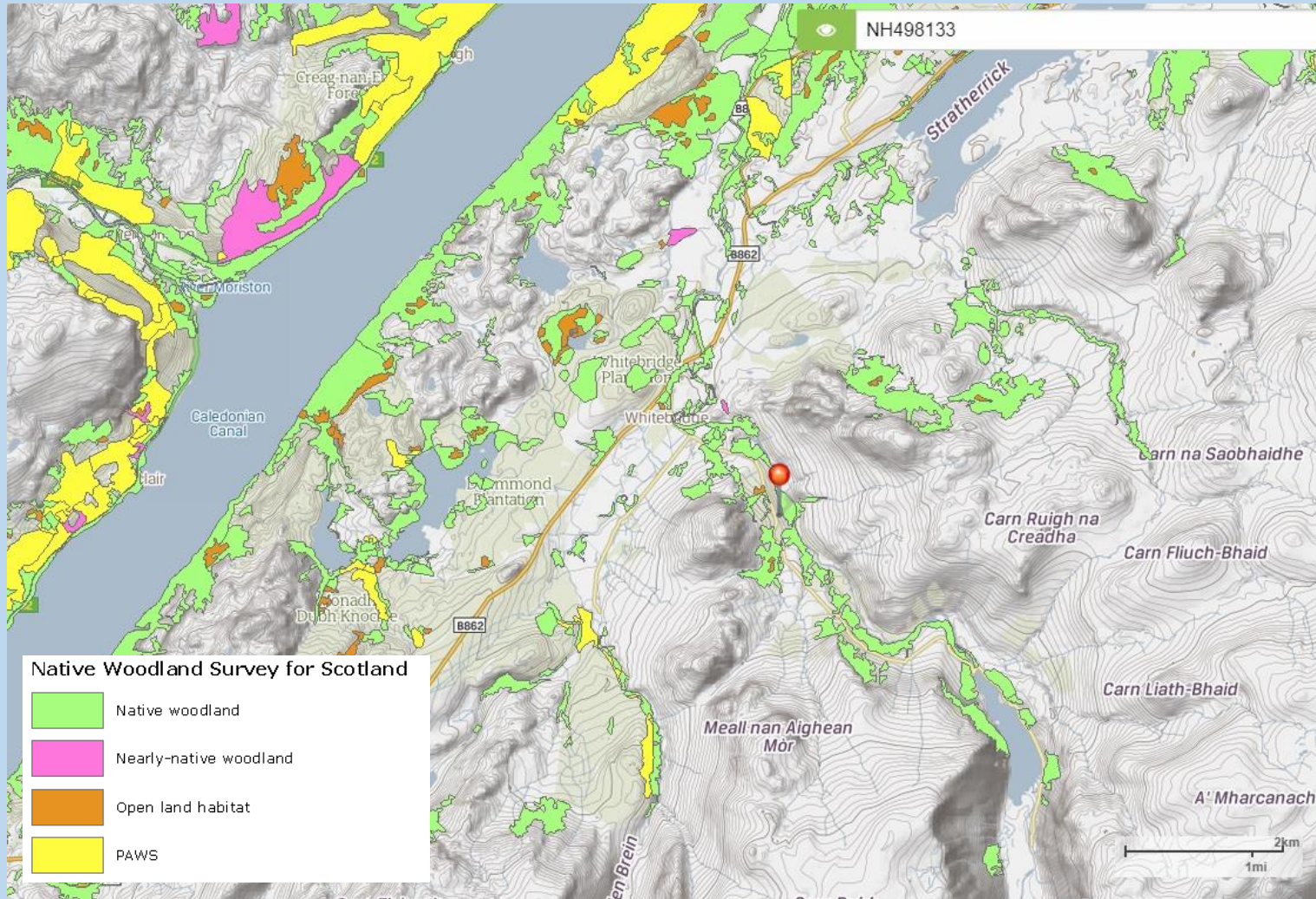
A strategy for Forest Habitat Networks

The concept of **FOREST HABITAT NETWORKS** is to link existing and new woodlands to form a continuous woodland cover. Scotland has been mapped using the **GENERIC FOCAL SPECIES** approach and the Biological and Environmental Evaluation Tools for Landscape Ecology (BEETLE) to model networks of functionally connected woodland areas based on assumptions about the permeability of the landscape to dispersal by a range of species

Woodland generalist and various woodland specialists (20m and 50m edge effects applied)
1000 m maximum dispersal distance
Regional networks

0   15   30   60 Kilometers

Legend:
- Atlantic oakwood networks
- High biodiversity pinewood networks
- Pinewood networks
- Riparian & wet (Carr) woodland networks
- High biodiversity mixed/broadleaved networks
- Broadleaved woodland networks
- Woodland generalist networks

Forest Research

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- identify locations for new blocks of woodland in open landscape along **NETWORK LINKAGES**, subject to a limit on how much land can be taken up without necessarily reducing overall farming productivity

- where woodland backs onto arable land, a measure of protection is given by creating **BUFFER MARGINS** around the woodland to move away any harmful agricultural activity (such as from spray drift)

- effort put in to filling in the gaps between existing woodland blocks to create larger areas has lower priority compared to creating **NARROW BANDS OF WOODLAND** planting as network linkages between the blocks

- **RIPARIAN COURSES** are valued as corridors for new, narrow bands of woodland planting either side, especially if they could link into existing woodland cover
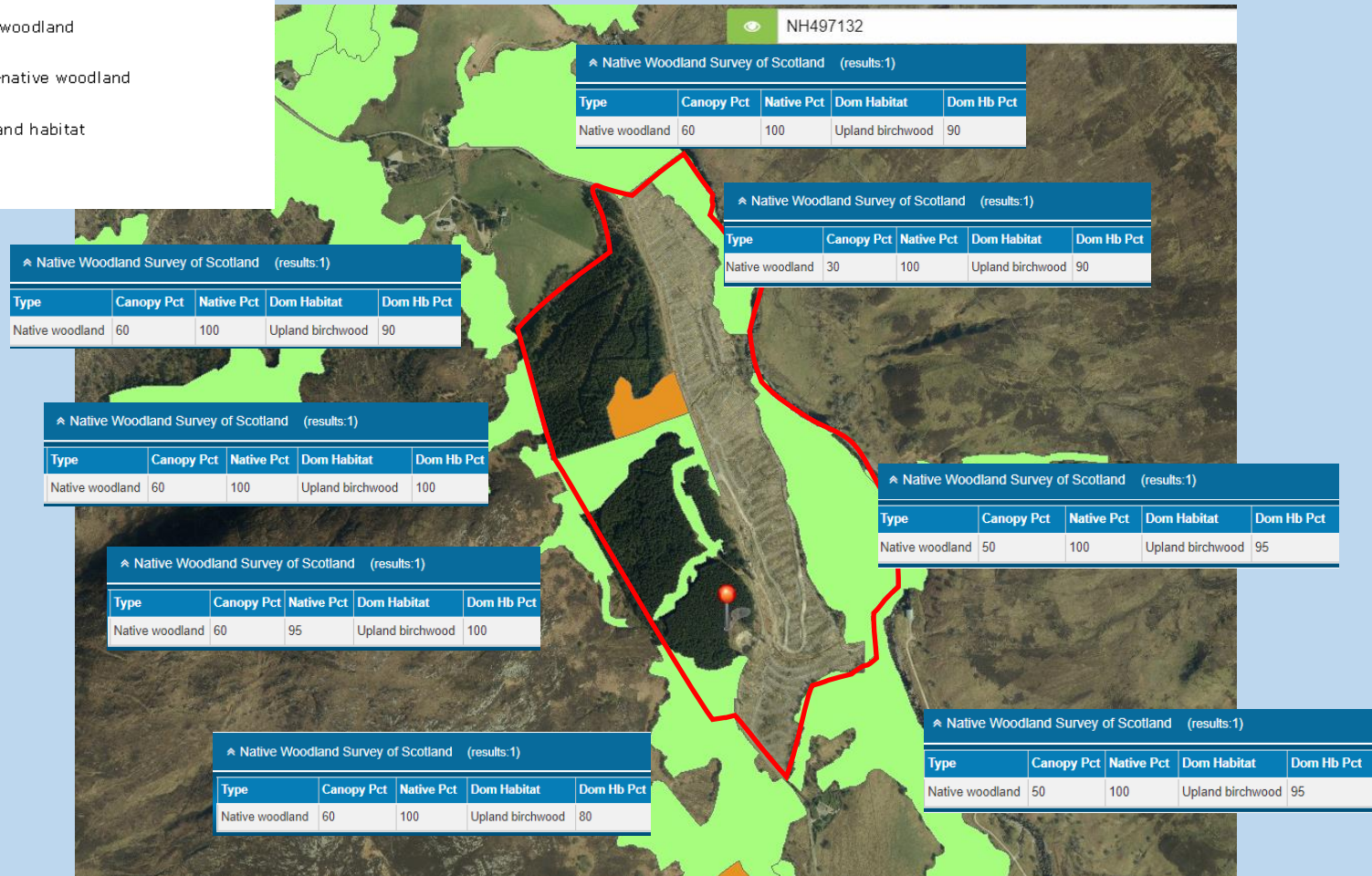
Native Woodland Survey for Scotland

Bands of native woodland stretch to the NW and SE of Birchfields, indicating the basis of **potential connectivity** by way of **Forest Habitat Networks**

Native woodland within and around Birchfields

Upland birch woodland with 30-60% canopy, 95-100% native species, and 80-100% habitat dominance

Integrated Habitat Network for Scotland

The **Integrated Habitat Network** for native woodlands in Scotland was mapped as an aid to the scoring process when assessing Forestry Grant Scheme applications for tree planting made under the Scottish Rural Development Program 2014-2020. It is backed by regional targets for **Habitat Network expansion**
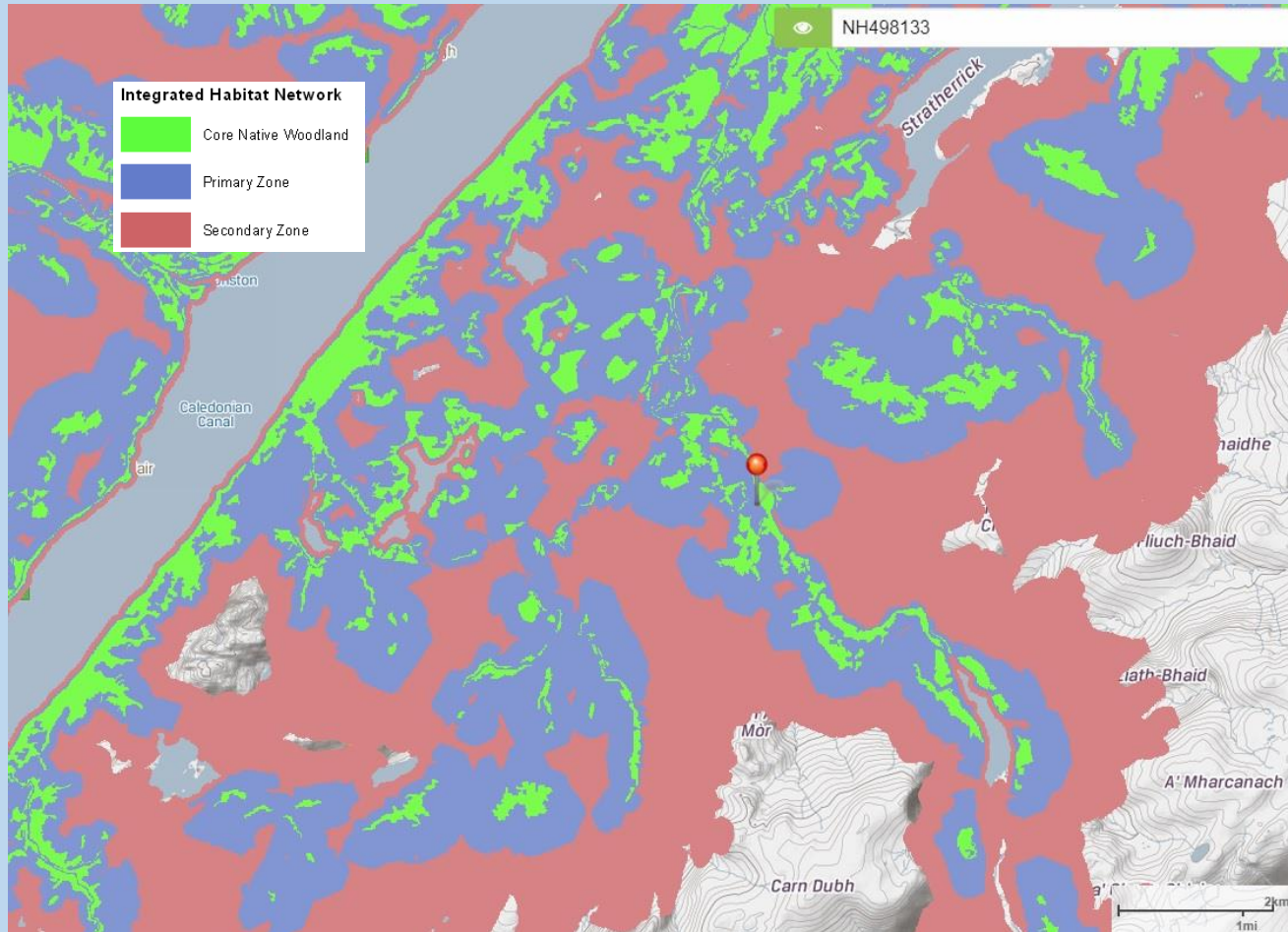

Birchfields sits in a significant potential **WILDLIFE CORRIDOR** based on that future Network expansion

Birchfields connections into protected areas
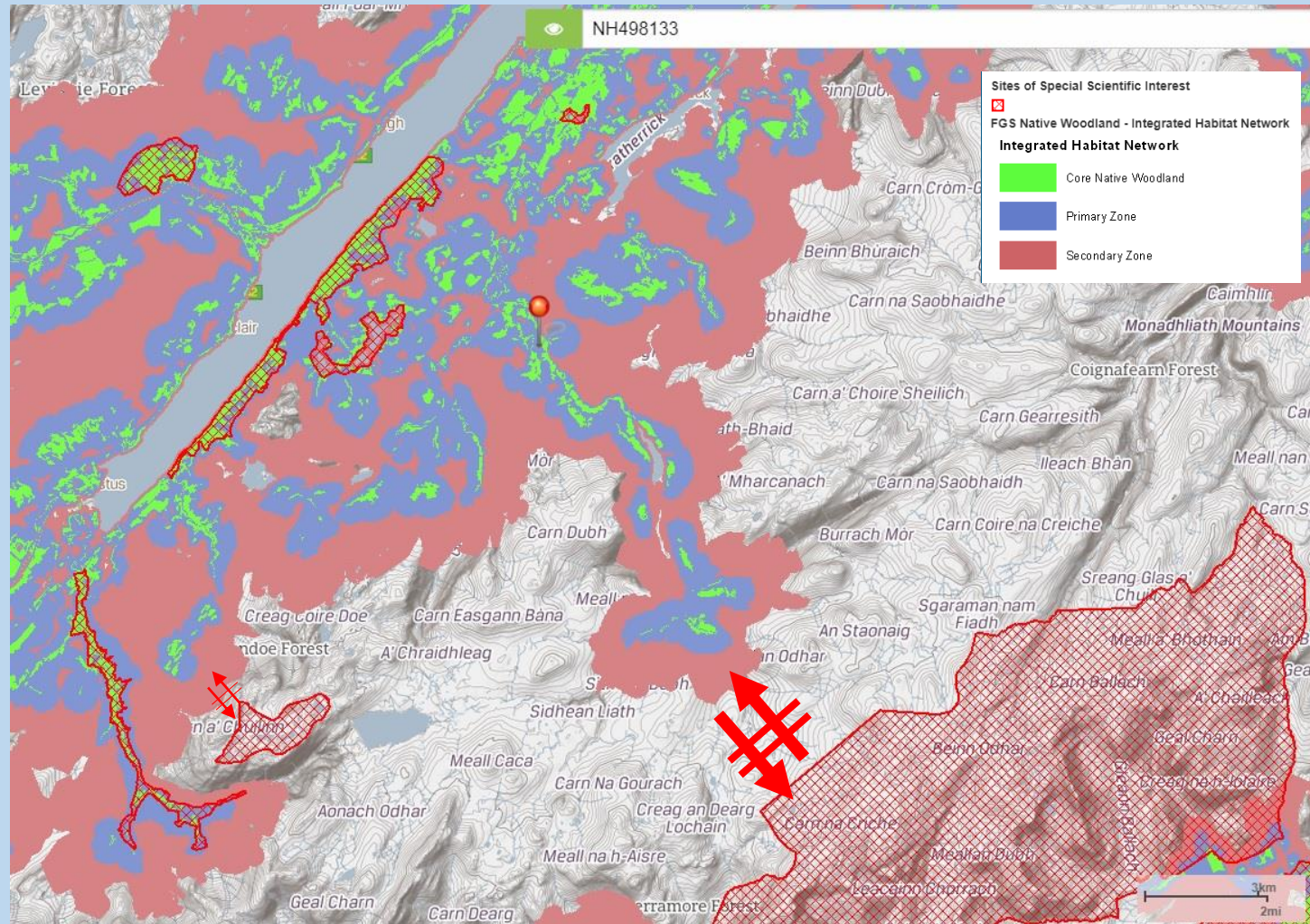
Potential **Habitat Network** links NW into Knockie Lochs SSSI, Easter Ness Forest SSSI, and on S to Glen Tarf SSSI, and N into Loch Bran SSSI, but **NOT** into Glendoe Lochans SSSI, and **NOT** S into Monadhliath SSSI

What species could use the Network Habitat link into Birchfields?
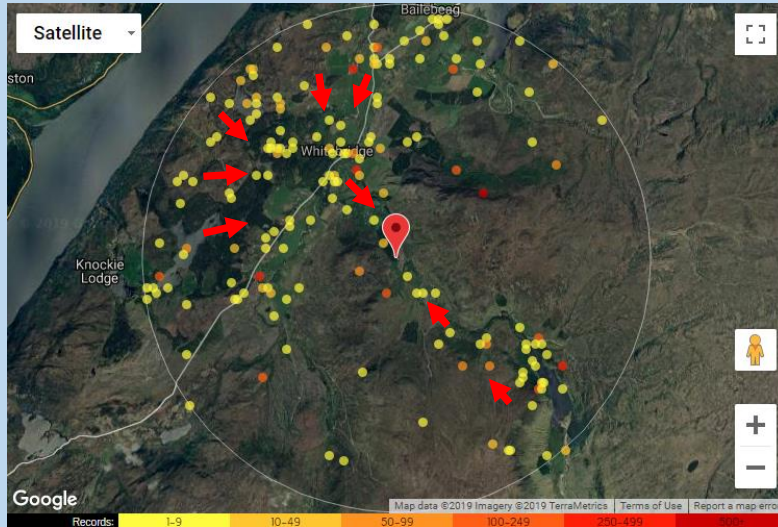
5km radius (NH497132)

1km radius (NH497132)

Group	Species	Group	Species
All species	811	Plants	418
Animals	279	Algae	1
Mammals	20	Bryophytes	83
Birds	0	[Hornworts]	0
Reptiles	1	[Gymnosperms and Ginkgo]	0
Amphibians	3	[Ferns and allies]	0
Fishes	2	[Clubmosses]	0
Molluscs	5	Angiosperms	301
Arthropods	161	Fungi	114
Crustaceans	1	Chromista	0
Insects	152	Protozoa	0
[SpidersAndAllies]	8	Bacteria	0
[Myriapods]	0		
[Worms]	1		

Group	Species	Group	Species
All species	205	Plants	169
Animals	36	Algae	0
Mammals	1	Bryophytes	76
Birds	0	[Hornworts]	0
Reptiles	0	[Gymnosperms and Ginkgo]	0
Amphibians	0	[Ferns and allies]	0
Fishes	0	[Clubmosses]	0
Molluscs	0	Angiosperms	84
Arthropods	13	Fungi	0
Crustaceans	0	Chromista	0
Insects	13	Protozoa	0
[SpidersAndAllies]	0	Bacteria	0
[Myriapods]	0		
[Worms]	0		

Mammals

| Species : Common Name	Records	Species : Common Name	Records
1. Capreolus capreolus : Roe Deer	16	11. Mustela nivalis : Weasel	2
2. Cervus elaphus : Red Deer	39	12. Myodes glareolus : Bank Vole	1
3. Cervus nippon : Sika Deer	32	13. Myotis daubentonii : Daubenton's Bat	2
4. Erinaceus europaeus : Hedgehog	2	14. Oryctolagus cuniculus : Rabbit	4
5. Lepus europaeus : Brown Hare	7	15. Plecotus auritus : Brown Long-Eared Bat	2
6. Lepus timidus : Mountain Hare	32	16. Rattus norvegicus : Brown Rat	1
7. Lutra lutra : Otter	11	17. Sciurus vulgaris : Red Squirrel	10
8. Martes martes : Pine Marten	3	18. Sorex araneus : Common Shrew	1
9. Meles meles : Badger	1	19. Talpa europaea : Mole	19
10. Mustela erminea : Stoat	1	20. Vulpes vulpes : Fox	3

Use of **NBN atlas** species data records to build a picture of species on site & which could migrate in to Birchfields **during HABITAT RESTORATION** - walk, fly, blown, drop (from birds)!

Trophic interactions between species – food webs

Simple **food web** examples illustrate **trophic interactions** between species, energy flowing upwards towards apex predators

A **trophic cascade** occurs when the animals at the top of the food web - the **apex predators** - modify the numbers not just of their prey, but also of species with which they have **no direct connection**. Their impacts **cascade down the food chain**
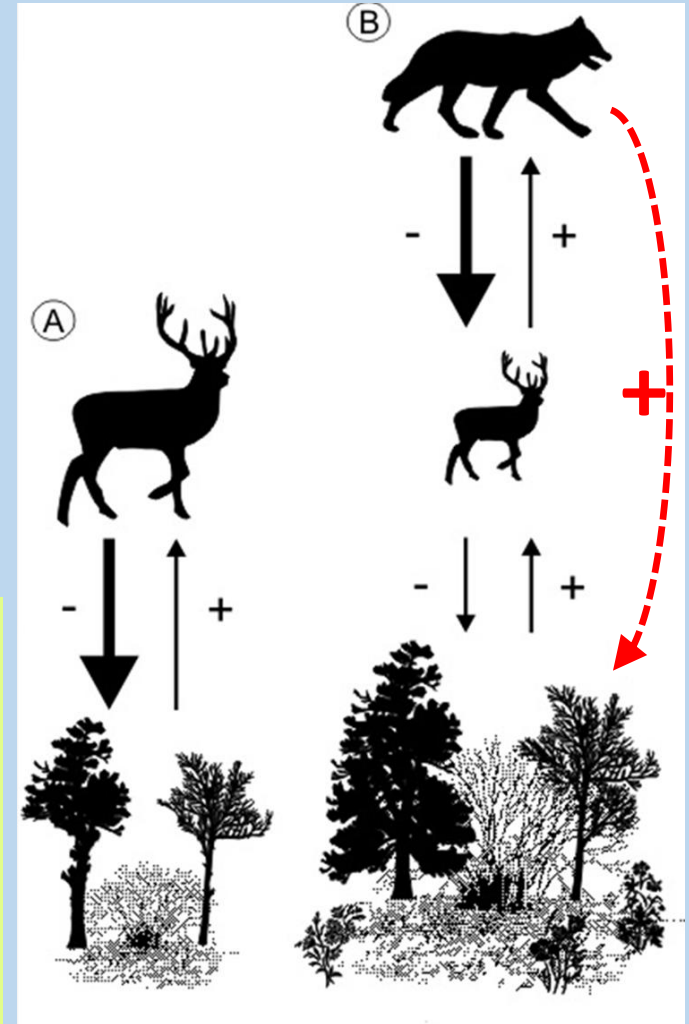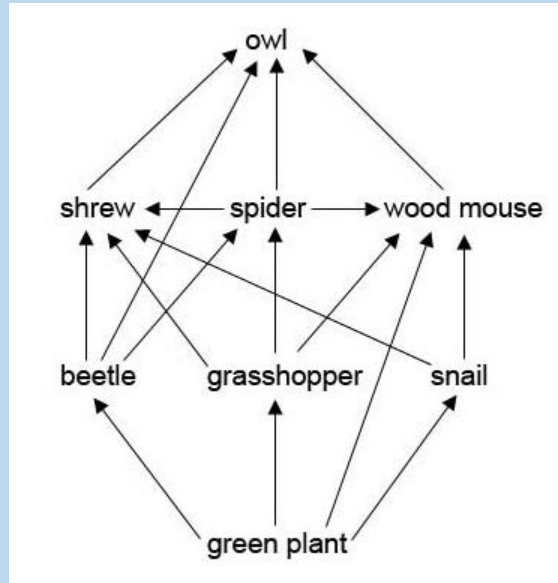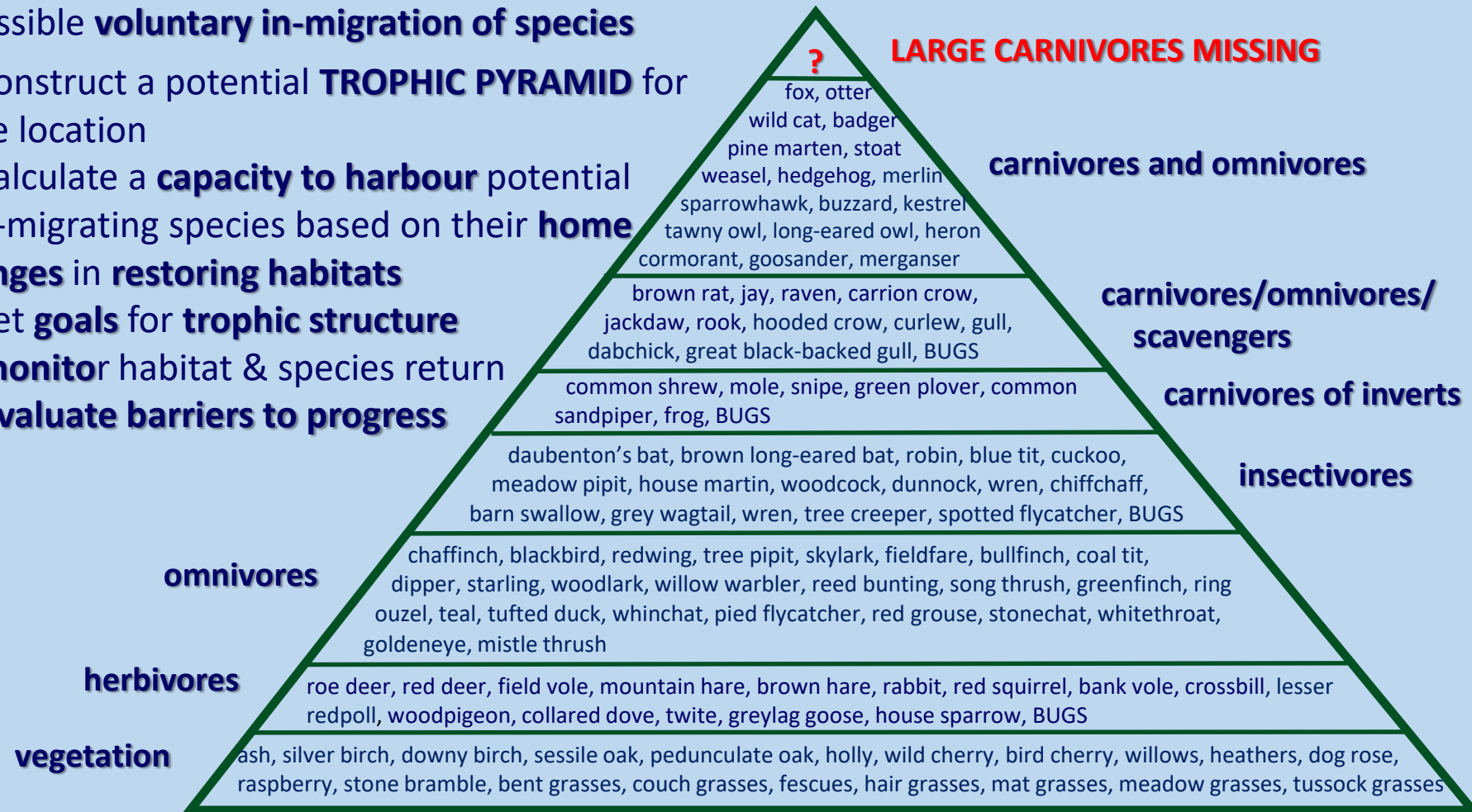

The aim at Birchfields should be to restore **TROPHIC STRUCTURE** at all levels

Assessing the potential trajectory and progress at Birchfields

Potential OUTCOMES can be predicted from the **community of species** and their **INTERACTIONS** that can be reinstated, based on a trajectory of **restoring vegetation** and possible **voluntary in-migration of species**

- construct a potential **TROPHIC PYRAMID** for the location
- calculate a **capacity to harbour** potential in-migrating species based on their **home ranges** in **restoring habitats**
- set **goals** for **trophic structure**
- **monito**r habitat & species return
- **evaluate barriers to progress**

?   **LARGE CARNIVORES MISSING**

fox, otter
wild cat, badger
pine marten, stoat
weasel, hedgehog, merlin
sparrowhawk, buzzard, kestrel
tawny owl, long-eared owl, heron
cormorant, goosander, merganser

carnivores and omnivores

brown rat, jay, raven, carrion crow, jackdaw, rook, hooded crow, curlew, gull, dabchick, great black-backed gull, BUGS

carnivores/omnivores/ scavengers

common shrew, mole, snipe, green plover, common sandpiper, frog, BUGS

carnivores of inverts

daubenton's bat, brown long-eared bat, robin, blue tit, cuckoo, meadow pipit, house martin, woodcock, dunnock, wren, chiffchaff, barn swallow, grey wagtail, wren, tree creeper, spotted flycatcher, BUGS

insectivores

omnivores

chaffinch, blackbird, redwing, tree pipit, skylark, fieldfare, bullfinch, coal tit, dipper, starling, woodlark, willow warbler, reed bunting, song thrush, greenfinch, ring ouzel, teal, tufted duck, whinchat, pied flycatcher, red grouse, stonechat, whitethroat, goldeneye, mistle thrush

herbivores

roe deer, red deer, field vole, mountain hare, brown hare, rabbit, red squirrel, bank vole, crossbill, lesser redpoll, woodpigeon, collared dove, twite, greylag goose, house sparrow, BUGS

vegetation

ash, silver birch, downy birch, sessile oak, pedunculate oak, holly, wild cherry, bird cherry, willows, heathers, dog rose, raspberry, stone bramble, bent grasses, couch grasses, fescues, hair grasses, mat grasses, meadow grasses, tussock grasses

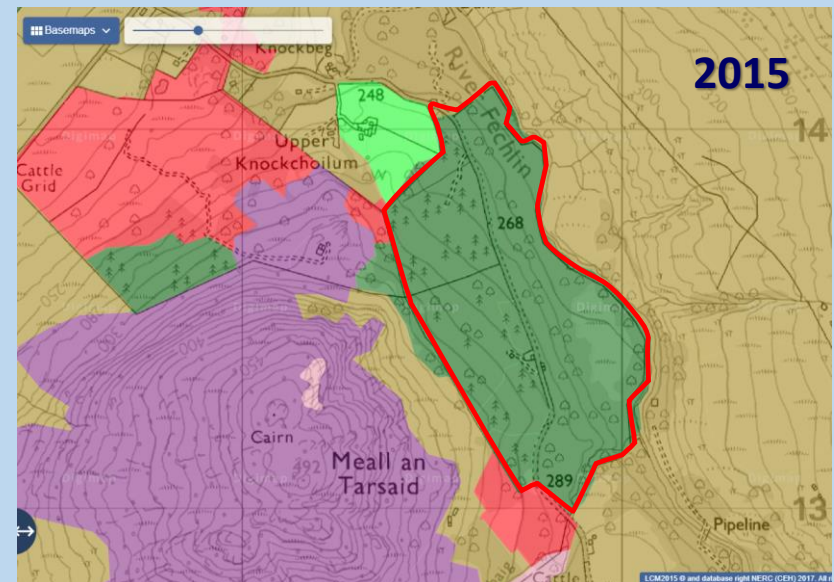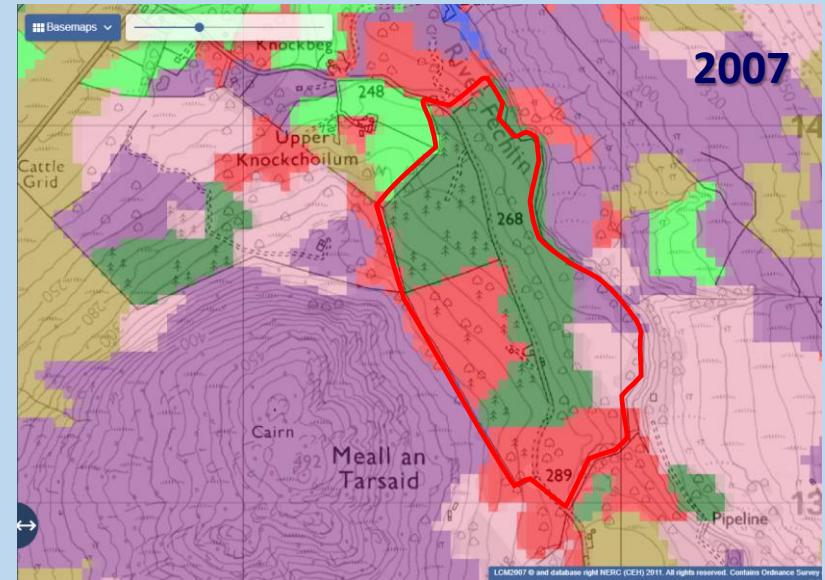Which are the **highly interactive** species? Which represent **target habitats** for Birchfields**?**

Home ranges of mammals, a reptile and amphibian in and near Birchfields - 40ha (99 acres)

WOLF!!!!

in

near

Stoat

Wood mouse

Wildcat

Common frog

Roe deer

Weasel

Badger

Common shrew & field vole

0.40 km²

Common lizzard

Fox
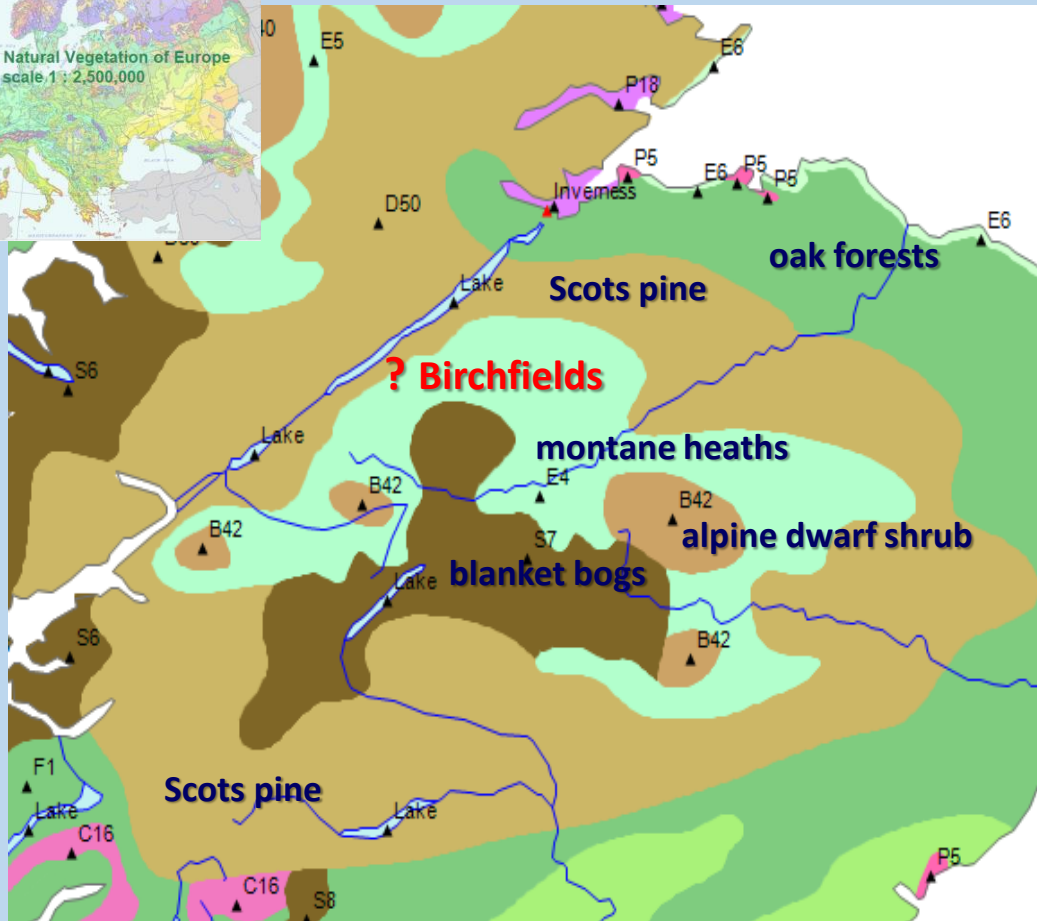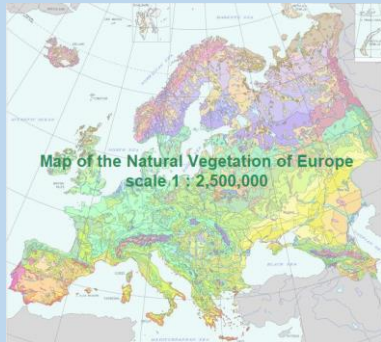
Red squirrel

Hedgehog

Mountain hare

Otter

Pine marten

Birchfields can only maintain populations of the smaller species **wholly within its confines.** Other species may utilise it as **part of their home range** or are just **passing through**

Limits of some mapping systems – CEH Land Cover Maps

Revision to 2015 shows no discrimination in woodland types on Birchfields – no birch and all conifer

Land Cover Map 2015

Land Cover Map 2015 was created by the Centre for Ecology and Hydrology, with funding from the Natural Environment Research Council

Legend:
- Broadleaved Woodland
- Coniferous Woodland
- Arable and Horticulture
- Improved Grassland
- Neutral Grassland
- Calcareous Grassland
- Acid Grassland
- Fen, Marsh and Swamp
- Heather
- Heather Grassland
- Bog
- Inland Rock
- Saltwater
- Freshwater
- Supra-littoral Rock
- Supra-littoral Sediment
- Littoral Rock
- Littoral Sediment
- Saltmarsh

2007

2015

Limits of some mapping systems – Natural Vegetation Mapping of Europe (2003)

Map of the Natural Vegetation of Europe
scale 1 : 2,500,000

oak forests

Scots pine

? Birchfields

montane heaths

alpine dwarf shrub

blanket bogs

Scots pine

Digital mapping system based on surviving remnants of natural and near-natural ecosystems and their correlation with site-specific conditions (climate, soil, temperature, nutrient & water balance) and the distribution of characteristic and differential plant species. Brings together plant ranges through **phytogeography and phytosociology** to display the potential distribution of the **dominant natural plant communities** under the current climatic and edaphic conditions, and across the **different zones of vegetation** with regard to **longitude, latitude and altitude**

Imprecision at this *local scale*
– best at showing trends, such as **Scots pine community** (D50=NVC W18)

National Forest Inventory – a snapshot in 2014
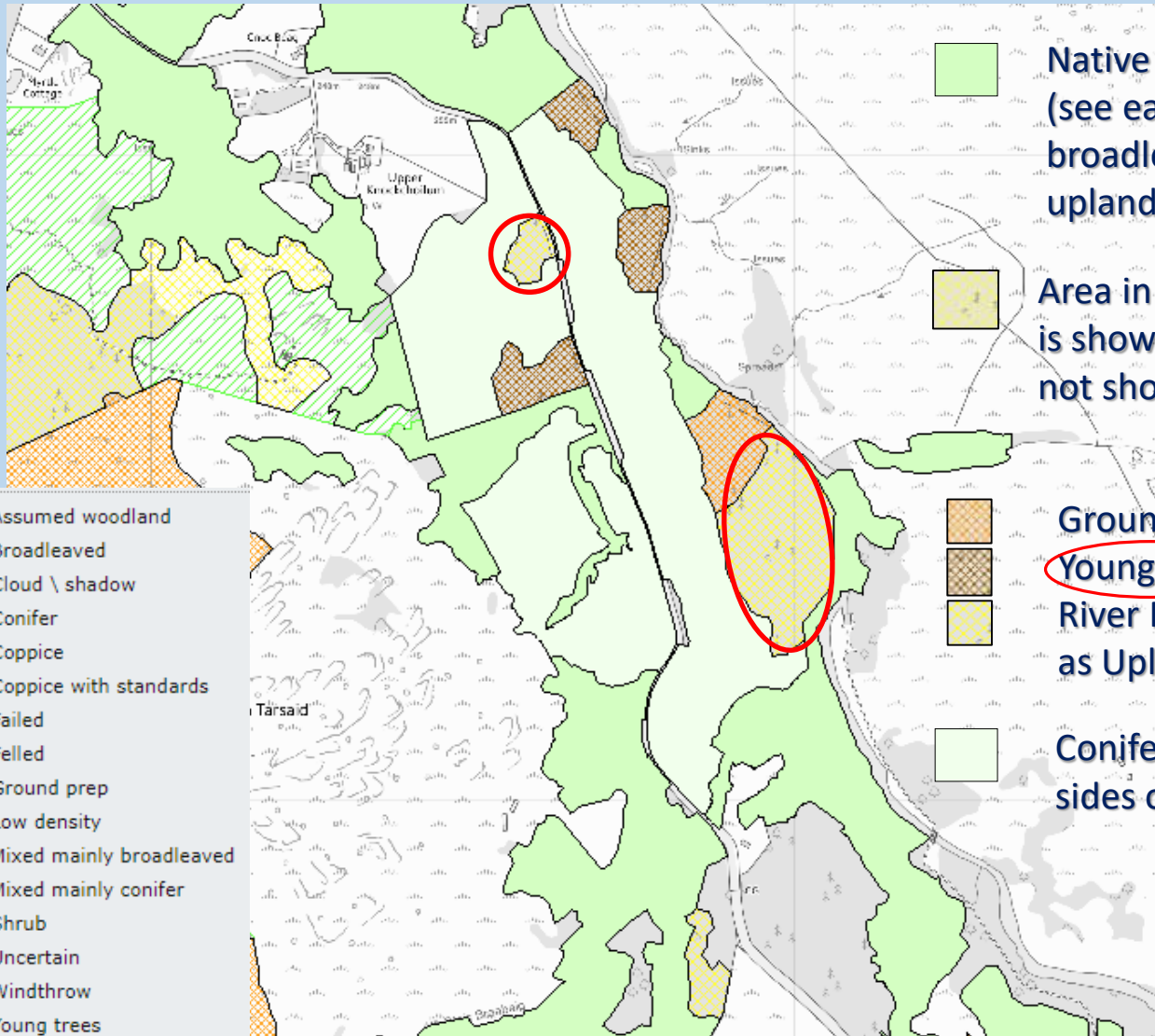
Native Woodland Survey for Scotland (see earlier) indicates that broadleaved woodland shown here is upland birch woodland

Area in upper quadrant to W of road is shown as Young Trees but this is not shown on Survey as Upland Birch

Ground preparation, Felled and Young Trees areas to E bound the River Feehlin. All these areas shown as Upland Birch on Survey

Conifer plantation woodland to both sides of road

Legend:
- Assumed woodland
- Broadleaved
- Cloud \ shadow
- Conifer
- Coppice
- Coppice with standards
- Failed
- Felled
- Ground prep
- Low density
- Mixed mainly broadleaved
- Mixed mainly conifer
- Shrub
- Uncertain
- Windthrow
- Young trees

Google Earth historical time satellite imagery 2005 and 2016
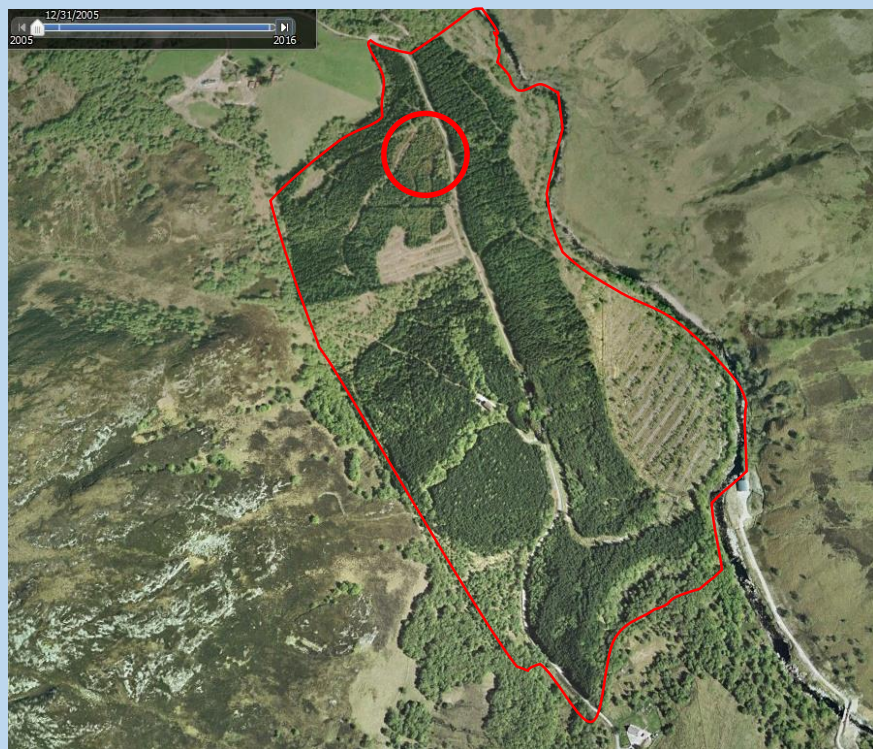
2005

2016

National Forest Inventory shows Young Trees in ringed area. Was this a much earlier area of felling? Is it developing Upland Birch woodland? Clear **felling of plantation** is apparent in 2005 in a small, upper quadrant section to the W of the road, and in areas to the E that bound the River Feehlin. **Clear felling of plantation** of the band that bounds the road to the E is shown in 2016. Progress in **canopy development of Upland Birch woodland** in the areas felled before 2005 is evident in 2016

Restoring natural vegetation at Birchfields – felling licences

9 Felling Licence Applications

- CASE_REF : CB274247
- PROPERTY : Birchfield
- FELL_TYPE : CF - Clear Felling
- DECISION : Conditional Licence
- DECISN_DAT : 13/12/2013
- STATUS : Expired Licence with Restocking Obligations
- CONS : Highland and Islands

FCS Grants and Regulations

Felling Licence Applications

- CF - Clear Felling
- FC - Felling Coppice
- FO - Felling Individual Trees
- SF - Selective Felling
- T - Thinning

5 Felling Licence Applications

- CASE_REF : FLA02508
- PROPERTY : Birchfield, By Whitebridge
- FELL_TYPE : CF - Clear Felling
- DECISION : Conditional Licence
- DECISN_DAT : 27/10/2017
- STATUS : Active Licence
- CONS : Highland and Islands

Is it the intention to **clear fell** areas of plantation woodland shown for thinning on the W side?

This would appear to be the next area to be felled

Expansion of Forest Habitat Network in Primary Zone
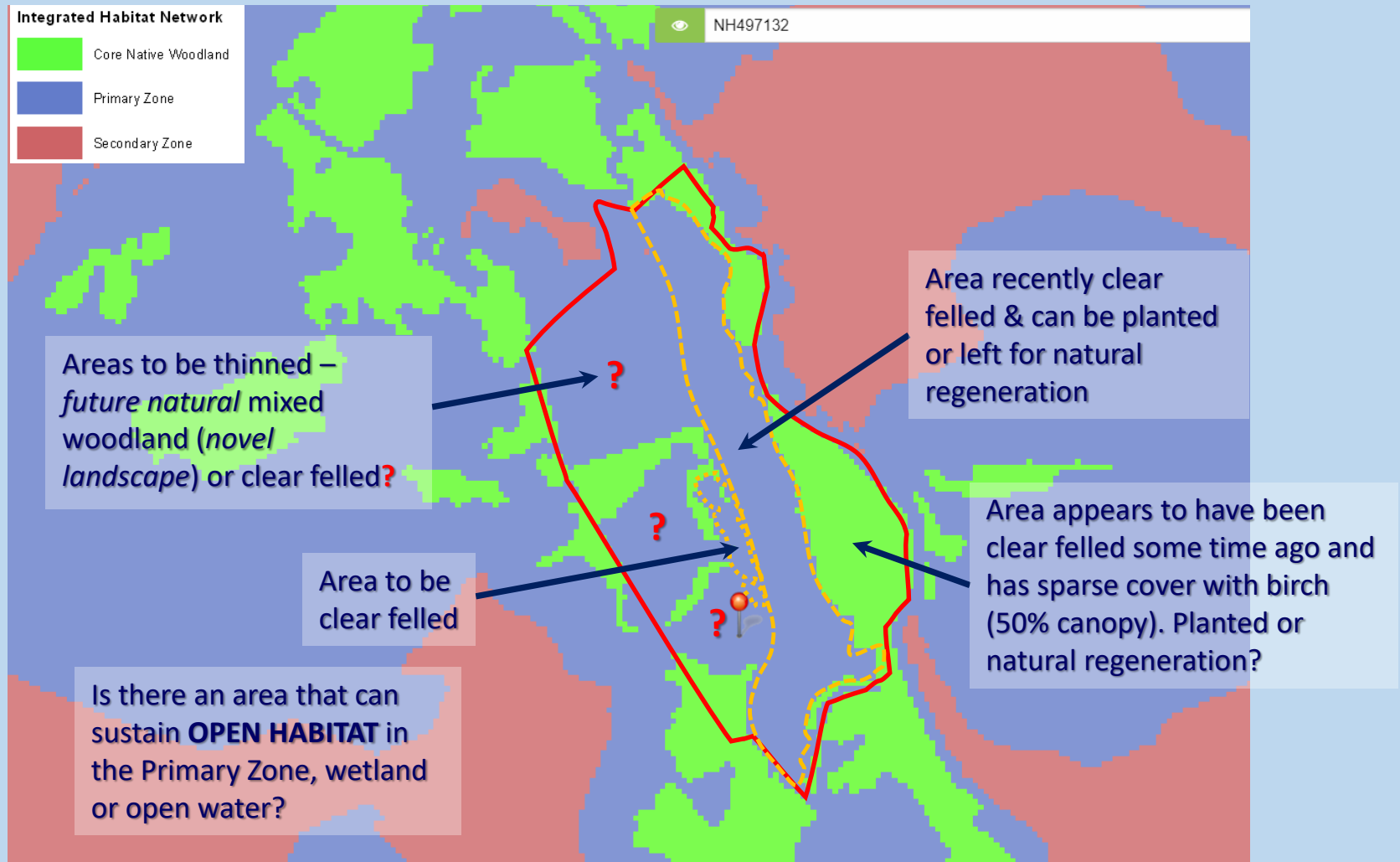
Determining the future trees and natural woodland communities at Birchfields

Forestry Commission developed an **ECOLOGICAL SITE CLASSIFICATION (ESC) for Forestry in Great Britain** as a decision support system that predicts **tree species** and **woodland communities** of the **National Vegetation Classification** (NVC) system for a location. The classification focuses on the key factors of site that influence tree growth, and that are important to the rest of the ecosystem. The close link between ESC and the NVC provides clear evidence of the ecological requirements of different vegetation communities, and exemplifies the ecological potential of the given site. The analysis is based on:
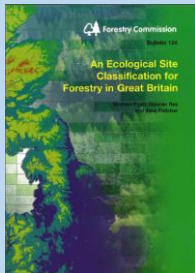
- **climate:** aspect, elevation, windiness and temperature
- soil **moisture**
- soil **nutrient**

Results are improved if local, finer-scale data on **soil type**, **soil moisture** and **soil nutrient** regime are inputted to the model. **Indicator plants** give the most precise indication of Soil Nutrient Regime, and there is a facility to add in observations of individual species through an option on vegetation surveys.

CLIMATIC DATA

Baseline climatic data: accumulated temperature (temperature days above 5^0C) continentality, exposure to wind, and moisture deficit (peak evaporation – precipitation) for the period 1961-1990 at a resolution of 250 metres. Rainfall is provided at 5km resolution for the same period
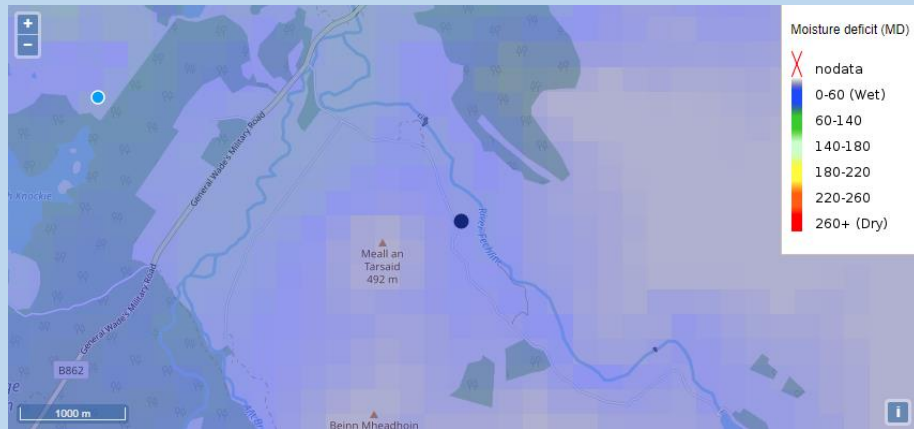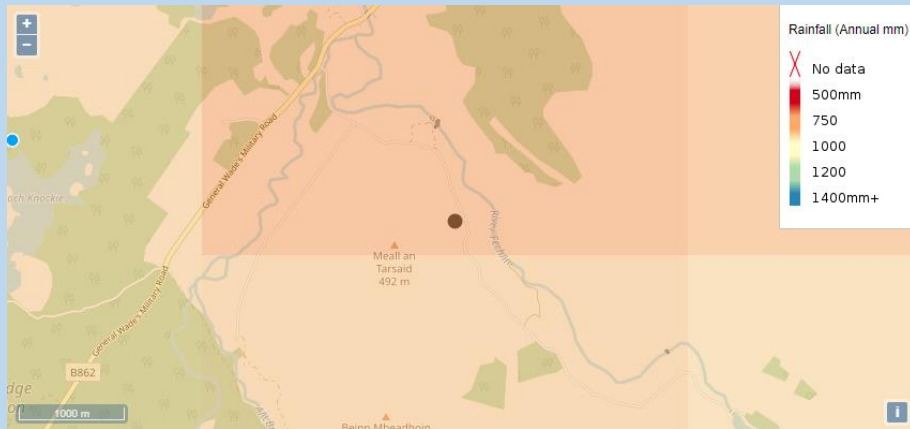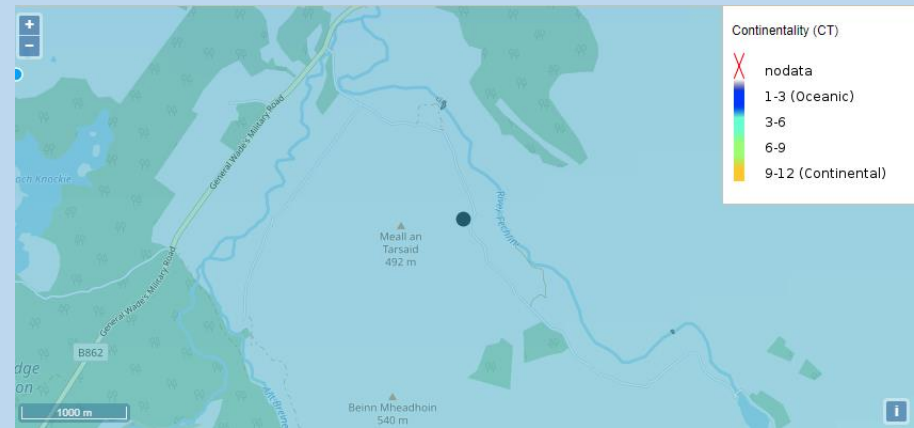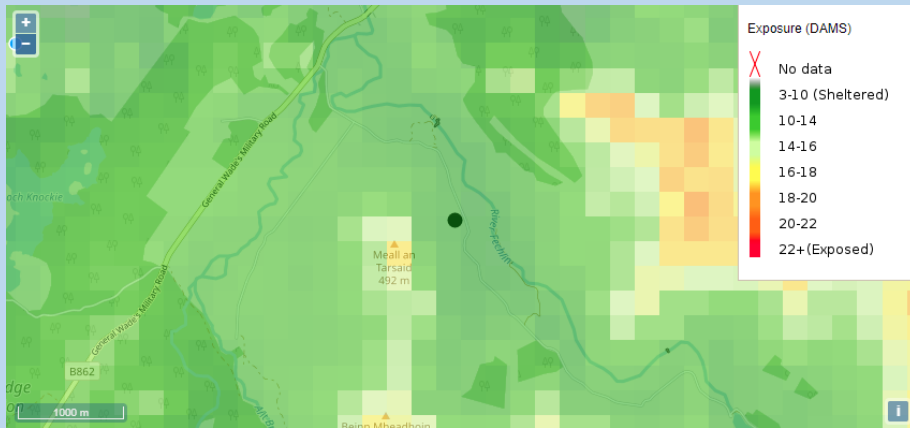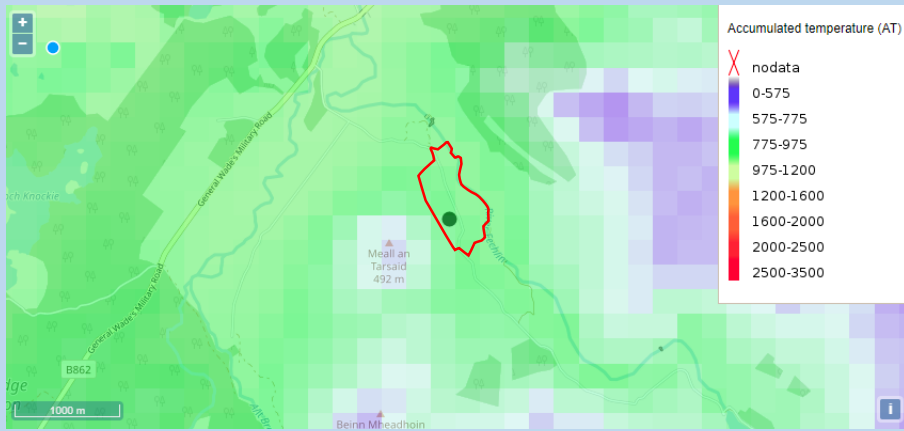
TOPOGRAPHIC DATA - elevation, aspect and slope, topographic shelter (topex) topographic wetness (CTI)
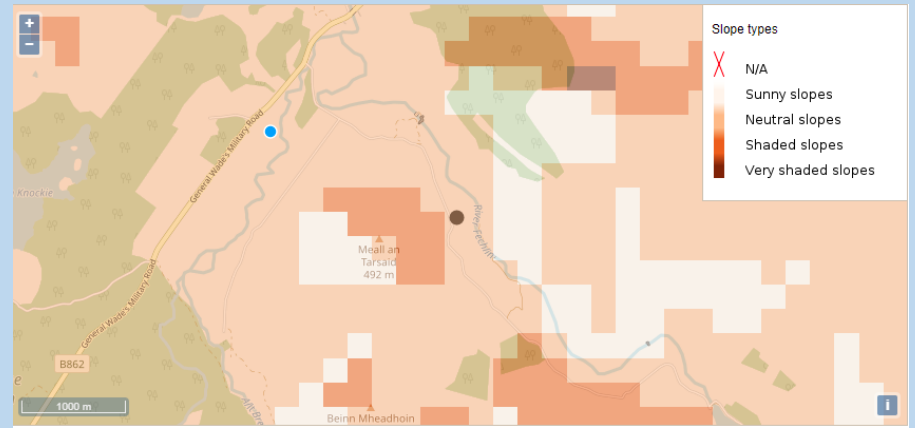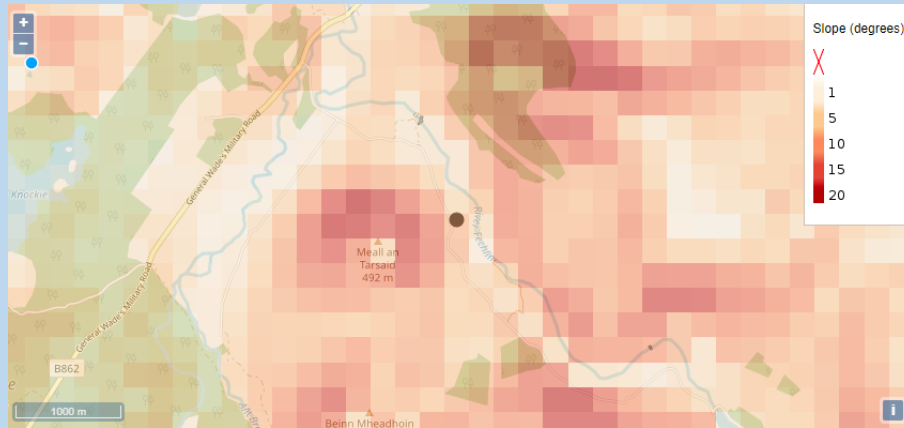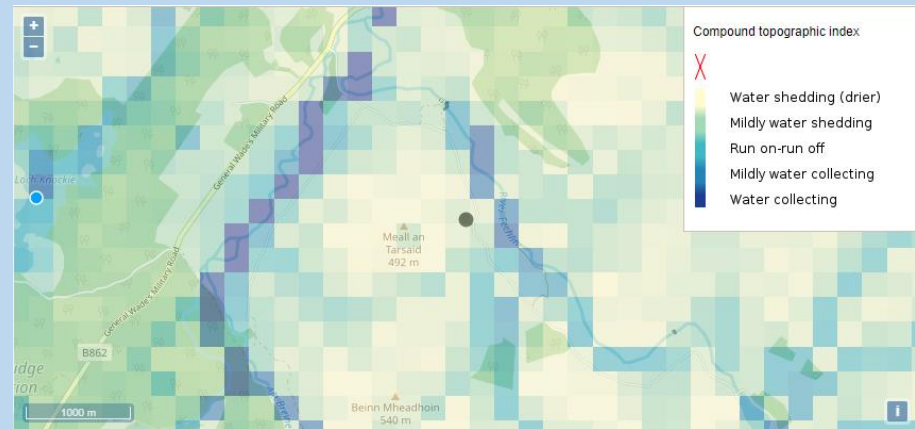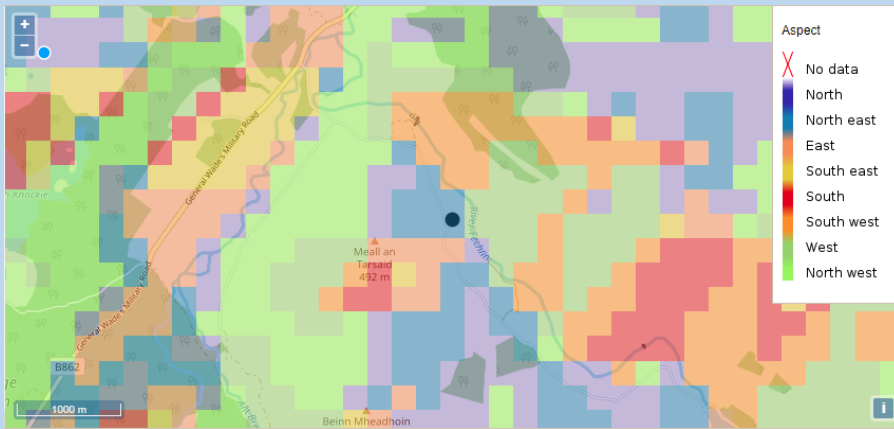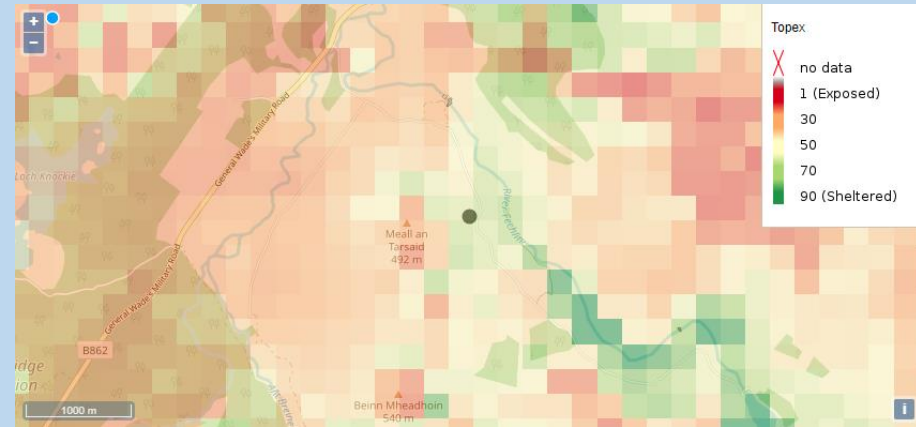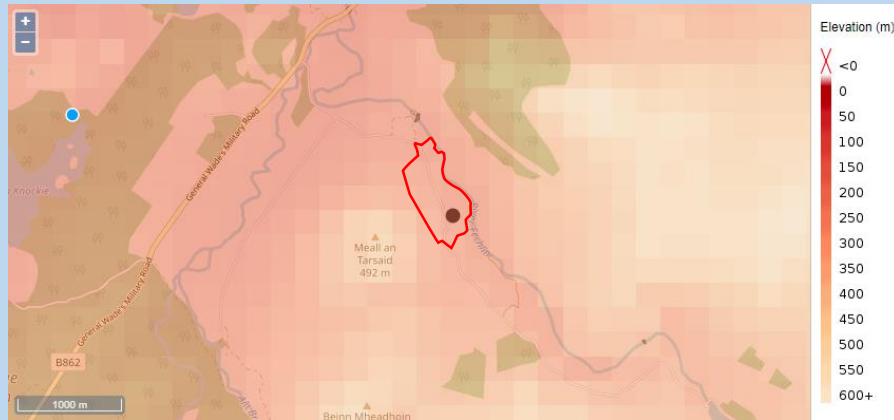
Baseline data on soil nutrient and moisture regime
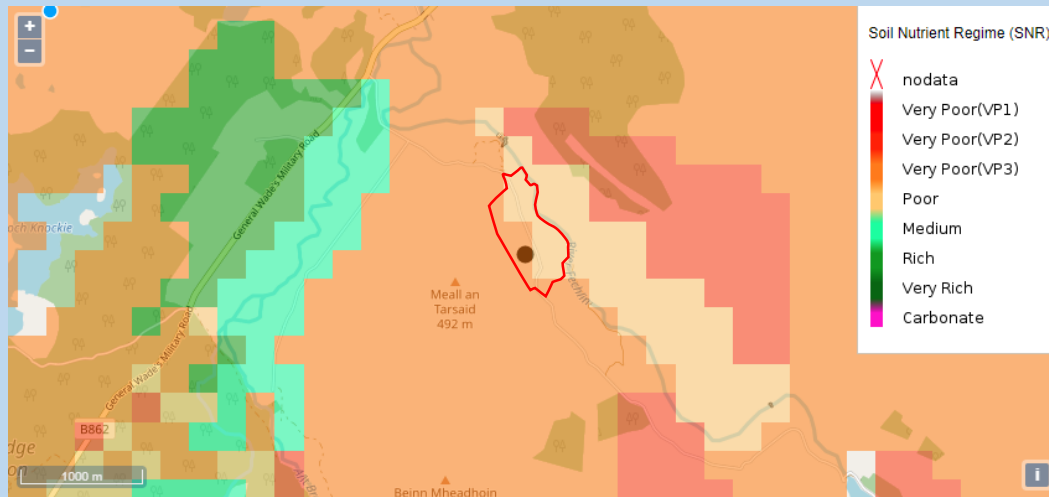
Soil Nutrient Regime classed as very poor VP1 (unflushed deep peat), very poor VP2 (heather dominated soils), very poor VP3(molinia dominated soils), poor (peaty gley), medium (surface water gley/brown earth), rich (brown earth of high base status), very rich(calcareous brown earth), carbonate (rendzinas)
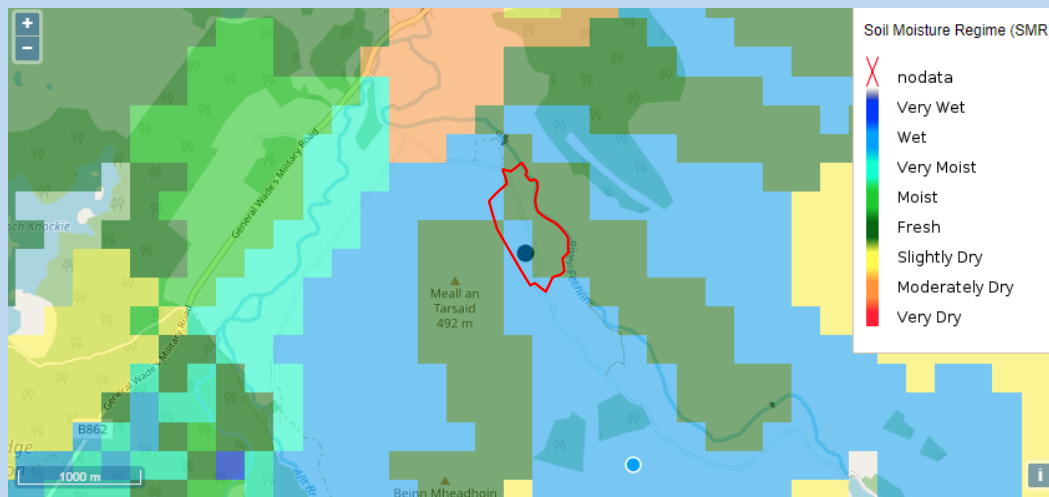
Soil Moisture Regime classed as water, very wet (deep peat), wet (peaty gley), very moist (surface water gley), moist (gleyed brown earth), fresh (brown earth), slightly dry (sandy podzol), moderately dry (shallow sandy podzol), very dry (rankers/shingle)

Maps of tree species suitability alongside climate and topographic conditions
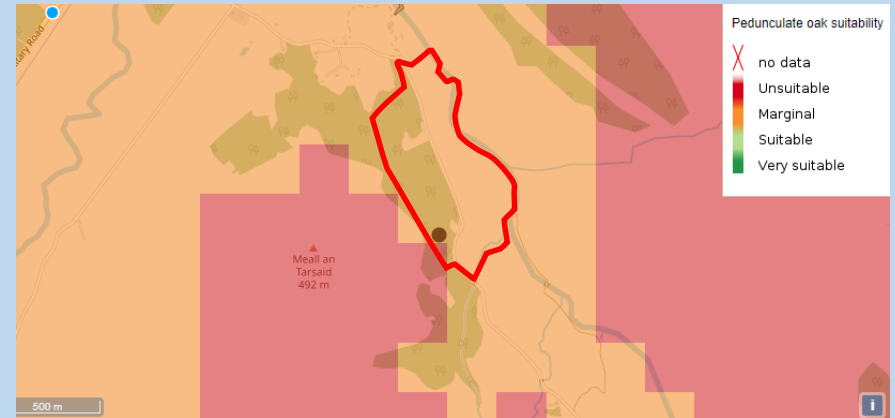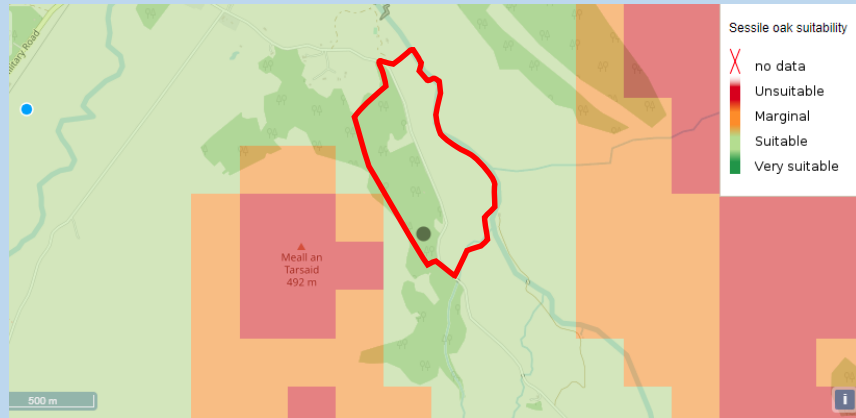
Sessile oak (*Quercus petraea* - upland) more suitable than **Pendunculate oak (***Quercus robur* - lowland)
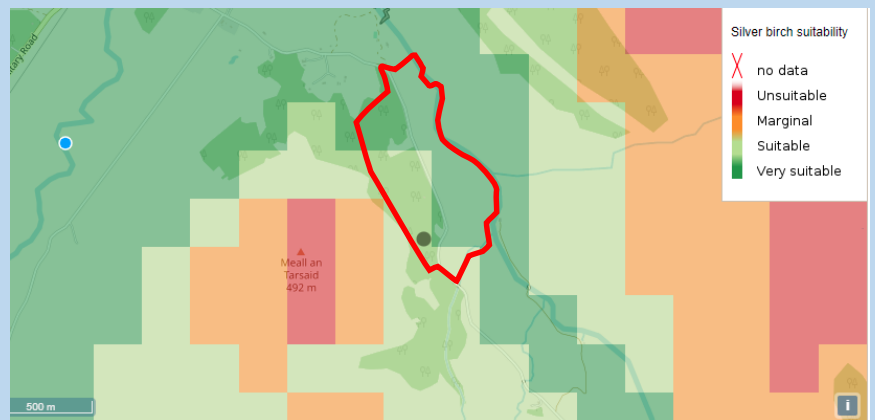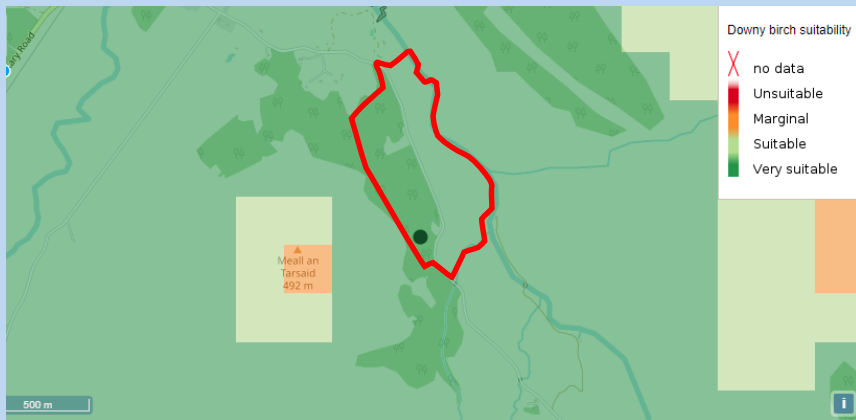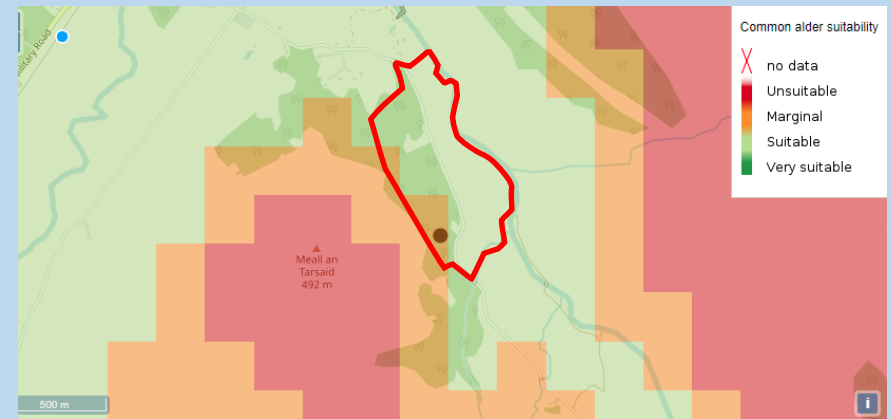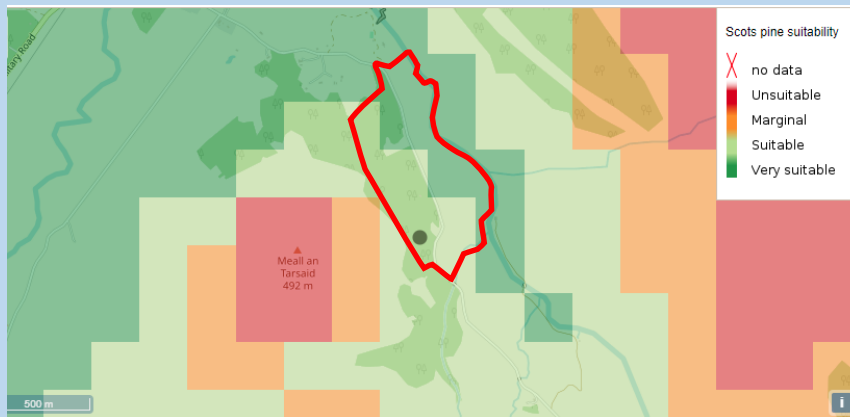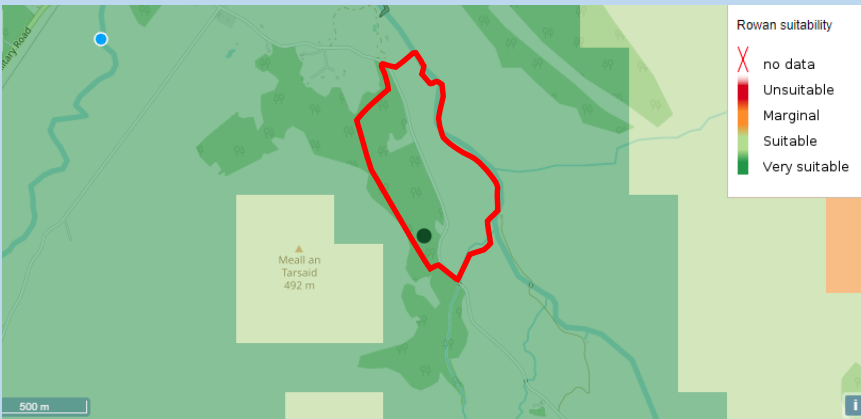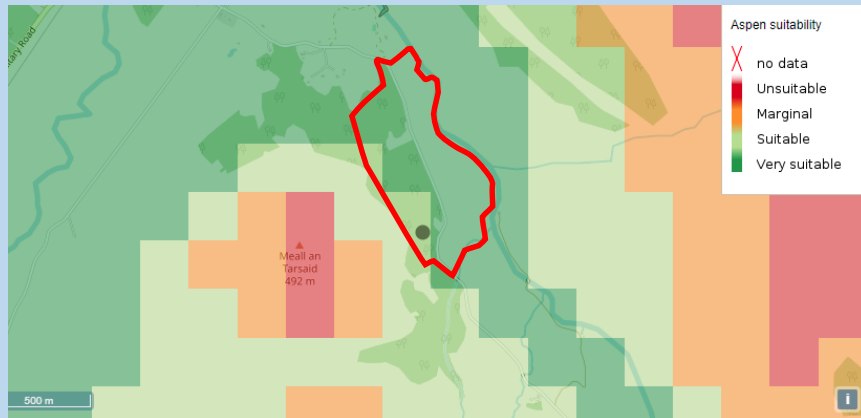
Downy birch (*Betula pubescens* – uplands, wetter, Scotland) marginally more suitable than **Silver birch** (*Betula pendula*)

New mapping March 2021

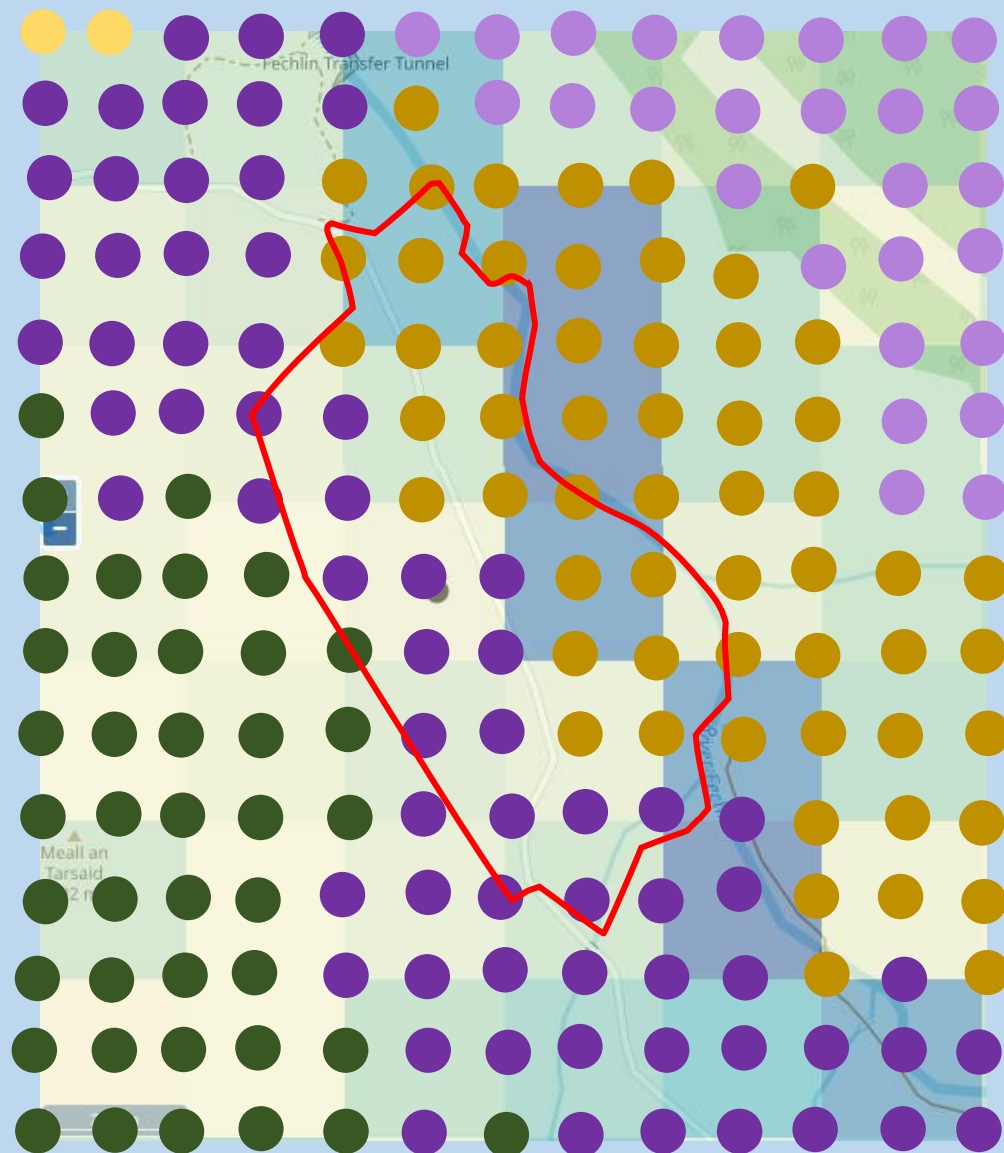# Maps of tree species suitability alongside climate and topographic conditions

Aspen (*Populus tremula*) **Rowan** *(Sorbus aucuparia)* & **Scots pine** *(Pinus sylvestris)* have widespread suitability

Alder (*Alnus glutinosa*) less so

New mapping March 2021

Potential pine, birch, and oak communities in and around Birchfields
- investigaton of finer scale mapping for ESC needed

Suitability key
- Very Suitable (0.75-1.00)
- Suitable (0.50-0.74)
- Marginal (0.30-0.49)

W17	Oak-birch with bilberry/blaeberry(Upland)	▲	
W18	Scots pine with heather	▲	

W4	Birch with purple moor grass	▲	

W7	Alder-ash with yellow pimpernel	▲	
W11	Oak-birch with bluebell/wild hyacinth	●	
W17	Oak-birch with bilberry/blaeberry(Upland)	●	
W18	Scots pine with heather	●	
W19	Juniper with wood sorrel	●	
W20	Salix lapponum-Luzula sylvatica	▲	

W4	Birch with purple moor grass	●	
W20	Salix lapponum-Luzula sylvatica	▲	

|			
W17	Oak-birch with bilberry/blaeberry(Upland)	▲	
W18	Scots pine with heather	●	
W19	Juniper with wood sorrel	▲	
W20	Salix lapponum-Luzula sylvatica	▲	

Maps of Indicative Native Woodlands at Birchfields

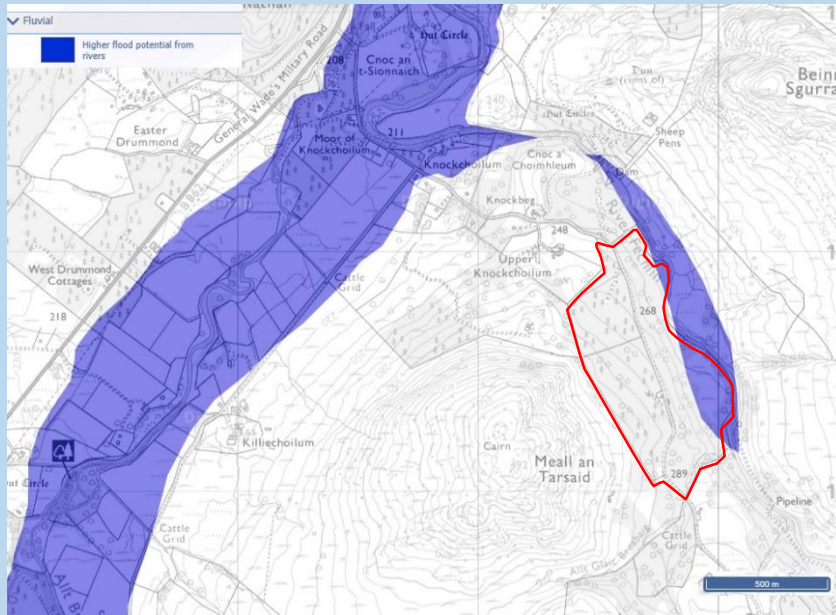Maps based on climate suitability for upland birch (W4) and Scots pine (W18)

New mapping March 2021

Maps of Indicative Native Woodlands at Birchfields

Maps based on climate suitability for upland oak (W11 and W17)

New mapping March 2021
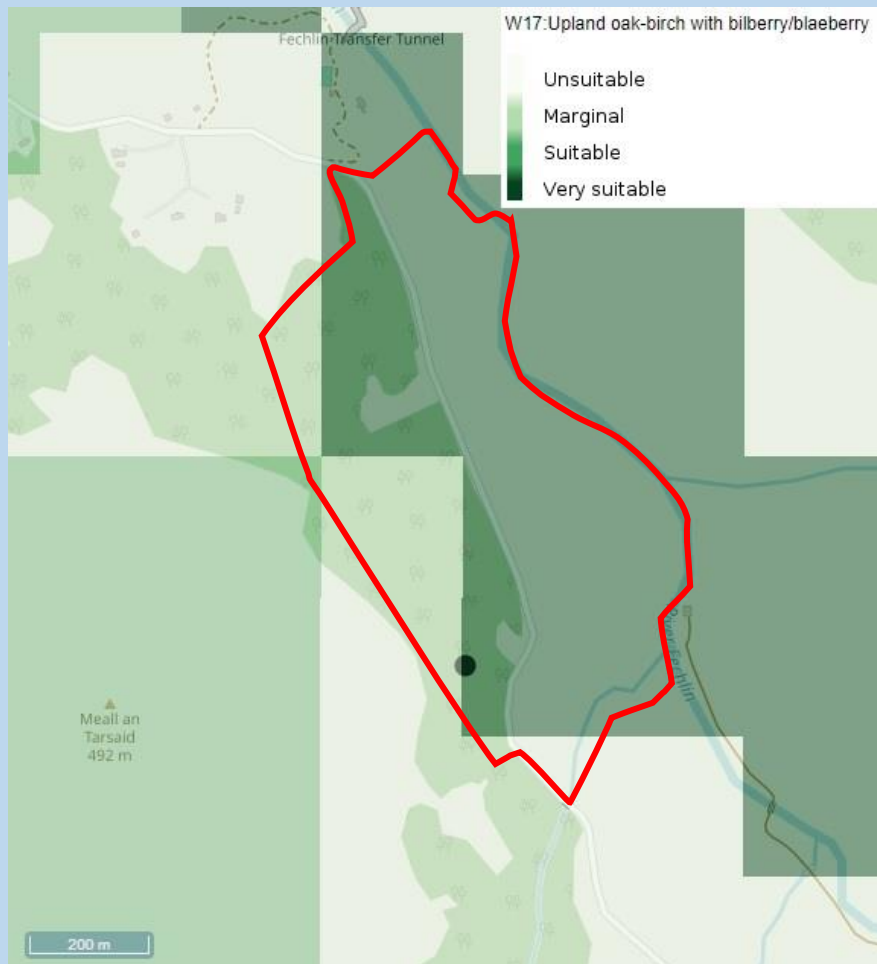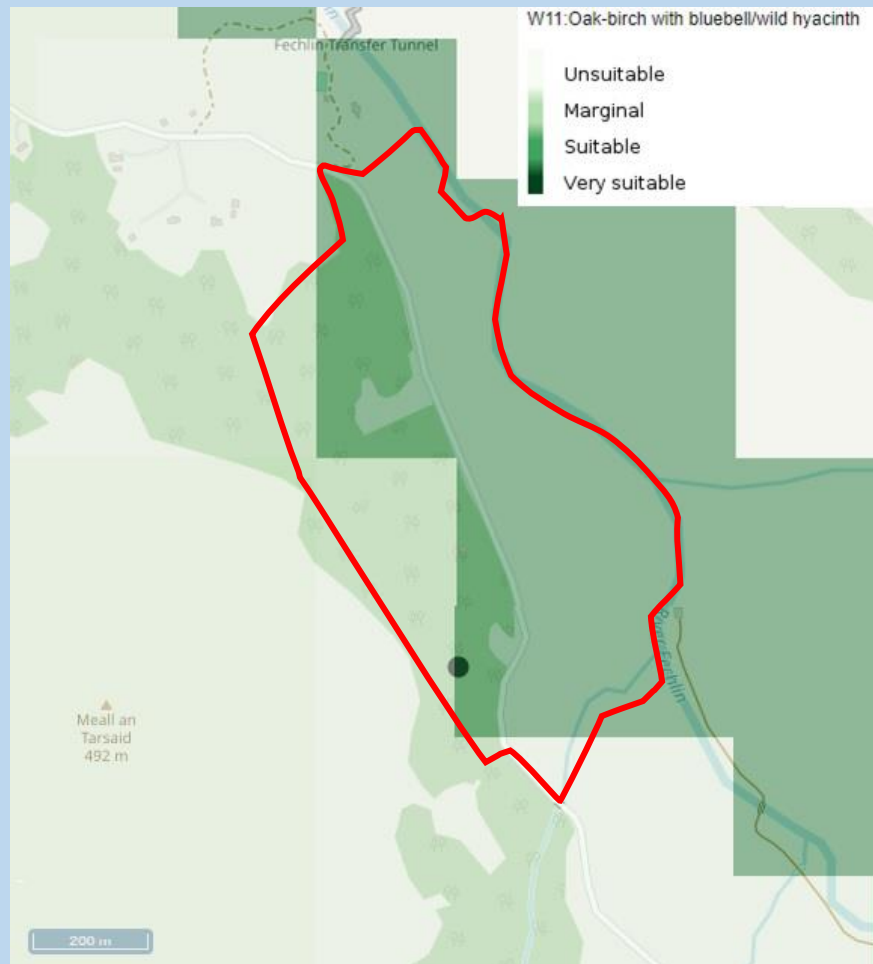
Flood potential at Birchfields

Soil moisture at Birchfields is wet to fresh, the topographic index appearing to suggest also a **gradient** between water shedding and collecting. Fluvial modelling indicates a **potential for flooding** of the eastern-most felled area by the River Feehlin
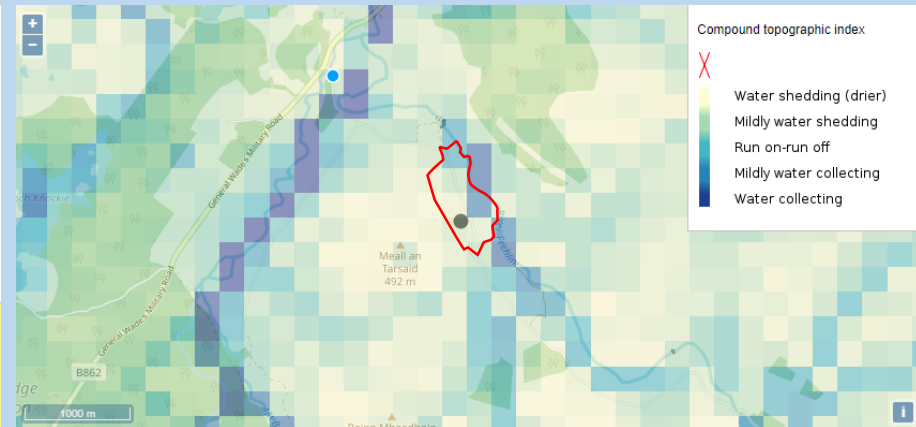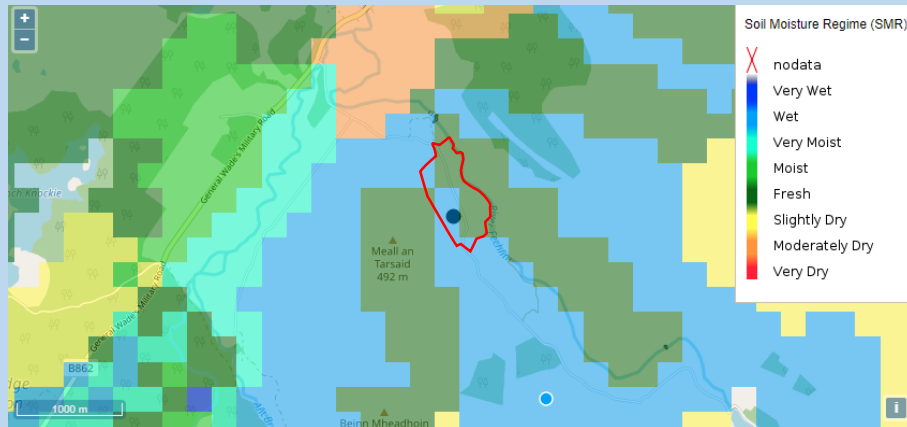
Does this have any implications for **vegetation restoration** in this area of Birchfields? **Aspen, alder**?

FINDINGS at Birchfields

- located within a highly significant potential **wildlife movement linkage** based on **Forest Habitat Network** mapping
- Birchfields is **connected to designated protected areas** via the habitat network links
- species data records show presence of a **wide range of species** located within the habitat network, as well as areas of **native** Upland birchwood
- migration into Birchfields would **restore trophic structure**
- **ecological richness** would be manifested by **trophic interactions** between such as mammalian mesopredators and avian predators preying on herbivorous small mammals and birds
- an imperative would be to **restore native woodland communities** within the **Primary Zone** for network expansion identified in Birchfields by Forest Habitat Network mapping
- **Ecological Site Classification** identifies oak (W11, W17) birch (W4) and Scots pine (W18) native **upland** woodland communities
- Eastern edge of Birchfields could be prone to **flooding** from river

QUESTIONS and NEXT STEPS

What is the **VISION** for **Birchfields**?
Does this approach of restoring **ecological richness** through **network design** fit with the vision?
What level of **ANALYSIS** and **DESIGN** is needed to support this vision?