

SM2: Final 2050 scenario vision and descriptions from Syder et al., *in prep*

Scenario Attributes	Description
Vision Statement	An overarching vision statement capturing their desired vision for the future
Ecosystem Services/Nature's Contribution to People	The benefits people obtain from the landscape. Used interchangeably for the purposes of this study based on which term stakeholders were most comfortable with.
Treescape Intervention	A specific change in land cover, use or management (e.g., woodland creation, peatland restoration, meadow restoration).
Spatial Criteria	A spatial criteria defining where a specific land-use should (or shouldn't) be located within the case study landscape (e.g., no tree planting on peat soils; prioritise woodland creation next to existing woodland)
Wider Change	Additional changes outside the list of land-use changes provided i.e., housing and infrastructure, solar or wind energy, permissive footpaths.

SM3: Ecosystem service assigned importance by stakeholder interest group in North Pennines & Dales (NP) and Elenydd (ED) Landscapes. Grey boxes represent this ES was mentioned in workshop discussions for that group, whereas white represents this was not mentioned. ✓ represents that ES included in final vision.

	Ecosystem service	Land		Access		Farming		Conservation	
		ED	NP	ED	NP	ED	NP	ED	NP
Provisioning	<i>Water supply</i>	✓					✓		
	<i>Green energy</i>								
	<i>Timber and other wood products</i>								
	<i>Food and other animal products</i>		✓			✓	✓		
	<i>Quarry material</i>								
Regulating	<i>Carbon sequestration</i>	✓	✓		✓	✓			✓
	<i>Biodiversity</i>	✓	✓	✓	✓	✓	✓	✓	✓
	<i>Air quality</i>								
	<i>Water quality</i>						✓	✓	
	<i>Water storage and flood management</i>		✓		✓	✓	✓		✓
Cultural	<i>Aesthetics</i>								
	<i>Education and research</i>				✓				
	<i>Health and wellbeing</i>			✓					
	<i>History and heritage</i>				✓				
	<i>Local communities</i>	✓							
	<i>Nature as culture</i>							✓	
	<i>Recreation</i>				✓				✓
	<i>Tourism</i>								
	<i>Access</i>	✓		✓					
	<i>Peace</i>								
	<i>Farming Heritage</i>					✓			

SM4 All groups' land use scenarios including ecosystem services, wider land use changes, interventions, and spatial criteria. Interventions are numbered and each spatial criteria which relates to each invention is labelled with corresponding numbers. We also note how participants' spatial criteria were treated in the spatial modelling. List of all data used can be found in Supplementary Methods SM1.

1) Elenydd LAND

Ecosystem services: Water, Biodiversity (woodland Special Areas of Conservation (SAC), curlew/upland bird), Carbon, Access, Community

Interventions: (1) Peatland restoration, (2) Woodland creation, (3) Wood pasture, (4) Other trees, (5) Scrub/Ffridd, (6) Mixed forestry, (7) Alter stocking density

<i>Spatial criteria</i>	<i>How we defined</i>
Scrub around bracken line where woodlands should be (5)	In locations which are currently bracken, using a bracken data layer from remote sensing
Scrub around 'edges' of forestry blocks to soften transitions (5)	In 20m buffer around existing coniferous woodland, deployed on pixels nearest to coniferous woodland first
Woodland near to water courses (riparian) (2)	Within 50m buffer of rivers/streams
Woodland near to existing woodlands to improve connectivity, connect SAC pockets first (2)	Buffer 200m around existing deciduous woodlands, deployed in SACs first
No planting where Curlew have been found (2, 3, 4, 5, 6)	Not in Claerwen NNR
Allow scattered trees on peat as part of natural colonisation (4)	On peat soils, within 100m buffer of deciduous woodland
No planting on SSSI meadows (2, 3, 4, 5, 6)	Not on priority grasslands
Shift from conifer woodland to mixed productive woodland (6)	On coniferous woodland pixels
Peatland restoration (1)	On peat soils (unless currently bog)
Altering stocking density (7)	Increase cattle livestock units by 100%, and decrease sheep by the same livestock units as the cattle.
Wood pasture on in-bye land and most productive areas (3)	Not within the upper limit of enclosure, deployed on highest agricultural land class first.

2) Elenydd CONSERVATION

Ecosystem services: Biodiversity, Climate change, Water Quality, Cultural people's heritage, Economy and livelihoods

Interventions: (1) Peatland restoration, (2) Hedges (3) Wood pasture, (4) Woodland (natural colonisation), (5) Woodland (planting), (6) Ffridd/scrub, (7) Meadows, (8) Mixed woodland, (9) Alter stocking density

<i>Spatial criteria</i>	<i>How we defined</i>
No planting in active bogs (3, 5, 6, 9)	Not on peat soils
No vegetation on lead mines/slay heaps (3, 4, 5, 6, 8)	Not on 4 known lead mines and 500m buffer around them

Mixed woodland planting only in areas of low ecological score (8)	On NRW ecological 5 only (lowest)
Ffridd/scrub planting in areas inaccessible by sheep/browsers (e.g going up crags) (6)	On cells defined as bracken or on steep slopes greater than 20 degrees
Ffridd/scrub in transition areas that are currently used for grazing (6)	In-bye grasslands (below the upper limit of enclosure layer)
No trees within 1km of curlew nesting area or in middle of in bye with hedges (3, 5, 6, 9)	Not in Claerwen NNR and 1km buffer Not in in-bye areas (below the upper limit of enclosure layer) which contain hedgerows
Allow scattered trees on peat as part of natural colonisation (4)	On peat soils, within 100m buffer of deciduous woodland
No planting on SSSI meadows (3, 4, 5, 6, 9)	Not on priority grasslands
Peatland restoration (1)	On peat soils (unless currently bog)
Altering stocking density (9)	Increase cattle livestock units by 100%, and decrease sheep by the same livestock units as the cattle.
Hedges (2)	We increased the length of hedgerows within each 10m cell by 100% (only in cells with current hedgerows).
Woodland planting as second alternative to natural colonisation. From local seed sources. Prioritize connectivity (5)	200m buffer from existing woodland
Natural colonisation of woodland (4)	100m buffer from existing woodland

3) Elenydd – FARMING

Ecosystem services: Peatland – carbon and water management, Food – passion for local meat and its nutritional value, Biodiversity, Culture and Farming Heritage of the landscape

Interventions: (1) Peatland restoration, (2) Ffridd/scrub, (3) Other trees, (4) Allow natural colonisation on peat, (5) Maintain species rich grasslands & rhos pasture

<i>Rules</i>	<i>How we defined</i>
No planting on peat (2, 3)	Not on peat soils
Create buffer to not allow natural colonisation around watercourses to protect water voles (2)	Not within 50m buffer around rivers and streams
Allow natural colonisation on peat (4) and ffridd (2)	Within 100m of current woodland on peat soils Within 100m of current scrub
Scattered trees must be around buildings and tracks to replace heritage ones lost (3)	Within 20m buffer of OS buildings (tracks not mapped)
No trees on rhos pasture or species rich grassland (2, 3)	Not on priority grasslands or rush pastures

4) Elenydd ACCESS

Ecosystem services: Mosaic of linked habitats – biodiversity, Reintroduction of species richness – e.g. red squirrels, Enhanced inclusive community engagement – wellbeing, Improved access for all – wellbeing, Local prosperity – economic benefits

Interventions: (1) Peatland restoration, (2) Other trees, (3) Deciduous woodland, (4) Ffridd/scrub, (5) Semi-natural grassland, (6) Less bracken, more heather, (7) Low carbon farming, (8) Alter stocking density

<i>Rules</i>	<i>How we defined</i>
Maintain and restore peat areas (1)	On peat soils (unless currently bog).
Other trees in corner of field margins and hedgerows (2)	Along boundaries of fields.
Natural colonisation along rivers and streams to extend current woodlands (3)	Within 100m of existing woodlands along waterways.
Expand ffridd from current areas through natural colonisation (4)	Within 100m of existing scrub.
Expand grasslands from current hay meadows (5)	Within 1km buffer of 'lowland meadows' which include hay meadows.
Low carbon farming (7)	We assume electrification in farming vehicles resulting in 50% reduction in fuel use.
Alter stocking density (8)	Increase cattle livestock units by 100%, and decrease sheep by the same livestock units as the cattle.
Less bracken on upland slopes (6)	Bracken cells, on slopes over 5 degrees.
Re-wetting grassland & Rhos pasture (buffer around streams/rivers) (5)	Areas defined as suitable for M23, M25 and M25 grassland (purple moor grass communities).

5) North Pennines & Dales - LAND

Ecosystem services: Carbon, Habitat Connectivity, Business resilience/economy, Increased biodiversity, Water management, Food production/animal

Interventions: (1) Tree standards, (2) Mixed woodland creation, (3) Semi-natural grassland, (4) Remove conifer plantations, (5) Scrub, (6) Orchards, (7) Peatland restoration, (8) Low carbon farming, (9) Alter stocking density

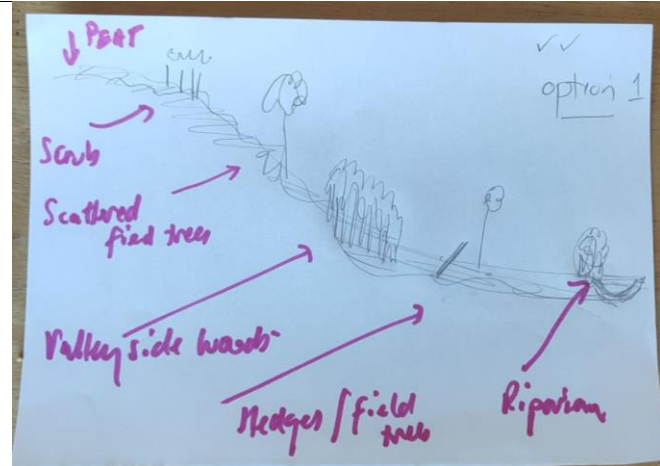
<i>Rules</i>	<i>How we defined</i>
Riparian and gill woodland at lower elevations (2)	Within 50m of rivers and streams, below the moorline.
Scrub in upland gills and bracken slopes (5)	Within 50m of rivers and streams, above the moorline. Areas defined as bracken using satellite imagery.
No planting on peat (1, 2, 5, 6)	Not on peat soils.
No planting where there are breeding waders (1, 2, 5, 6)	Not in combined BTO wader zones (wader hotspots).
No planting on key habitats (e.g. calamarian grassland, upland grasses/flushes) (1, 2, 5, 6)	No planting on Natural England priority habitats: Calaminarian grassland, limestone pavement, purple moor grass and rush pastures, upland calcareous grassland, upland flushes, fens and swamps, upland hay meadow.
Broadleaves on the edge on boundaries (1)	On grassland field boundaries.
Expand hay meadows (3)	Within 1km of current hay meadows.
Orchard (no rules given) (6)	Mentioned as a silvopastoral system, so these were placed in improved grassland areas only.

Peatland restoration (7)	In areas of peat soil (unless currently bog), or on areas of degraded bog (defined from NE peat status data and muirburn data).
Remove conifer plantations (no rules given) (4)	If conifer is currently on peat soils, these are converted to bog. If conifer is currently on non-peat soils, they are converted into broadleaved woodland.
Low carbon farming (8)	We assume electrification in farming vehicles through 50% reduction in fuel use.
Alter stocking density (9)	Increase cattle livestock units by 50% and decrease sheep by the same livestock units as the cattle.

6) North Pennines & Dales – CONSERVATION

Ecosystem services: Wildlife, Carbon, Water, Rural livelihoods, Recreation and tourism

Interventions: (1) Scrub, (2) Scattered field trees, (3) Woodland planting, (4) Woodland natural colonisation, (5) Hedgerows, (6) Wood pasture, (7) Mixed productive woodland, (8) Peatland restoration

Rules	How we defined
No planting on peat (1, 2, 3, 6, 7)	Not on peat soils.
Avoid priority habitats, except heather (1, 2, 3, 4, 6, 7)	Not on Natural England priority habitats, except Lowland heathland, Upland heathland, Grass moorland.
Don't allow planting in wader zones, except for upland gills & steep slopes (1, 2, 3, 6, 7)	Avoid areas in combined BTO wader zones (wader hotspots), unless upland gills (50m buffer from rivers, above the moorline), or on slopes above 20 degrees.
Mixed woodland on accessible slopes (7)	Within 100m of roads.
Woodland in gills, riparian areas and steep slopes and prioritise connectivity (3)	Gills & slopes as 50m buffer around rivers and watercourses. Steep slopes over 20 degrees. Deploy interventions closest to existing woodlands first.
Peatland restoration (8)	In areas of peat soil (unless currently bog), or on areas of degraded bog (defined from NE peat status data and muirburn data).
Woodland natural colonisation (4)	Within 100m buffer of existing woodlands.
	<p>Scrub above 400m. Scattered field trees between 200 and 600m. Wood pasture below 300m.</p>

7) North Pennines & Dales – FARMING

Ecosystem services: Sustainable working landscapes – community driver, Food production through good soil health, Biodiversity – maintaining high quality habitats within the landscape, Water quality, supply and storage

Interventions: (1) Maintain semi-natural grasslands, (2) Replace conifer woodland with broadleaved, (3) Scrub, (4) Wood pasture/parkland, (5) Low carbon farming, (6) Other trees

<i>Rules</i>	<i>How we defined</i>
No planting on peatland (3, 4, 6)	Not on peat soils
Scrub in upland gills (3)	Within 50m buffer around streams above the moorline, on slopes above 5 degrees.
Wood pasture for livestock in lower area (4)	On improved grassland, below the moorline.
Tree standards within hedgerows (6)	On cells where hedgerows are present.
No wood pasture in wader areas (4)	Not in combined BTO wader zones (wader hotspots).
Prioritise wood pasture in buffers around existing woodland (4)	Place intervention on cells closest to existing woodland first.
No planting on good species rich grassland (3, 4, 6)	No planting on Natural England priority grasslands: Calaminarian grassland, Lowland calcareous grassland, Lowland meadows, Upland calcareous grassland, Upland hay meadow.
Use unproductive areas for biodiversity (3, 4, 6)	On agricultural land classification 4 & 5 only (the least agriculturally productive).
Low carbon farming (5)	We assume electrification in farming vehicles through 50% reduction in fuel use.

8) North Pennines & Dales – ACCESS

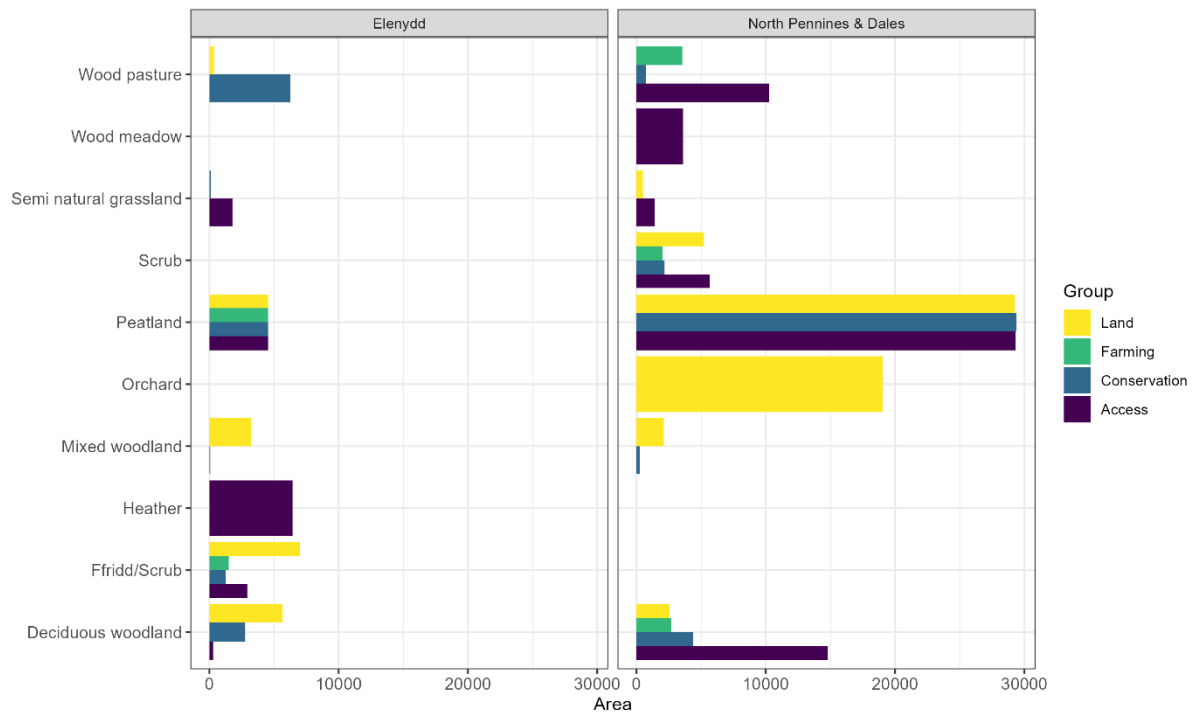
Ecosystem services: Biodiversity, Carbon sequestration and flood mitigation (joint second position), Recreation and tourism values linked to health and well-being benefits for people, Educational opportunities to enhance understanding of the natural and cultural heritage of the region, through research and developing skills and jobs, Biocultural heritage protected for past, present and future.

Interventions: (1) Wood meadows, (2) Peatland restoration, (3) Scrub, (4) Other trees, (5), Deciduous woodland, (6) Replace conifer with broadleaved, (7) Semi-natural grassland, (8) Wood pasture, (9) Alter stoking density

<i>Rules</i>	<i>How we defined</i>
Wood meadows within in-bye enclosed land (1)	On improved grassland below the moorline
Prioritise peatland restoration in areas used for grouse shooting (2)	Deployed on areas of muirburn first
Scrub below open moorland (3)	Below the moorline
Trees on boundaries (4)	On grassland boundaries
Woodland creation in upland gills and blacken slopes (5)	Upland gills: 50m around streams above the moorline, above 5 degrees.

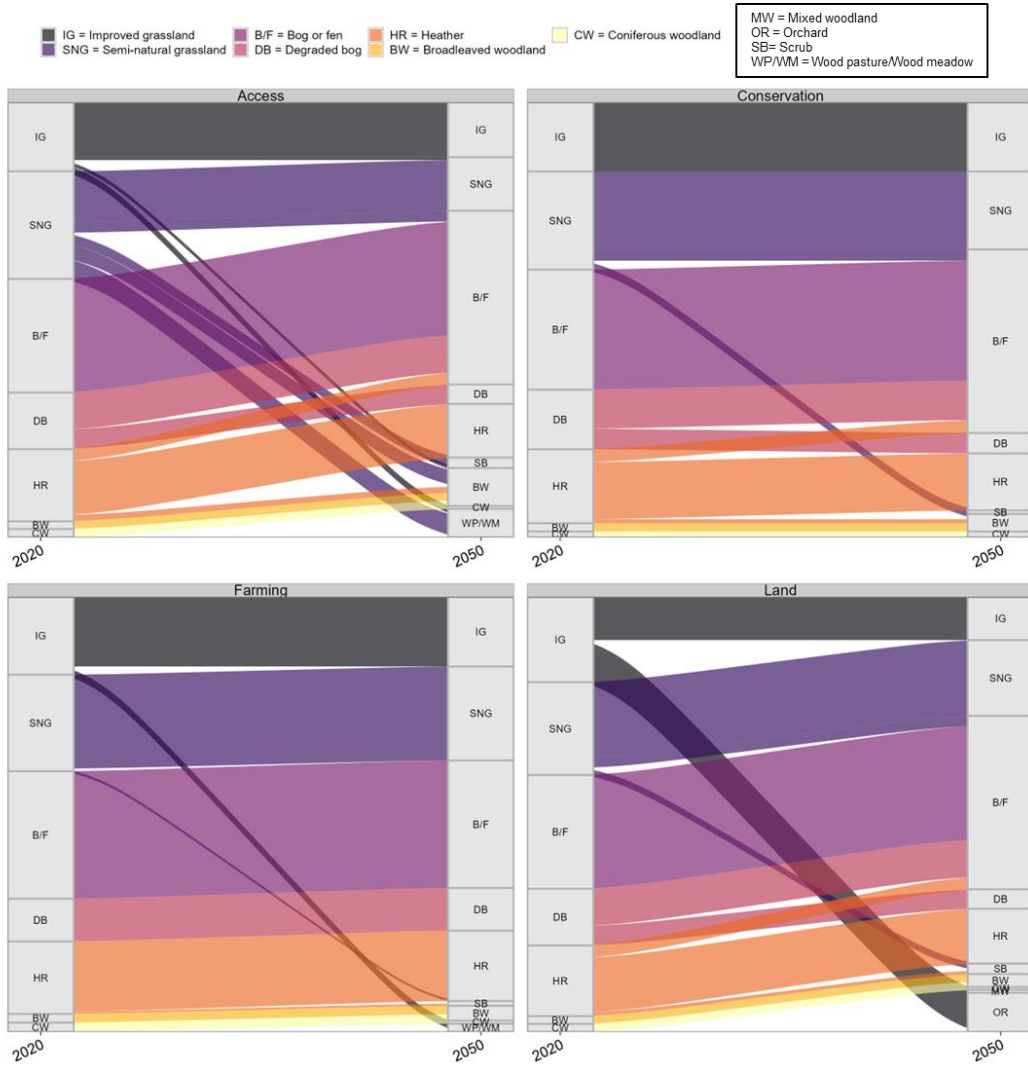
	Bracken slopes: Areas classified as bracken using satellite imagery.
Peatland restoration (2)	In areas of peat soil (unless currently bog), or on areas of degraded bog (defined from NE peat status data and muirburn data).
All planting on unproductive land with least impact on waders (1, 3, 5, 6, 8)	On agricultural land class 4 and 5 only (least agriculturally productive) and not in combined BTO wader zones (wader hotspots).
Replace conifer with broadleaved woodland and expand (6)	Replace where currently coniferous land cover, and then expand within 200m buffer.
Semi-natural grassland (7)	No rules provided, assume on improved grassland only
Wood pasture (8)	No rules provided, assume on semi-natural grasslands only
Alter stocking density (9)	Increase cattle livestock units by 50% and decrease sheep by the same livestock units as the cattle.

SM5: Area (ha) of new interventions for all participatory land use scenarios, by landscape and stakeholder group.

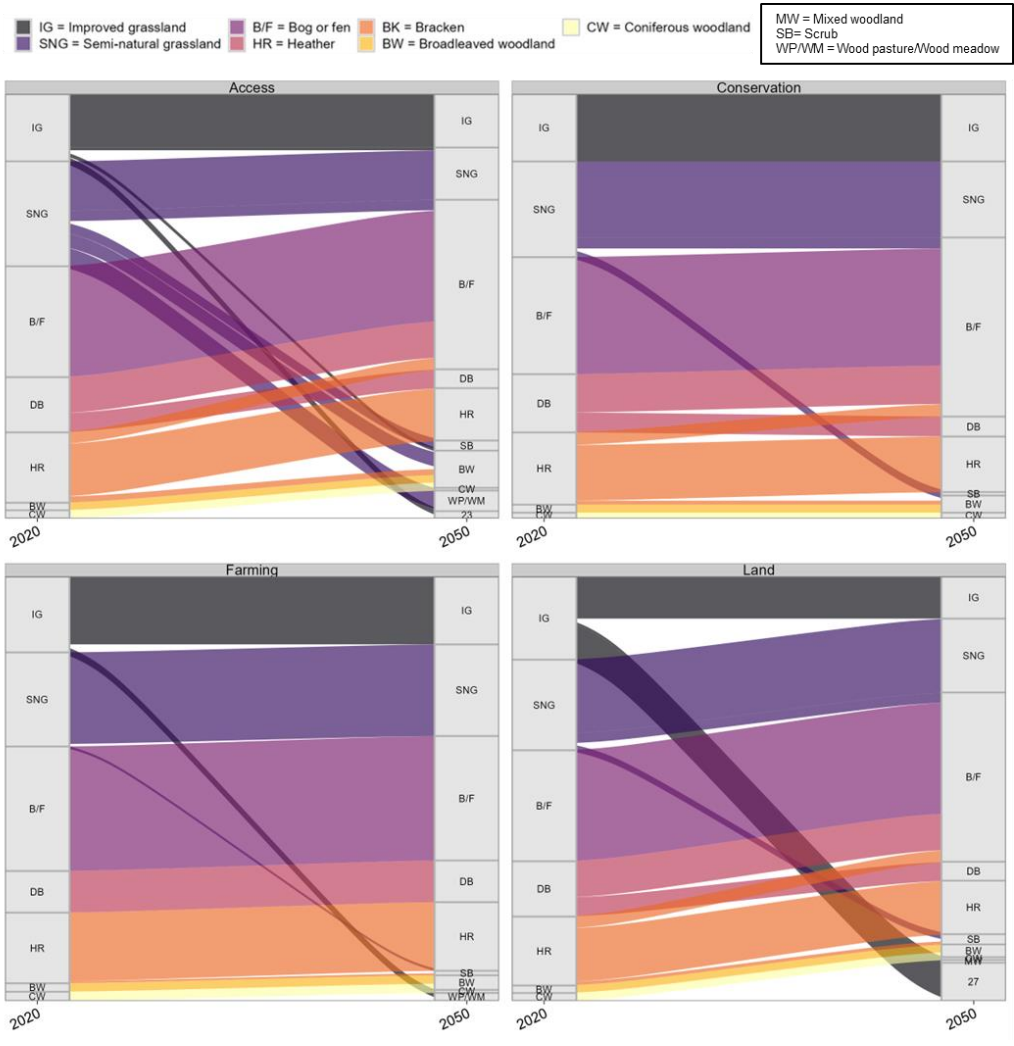


SM6: Land use transitions in participatory land use scenarios in A) North Pennines and Dales and B) the Elenydd. Land cover classes on the left represent the present-day land cover, with future land cover shown on the right. Line thickness is proportional to area of land undergoing transition.

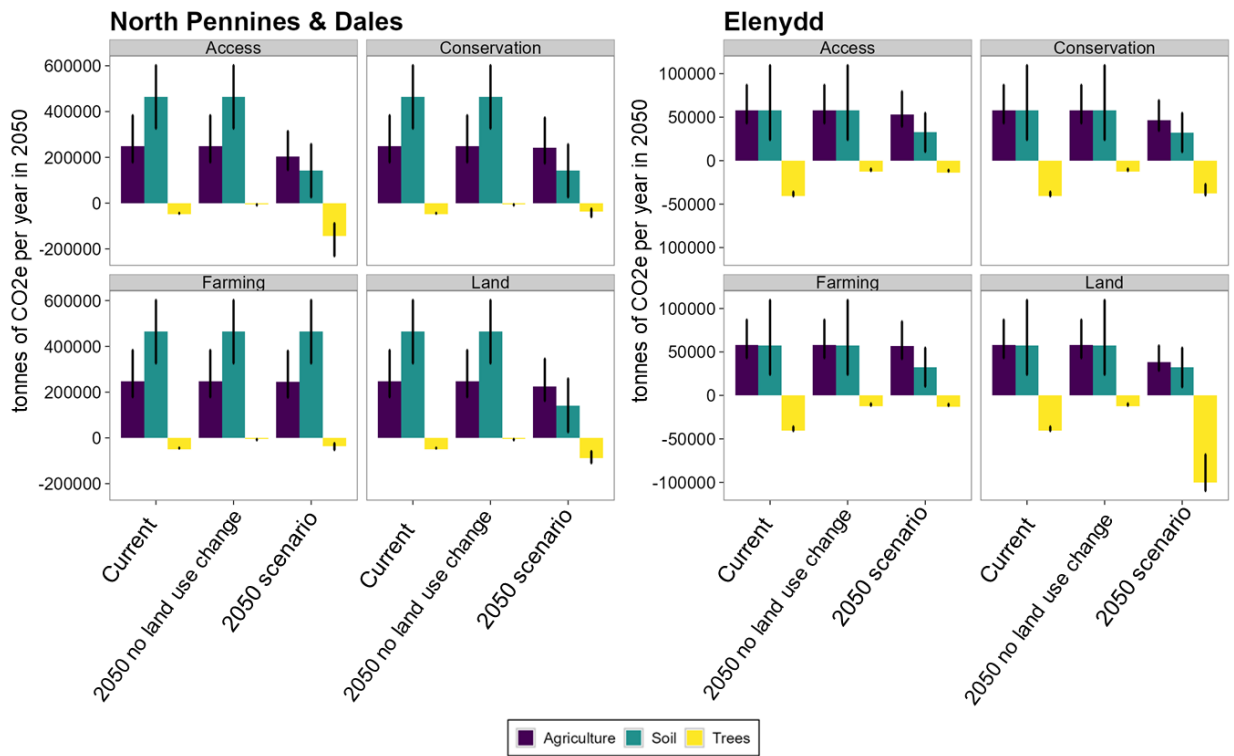
A) North Pennines & Dales



B) Elenydd



SM7: Annual net greenhouse gas emissions for the current landscape, in 2050 with no changes (i.e. no land use change) and 2050 with the participatory scenario. Emissions (tonnes of CO₂e per year in 2050) are split into emissions from agriculture (purple), emissions from soils (turquoise) and sequestration from trees (yellow).



SM8: Predicted changes on individual bird species which make up the upland bird indicator. C.= Carrion Crow, CU = Curlew, L. = Lapwing, MP = Meadow Pipit, OC = Oystercatcher, PW = Pied Wagtail, RG = Red Grouse, S. = Snipe, SC = Stonechat, W. = Wheatear, WC = Whinchat.

