

Table S1. UK CEH Land Cover 2019 classes description. Source: [56]

UK CEH Land Cover Class [56]	UK BAP Broad Habitat [82]	UK CEH Land Cover classes description
Broadleaf woodland (BW)	Broadleaved mixed and yew woodland	BW includes stands of both native and non-native broadleaved trees and yew. Woodlands dominated by coniferous species but with >20% cover by deciduous species are included in this category. BWs are characterised by stands >5 m high with tree cover >20%. Scrub (<5 m) requires a cover >30% for inclusion. Such fine distinctions cannot be made through Sentinel 2 images.
Coniferous woodland (CW)	Coniferous woodland	CW is characterised by vegetation dominated by trees >5m high when mature, which forms a canopy having a cover of >20%. It includes semi-natural stands and plantations and includes both native and non-native coniferous trees.
Arable	Arable and horticulture	Arable includes annual crops, perennial crops such as berries and orchards and freshly ploughed land. This is a very broad due to the spectral confusion between arable and improved grassland.
Improve grassland (IG)	Improved grassland	IG is characterised by vegetation dominated by a few fast-growing grasses such as <i>Lolium</i> spp. and white clover (<i>Trifolium repens</i>), on fertile, neutral soils. IG is typically either managed as pasture or mown regularly for silage production or in non-agricultural contexts for recreation and amenity purposes. Confusion with grass-like crops is likely to occur.
Acid grassland (AG)	Acid grassland	AG can be spectrally variable, depending on dominant. AG is dominated by <i>Molinia caerulea</i> with a distinct signal from more species diverse, mixtures of grasses, rushes, mosses, herbs and sedges.
	Heather	

Dwarf shrub and heath		Dwarf Shrub and Heath is characterised by vegetation that has >25% cover of plant species from the heath family or dwarf gorse <i>Ulex minor</i> . It generally occurs on well-drained, nutrient-poor, acid soils. It is included as heather when there is greater than 25% coverage.
	Heather grassland	
Inland rock	Inland rock	This type covers both natural and artificial exposed rock surfaces which are >0.25ha, such as inland cliffs, caves, screes, and limestone pavements.
Freshwater	Standing open water and canals	The UK CEH Freshwater class comes from merging two BAP broad habitats (Standing Open Water and Canals, and Rivers and Streams) since they cannot be separated by spectra. Water bodies > 0.5 ha and wider than 40m are mapped with very high accuracy.
	Rivers and streams	
Urban	Built-up areas and gardens	Within the Built-up Areas and Gardens BAP Broad Habitat we can reliably separate two UKCEH Land Cover Classes: Urban and Suburban. Urban includes dense urban, such as town and city centres, where there is little, if any, vegetation. Suburban includes suburban areas where the spectral signature is a mix of urban and vegetation signatures.
Suburban		

Table S2. Habitat requirements of 5 studied species (further explanation of Table 3)

Species	Habitat requirement and management of the selected species
<i>Silver-washed fritillary (SWF) butterfly</i>	<p>The silver-washed fritillary (SWF) butterfly is one of the most graceful butterflies in Britain. It is found across southern England and Wales and throughout Ireland. SWF number declined during the twentieth century but has spread significantly in the recent decades (with a range expansion of 56% since the 1970s), thus the SWF is a low conservation priority. SWF is a large powerful flier albeit it is limited to broadleaved woodland, especially oak woodland, with sunny rides (ideally 10-20 m width) and glades and woodland edge. For colonisation purposes, it might require a degree of habitat connectivity and continuity, despite its wide dispersal capability.</p> <p>The SWF adults fly from late June until late August, feeding primarily on flowers such as bramble, and most eggs are laid 1-2 m above ground from mid-July until the end of September. The caterpillar occurs between mid-August</p>

	<p>by end of May. The main caterpillar food is Common Dog-violet (<i>Viola riviniana</i>) which grows in shaded broadleaved woodlands.</p> <p>Good management of woodlands is not only referring to planting trees and visualise the forest as a unitary process. It should take and understand as a complex system where soil, fauna, ancient trees, birds, mammals, insects, and butterflies are interlinked and play an equal role. Good management of a habitat species take many years of research and monitoring of the species habitat and food requirements.</p>
<i>Small blue (SB) butterfly</i>	<p>The Small Blue (SB) is Britain's smallest butterfly and is listed as a species of principal importance for biodiversity conservation under Wildlife and Countryside Act (1981) and Section 41 of the Natural Environment and Rural Communities Act 2006. It has suffered a decline by 44 % across the UK since 1979. In SH AONB the SB distribution is also declining, with the remaining sites become more isolated and remote and now it is found in just 26 locations across the area.</p> <p>The adults fly between mid-May and early July and there may be a second generation towards the end of August. The caterpillar foodplant is Kidney vetch. The SB butterfly is well known as an indicator of healthy chalk grassland which can provide indirectly 'public goods'. Landowners and farmers can maintain and create suitable habitats for SB butterflies through specific land management practices.</p>
<i>Skylark</i>	<p>Skylark is a ground-nesting bird and lives on farmland habitats, both arable land and grassland, and on non-farmland habitats, such as moorland, heath, dunes, and salt marshes. In SH AONB, Skylark favours open and short height vegetation (their choice of nesting site is influenced by the height and density of the crop - the ideal vegetation height is 20-50 cm, can go up to 2 m). Skylark doesn't breed without a good view of predator threat), managed/ grazed grassland and heathland, arable crops. At farmland scale, skylark shows different preferences on the crop usage, crop diversity, and vegetation margins as well as production mode (organic farming) [95].</p> <p>Likewise, [95] show the preferences on crops depending on the Skylark needs. For instance, the most preferred habitats are set-aside, grassland, and spring sown cereal for nesting purposes, while the habitats set-aside, legumes, and grassland are preferred for foraging. Skylark also avoids nesting and feeding close to urban areas and rich soils.</p> <p>Moreover, [96] found a positive correlation between the availability of cereals and regional skylark densities, despite the declines being steepest in regions most associated with agricultural intensification as in eastern and southern Britain [97].</p> <p>Bean and oilseed rape crops were not commonly used to nest in. This is most likely to be due to the fast-growing nature of the crops [98].</p> <p>Murray et al. [99] observed that when winter oat was substituted with winter barley, Skylark showed attraction for nesting, possibly due to the winter oat</p>

		<p>crops growing fast and dense and making the crop area unattractive to nesting birds earlier in the season than winter barley.</p> <p>Another ideal nesting habitat would be in the spring cereals or a spring break crop (other than oilseed rape - which grows too quickly-) in the rotation [99]. Skylarks can also nest in silage fields. However, these nests are only successful if the field is not cut or grazed between early April and the end of May.</p> <p>The 1992 rules for both rotational and non-rotational set-aside allow for field margins, as long as they are at least 20 m wide throughout and cover an area of at least 0.3 ha. Strips within the field would also provide opportunities to establish a favourable habitat for this species. Also, it can act as a buffer zone, provide access for farmers and walkers, boost numbers of beneficial insects, and attract birds and butterflies.</p> <p>Good management of this habitat will result in thriving biodiversity, through increasing the group nesting birds and insect populations, improving soil organic matter and carbon sequestration, reducing leaching of nitrate and other pesticides into the groundwater.</p>
<i>Hazel/ Common dormouse</i>		<p>The hazel dormouse (HD) is a protected species in the UK under the Wildlife and Countryside Act, 1981, UK Post-2010 Biodiversity Framework and listed as a European Protected Species under Annex IV of the European Habitats Directive. It used to be widespread in Britain but has suffered a population decline of 51% since 2000. The dormouse is now confined mostly to southern England and Wales with a patchy distribution.</p> <p>The HD is a nocturnal mammal, which lives in deciduous woodland (preferring yew, rowan, and hazel during ranging), hedgerows and dense scrub, spending most of the time up in the branches and rarely coming down to the ground, in which the female will give birth to up to seven young. They hibernate during the winter months.</p> <p>Studies have shown that the good management of woodland and hedgerows habitats increases the survival of dormice [100], and dormouse populations are resilient and respond positively to woodland management [101-103]. Hence, good habitat management for this species will result in a well-connected network of big and diverse native hedges linking deciduous woodlands across the landscape. This will also benefit a wide range of other species including birds such as yellowhammer and whitethroat, bats such as the barbastelle, butterflies, moths, and many other insects.</p> <p>In contrast, inappropriate or lack of long-term woodland and hedgerow management and fragmentation of woodlands and hedges are thought to be major reasons for this species decline [102].</p>
<i>Dragonflies and Damselflies</i>		<p>According to British Dragonfly Society (BDS) there are around 40 species of dragonflies and damselflies in SH AONB with all having varying habitat requirements but mainly clean and shallow waters, these can be part of a lake,</p>

	<p>pond, river, stream, ditch, or canal although none are likely to be found in moving waters.</p> <p>Their life cycles all consist of an egg, larva, (or nymph) and adult stage although the length of time spent in each stage can also vary greatly between species. Eggs can be laid in plant material, rotten wood, mud, in stream beds or deposited directly into the water. All the British dragonflies develop in water and depending on the species, the larval stage can last from two months to more than five years in the case of the Golden-ringed Dragonfly.</p>
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Table S3. Species habitat requirement and opportunities to create/improve/extend suitable habitat for selected species, Source: Expert consultation and literature in various places

Species	Silver-washed fritillary butterfly	Small blue butterfly	Skylark (nesting)	Hazel dormouse	Dragonflies and Damselflies
Habitat requirements	Mixed deciduous woodland (part managed and not over-dense); Woodland edges with sunny, flowery rides and glades Heather and scrub.	Individual shrubs and paths through scrub/woods. Brownfield sites with calcareous characterises. Presence of Kidney Vetch; High slope degree	Farmland; Arable (ideal crops: spring and winter barley, spring wheat); Grassland; Heather. (Nesting site is also influenced by the height and density of the crop; ideal vegetation height is 20-50 cm, max. 200 cm).	Hedgerows; Farmland Mid-height trees (5-10 m tall); Woodland edges; Scrub	Various wetlands (ditches, brooks, lakes, ponds, canals, etc)
Habitat connectivity	A high degree of habitat continuity for colonisation purposes.	Networks of pale/chalky paths and scrub Low dispersal ability in fragmented habitats.	Depending on agricultural practices within the dispersal movement.	Depending on arboreal canopy continuity and hedgerows connectivity.	These are good colonisers of new habitat when it's restored or created.
Dispersal Movements	Powerful flier: it is restricted by the habitat preferences	It moves relatively large distances; thus, wind can contribute to this ability to move impressive distances.	Short distance (intracontinental/ domestic) migrant Home range 1.08 ha [98]	Up to 500 m [102]; Home range- 5100 m ² [103]	Highly mobile for many species;
Food requirement	Viola (mainly Riviana, Reichenbachiana, Hirta and Odorata)	Kidney Vetch (sole foodplant)	High protein invertebrates, mixed diet of seeds.	Buds, hazelnuts, berries, and insects.	Aerial inverts (adult) Aquatic inverts (larva)

Pressure factors	Deforestation	Strongly linked to the condition of Kidney Vetch Habitat fragmentation; Rabbits and sheep grazing	Pesticides; Predators (Corvids); Recreational disturbances; Intensive grazing and frequent grass cutting regimes.	Habitat fragmentation Predators	Poor water quality; Removal of bankside and aquatic vegetation; Livestock by damaging bankside and aquatic vegetation; Invasive plant species dominating aquatic vegetation; Climate change.
Life history stages/ Life span	Ovum- end of July until mid-September; Larva- mid-August until end of May; Pupa- mid May until end of July; Imago- mid-June until end of August	Ovum- end of May until end of August; Larva- June until end of April; Pupa- April and May; Imago- mid-May to end of August.	Up to 3 years	Around 5 years	Often several years as larva, up to a month as an adult.
Opportunities to create/improve/extend suitable habitat for this species	Creating and managing open rides and glades through the woodland. Thinning to encourage the development of the woodland shrub layer. Restoring/maintaining traditional coppicing rotations.	Overgrazing should always be avoided, especially in the summer and by sheep as these can remove the flower heads of Kidney Vetch (where larvae are feeding as well as destroy roosting sites). Light grazing by livestock in autumn and early winter is ideal, and dominant grasses.	Nests are only successful if the field is not cut or grazed between early April and the end of May. Introduce arable crops on livestock farms (other than maize) to provide feeding and nesting habitat in pastoral areas, ideally untreated. Unsprayed unimproved grasslands and uncut	Restoring overgrown/neglected hedgerows by hedge-laying or coppicing and planting up gaps. Extending the hedge management cycle to allow hedges to allow growing. Planting new hedgerows especially on sites where creation would extend or	Allowing bankside vegetation to develop along rivers, streams, ditches, ponds, etc. Rotational cutting of bankside vegetation in small sections and creating buffer strips around ponds on agricultural land to prevent spray drift from reaching the water.

		<p>Controlling invasive species such as tor grass, stinging nettle, creeping thistle, and common ragwort.</p> <p>Protection from nutrient by fertilisation or agricultural spray drift.</p>	<p>margins left adjacent to hedgerows can provide a good source of insects and added cover when nesting.</p> <p>Well-managed hedgerows that are dense from top-to-bottom and generally not more than 2 m high.</p>	<p>link existing lengths of hedgerow or woodland.</p> <p>Restoring and maintaining hazel coppice rotations in woodland.</p>	<p>Designing new ponds and avoid introducing fish or domestic waterfowl.</p> <p>Avoid the introduction of invasive plant species.</p> <p>Managing trees around a pond to allow more light in and prevent large amounts of leaf litter from entering the water.</p>
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Table S4. Workflow of modelling the habitat suitability and connectivity

Species	Factors	Data used	ArcGIS Tools	Model
Silver-washed fritillary butterfly	Habitat type Broadleaved woodland edge Footpaths	UK CEH LC2019 Open Street map Roads SWF occurrence records (2015-2019)	Reclassify LC Extract Broadleaved woodland Buffer 20 m Broadleaved woodland edge Extract footpaths only that goes through broadleaved woodland	Scoring system 1-5
Small blue butterfly	Habitat type Slope	Priority Habitats Natural England UK CEH LC2019 DEM Small Blue occurrence records (2015-2019)	Reclassify LC Reclassify Slope	Scoring system 1-5
Skylark	Habitat type Crop type Settlements	UK CEH LC2019 UK CEH Crop2019 Skylark occurrence records (2010-2019)	Buffer 100 m around settlements Reclassify LC	Scoring system 1-5
Hazel dormouse	Habitat type	UK CEH LC2019 Dormouse occurrence records (2008-2019)	Reclassify LC	Scoring system 1-5
Dragonflies & Damselflies	Habitat type Watercourse	UK CEH LC2019 OS Open Rivers Dragonfly and Damselfly occurrence records (2010-2019)	Select by Attribute Extract all ditches, brooks Buffer- 20 m Reclassify LC & watercourse	Scoring system 1-5

Table S5. Habitat assessment approach and contribution of VHR satellite imagery

Method	Description
Visual interpretation of VHR satellite data	<p>Farms usually have geometric shapes—circles or rectangles—that stand out against the more random patterns as arable and pasture fields. Also, bodies of water—rivers, lakes, ponds, and streams—are often the simplest features to identify because they tend to have unique shapes and dark colour (water absorbs light), or riparian corridors along streams. Moreover, in a “natural colour” band combination the vegetation can be seen in different shades of green (during spring-summer), so grassland tends to be pale green to grey, depending on how it is managed, and woodlands are in various shades of green, depending on the age. Bare or very lightly vegetated ground is usually seen as a shade of brown or tan. When the ground is white or very pale tan, especially in dried lakebeds, it is because of salt, silicon, or calcium-based minerals. The colour of bare soil also depends on the mineral content and newly burned land can be seen as dark brown or black, but the burn scar fades to brown before disappearing over time. Residential areas, suburban and urban, and other densely built areas are typically silver or grey from the concentration of concrete and other building materials. Some cities have a more brown or red tone depending on the materials used for rooftops.</p> <p>“False colour” composites (Red-B4, Green-B3, Blue-B2) were also used. In these, vegetation appears in shades of red, urban areas are cyan blue, and soils vary from dark to light browns. This is a very commonly used band combination for vegetation studies, monitoring drainage and crop growth, and soil patterns. Coniferous trees appear darker red than broadleaved woodland. Deep red could indicate broadleaf and/or healthier vegetation whilst lighter red is represented by grasslands. Several examples of the imagery used for interpretation are given in Figure S1.</p>
	<p>For the automated approach, we used supervised classification (e.g. maximum-likelihood classification tool) in ArcGIS 10.6.1. The main objective of the image classification procedure is to automatically categorise all pixels in an image into land cover/use classes or themes [107]. Therefore, the main steps in performing supervised classification for our studies areas were as follows: firstly, we prepared the images, projecting them under the same projection (Project Raster or Define Projected Coordinate System: GCS WGS 1984; Projection: WGS 1984)</p>

	<p>to ensure the spatial accuracy of the image, then we created signatures training samples for each habitat/land use category from image and apply to the whole area of interest. The accuracy of this method highly depends on the samples taken for training, thus we sampled over 30 classes (depending on the area size and diversity in features). Finally, apply maximum-likelihood classifier which assigned the pixel to the signature classes that maximizes the probability function. Maximum-likelihood estimation is probably the most popular classifier in remote sensing. It assumes that features associated with each class are distributed according to a Gaussian distribution.</p>
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Figure S1. Examples of VHR satellite data